Westwood Survey Field Notes

Project Name: Tehachapi Transmission Line Survey Project Number: 20062569

Date	Time	Temperature	Weather	Wind	Occ Pt	Inst Height	BS Pt	BS Height	Point Range	Initials
9/27	10:20	60°	Sunny	2 WNW	285	5.40	286	6.77	9001 - 9049	JMP
9/27	11:00	68°	Sunny	3 WNW	286	5.35	285	5.06	9050 - 9101	JMP
9/27	11:50	71°	Sunny	1.5 W	287	5.12	286	6.77	9102 - 9125	JMP
9/27	12:45	73°	Sunny	CALM	288	5.35	286	6.77	9140 - 9163	JMP
9/27	1:25	75°	Sunny	3 WNW	289	5.30	286	6.77	9164 - 9209	JMP
9/27	2:25	76°	Sunny	5 N	290	5.43	291	5.40	9222 - 9276	JMP
9/27	3:13	76°	Sunny	6 N	291	5.67	290	6.77	9276 - 9302	JMP
9/28	9:10	67°	Sunny	5 W	292	5.68	293	6.77	9320 - 9364	JMP
9/28	10:00	69°	Sunny	4 W	293	5.57	292	5.35	9365 - 9413	JMP
9/28	11:30	75°	Sunny	4 W	294	5.52	295	6.77	9414 - 9437	JMP
9/28	11:49	76	Sunny	4 WNW	295	5.46	294	6.87	9438 - 9462	JMP
9/28	1:25	83°	Sunny	2 NNW	297	5.34	298	5.30	9485 - 9508	JMP
9/28	1:50	85°	Sunny	3 NNW	299	5.46	296	6.77	9509 - 9532	JMP
9/28	2:20	86°	Sunny	3 NW	300	5.54	296	6.77	9533 - 9556	JMP
9/28	4:20	83°	Mst Sunny	14 NNW	301	5.63	296	6.77	9571 - 9594	JMP
9/28	5:10	83°	Sunny	10 NNW	302	5.5	296	6.77	9595 - 9618	JMP
9/28	5:35	81°	Sunny	8 N	303	5.4	304	6.77	9619 - 9642	JMP
9/28	6:00	79°	Sunny	10 N	305	5.57	304	6.77	9643 - 9666	JMP
9/29	1:05	61°	Mst Sunny	16 N	307	5.45	304	6.77	9740 - 9755	JMP
9/29	1:35	61°	Mst Sunny	20 N	309	5.38	242	6.77	9756 - 9771	JMP
9/29	1:55	62°	Mst Sunny	16 N	311	5.44	242	6.77	9772 - 9787	JMP
9/30	7:40	39°	Clear	4 E	306	5.03	304	6.77	9788 - 9814	JMP
9/30	7:50	39°	Clear	6 E	307	5.35	304	6.77	9815 - 9838	JMP
9/30	8:15	41°	Clear	5 E	308	5.31	254	4.84	9839 - 9862	JMP
9/30	8:45	43°	Sunny	3 E	309	5.49	242	6.77	9863 - 9886	JMP
9/30	9:15	46°	Sunny	7 E	310	5.63	242	6.77	9887 - 9910	JMP
9/30	9:30	47°	Sunny	6 E	311	5.55	242	6.77	9911 - 9934	JMP
9/30	10:00	48°	Sunny	5 ESE	312	5.60	242	6.77	9935 - 9958	JMP

POLE 27

CONNECTIONS ONLY

2

Westwood Survey Field Notes

Project Name: Tatanka Transmission Line Survey Project Number: 20062569

Date	Time	Temperature	Weather	Wind	Occ Pt	Inst Height	BS Pt	BS Height	Point Range	Initials
9/30	10:25	49°	Sunny	7 ESE	313	5.59	242	6.77	9959-9982	
9/30	11:05	49°	Sunny	4 SSE	314	5.58	319	6.77	9983-10006	
9/30	11:23	54°	Sunny	4 SSE	315	5.41	319	6.77	10007-10037	
9/30	11:37	55°	Sunny	3 SSE	316	5.35	319	6.77	10038-10067	
9/30	11:52	56°	Sunny	6 SSE	317	5.54	319	6.77	10068-10119	
9/30	12:27	57°	Sunny	9 SSE	318	5.53	319	6.77	10120-10142	
9/30	12:50	58°	Sunny	5 SSE	319	5.40	321	6.77	10143-10165	
9/30	1:15	59°	Sunny	4 SSE	320	5.49	321	6.77	10166-10188	
9/30	1:35	59°	Sunny	4 SSE	321	5.50	320	6.77	10189-10211	
9/30	1:57	60°	Sunny	7 S	322	5.50	321	6.77	10212-10234	
9/30	2:16	61°	Sunny	5 S	323	5.36	321	6.77	10235-10260	
9/30	3:50	62°	Sunny	8 S	324	5.54	325	6.77	10261-10286	
9/30	4:25	62°	Sunny	10 S	325	5.44	324	6.77	10287-10311	
10/1	7:15	44°	Clear	11 S	285	5.43	286	6.77	10313-10337	
10/1	7:05	44°	Clear	10 S	326	5.15	286	6.77	10340-10361	
10/1	8:30	45°	Clear	8 S	327	5.52	286	6.77	10362-10383	
10/1	9:00	47°	Sunny	8 S	287	5.33	286	6.77	10384-10405	
10/1	9:25	49°	Sunny	8 S	328	5.41	286	6.77	10406-10427	
10/1	9:45	51°	Sunny	12 S	329	5.50	286	6.77	10428-10449	
10/1	10:20	53°	Sunny	12 S	330	5.57	289	6.77	10450-10471	
10/1	10:50	54°	Sunny	12 S	331	5.45	291	6.77	10472-10493	
10/1	11:20	59°	Sunny	10 S	332	5.47	291	6.77	10494-10515	
10/1	11:55	60°	Sunny	8 S	333	5.39	291	6.77	10516-10537	
10/1	12:30	64°	Sunny	9 S	334	5.56	292	4.55	10538-10558	
10/1	1:00	65°	Sunny	11 S	335	5.59	292	4.55	10559-10581	

TATANKA WIND ENERGY PROJECT - ND

PUBLIC SERVICE COMMISSION PRE-CONSTRUCTION MEETING NO. 00002
Tatanka Project Site
July 13, 2007

MEETING MINUTES

ATTENDEE NAME	COMPANY NAME	ATTENDED
Jerry Lein	Public Service Commission	Y
Ed Englert	Acciona Energy North America Corp.	Y
Todd Wilen	Acciona Energy North America Corp.	Y
Bill Jackson	M.A. Mortenson Company	Y
Matt McCain	M.A. Mortenson Company	Y
Ryan Klug	M.A. Mortenson Company	Y
Roy	Great Southwestern Construction, Inc	Y

ITEM	STATUS	STARTED	DUE	ISSUE(s)	RESPONSIBILITY

In accordance with paragraph 6 of the Commission Orders the project intends to start groundbreaking and construction on Monday July 30, 2007.

Meeting was conducted by Jerry Lein of the PSC. The majority of the meeting was spent discussing the Orders of the Commission.

Discussion Items Per Review of the Orders

ORDER 4

Per this item, Todd Wilen is named the "Tatanka Representative" and Ed Englert is named the "Construction Supervisor".

ORDER 5

Need to email and mail ten (10) copies of Original Permits and Licenses. Also, one copy to be sent to Jerry via email.

OPN

Acciona Energy North America Corp.
Ed Englert

Will mail to:
State of North Dakota Public Service Commission
Attention: Illona Jeffcoat-Sacco, Executive Secretary
State Capitol
12th Floor, Dept 408
600 E. Boulevard Ave.
Bismark, ND 58505-0480

ORDER 6

It was noted that the "Davis House Issue" concerning the distance from the Transmission Line has been resolved.

Format for the weekly update: Mortenson will send to Acciona (Ed/Todd) for review. Acciona will forward to Jerry Lein. The PSC has requested it to include a Progress Report and anticipated activities for the following week.

ITEM	STATUS	STARTED	DUE	ISSUE(s)	RESPONSIBILITY

ORDER 9

Acciona has completed a survey of the area concerning the items referenced in this Order. Mortenson and the Subcontractor working on the construction of the line will continue to look for and report any new findings.

ORDER 15

Replacement for trees and other wooded vegetation has been left up to the discretion of the project to determine methods and results that please all landowners and effected parties.

ORDER 16

The PSC has indicated they are specifically looking for the As-Built Plan and Profile Drawings for this order. This information will be provided at the conclusion of the project.

ORDER 19 **NEW** — **M.A. Mortenson Company** Ryan Klug

Two areas along the line include movements of structures. Updated drawings that portray the moves will be sent in for review and approval.

ORDER 21 **NEW** — **Public Service Commission** Jerry Lein

Need verification from the Commission if they have refunded the Application Fee to Acciona.

OTHER

Discussion took place concerning the yellow guy wire sleeves. Jerry stated that yellow guy wire sleeves were required in "areas exposed to pedestrian traffic and established parking areas". However, Mr. Lein would not object to more extensive use of yellow guy sleeves.

After the meeting, Jerry was able to participate in a driving tour of the proposed Transmission Line route with Matt McCain and Ryan Klug of Mortenson.

cc: John Morrison
cc: Marcus da Cunha

The preceding represents our interpretation of the items discussed and decisions reached during and after this meeting. Please notify us in writing within five (5) working days of receipt of these minutes in the event of any oversight and/or omissions.

Respectfully Submitted,

Dated: 07/21/07

_____

Ryan Klug
Project Engineer

Prepared By: M.A. Mortenson Company

February 27, 2007

Ms. Kimberly J Radermacher
P.O. Box 39—216 Main St
Ellendale, ND 58436

RE: Wind farm construction by Tatanka Wind Power, LLC and its parent company, Acciona Wind Energy USA, LLC.

Dear Ms. Radermacher:

Albertha Township, Dickey County, North Dakota, does not have any zoning restrictions, so we, the supervisors, have determined we have no jurisdiction on private land over the placement of the wind turbines, transmission lines, poles, wires or associated facilities constructed within the township by Tatanka Wind Power, Acciona Wind Energy or any companies involved in its construction.

Sincerely,

Jerry Wagner, Chairman

Barry Holm, Supervisor

Doug Zahn, Supervisor

PRELIMINARY CLASS III CULTURAL RESOURCE INVESTIGATION REPORT FOR TATANKA WIND FARM

December 12, 2006

Westwood Professional Services, Inc.
Steven J. Blondo
Ryan P. Grohnke

10,000 Lakes Archaeology, LLC
Amanda M. Gronhovd, MA, RPA

INTRODUCTION

The team of Westwood Professional Services, Inc. (Westwood) and 10,000 Lakes Archaeology, LLC (10,000 Lakes Archaeology) was retained by Acciona Wind Energy U.S.A. to conduct a cultural resource assessment for the Tatanka Wind Power Project in Dickey and McIntosh Counties, North Dakota and McPherson County, South Dakota (Exhibit 1). The proposed project consists of approximately 120 turbine locations, a 12-mile transmission line, and associated access roads and buried cable corridors. The Area of Potential Effect (APE) involves parcels with a land area of approximately 55 square miles or a total of approximately 35,200 acres. The parcels within the APE are located in Sections 17 through 24, and 26 through 34 of Township 129N, Range 66W; Section 19 of Township 129N, Range 65W; and Sections 1 through 18, 20 through 22, and 29 of Township 128N, Range 68W. These sections fall within Albertha, Bertsimas, Coldwater and Spring Valley Townships in Dickey and McIntosh Counties, North Dakota and Wacker Township in McPherson County, South Dakota. The project area consists primarily of range land and agricultural land with widely scattered farmsteads.

CLASS I CULTURAL RESOURCE LITERATURE SEARCH

During the weeks of August 14th and September 4th, Westwood Cultural Resource Specialist Ryan Grohnke conducted a background literature search of previously recorded sites and surveys at the North Dakota Heritage Center in Bismarck, North Dakota. The State Archaeological Research Center in Rapid City, SD also conducted a similar search for previously recorded sites in the South Dakota portion of the project area. Sixteen previously recorded or reported sites and site leads were found within or near the APE. There have been few areas previously surveyed within the proposed project location. Based on the number of sites present, it appears as though the project area has a relatively high potential for containing unrecorded archaeological sites. The literature search that was performed satisfied requirements for a Class I Literature Search in North Dakota and a Level I Records Search in South Dakota.

A field visit to the project area was also conducted to assess the potential for other unrecorded sites in the APE. Observations of the terrain, along with landowner

discussions, suggest a moderate to high potential for cultural resources throughout the Tatanka Wind Farm APE.

The proposed transmission line has an APE consisting of a 1.2-mile-wide corridor (10% of transmission line length, as required by North Dakota Law), which was also assessed during the Class I Cultural Resource Investigation. This investigation involved a literature search and a field visit.

PROPERTIES LOCATED

During the background literature search, a number of cultural resources were found within the APE. Only a small portion of the APE has been field surveyed for cultural resources. Locations that have been formally surveyed generated a high density of archaeological sites. Sites located within one mile of the proposed APE are outlined in Tables 1 and 2.

Table 1. Confirmed and Reported Archaeological Sites

Number	Site Name	Sec/Twp/Range	Site Description
32DI0045	N/A	Sec 28-T129-R66	Lithic Scatter
32DIX0077	N/A	Sec 29-T129-R66	Pits
32DIX0136	N/A	Sec 29-T129-R66	Stone Circles
32DIX0001	Hart's Gulch Old Trail	Sec 19-T129-R65	Foundation, Depression
32DI0014	Hart's Gulch Indian	Sec 19-T129-R65	Grave
32DIX0015	Hart's Gulch Remains	Sec 19-T129-R65	Foundation, Depression
32DIX0137	N/A	Sec 15-T129-R66	Stone Circle
32DIX0107	N/A	Sec 18-T129-R65	Buffalo Jump
32DIX0120	N/A	Sec 18-T129-R65	Stone Circle, Hearth
32DIX0113	Pedder Johnson Farmstead	Sec 13-T129-R66	Grave, Artifact Scatter
39MP0003	Lendell's Petroglyph	Sec 12-T128-R68	Petroglyph
39MP0004	N/A	Sec 11-T128-R68	Petroglyph

Table 2. Historic Properties

Number	Sec/Twp/Range	Site Description
32MT0026	Sec 24-T129-R67	Farmstead
32DIX0019	Sec 29-T129-R66	Wolff Post Office
32DIX0018	Sec 5-T129-R66	Albertha Post Office
32DIX0140	Sec 30-T129-R66	Township Hall

The initial visit to the project area revealed generally rolling to large hills in the north. This area is typically grass-covered rangeland with low to no surface visibility. The southern portion of the project area consists of relatively flat uplands. These uplands are either grassland pasture with little to no surface visibility or agricultural land whose visibility depends on the particular crop and time of the farming season. The far northeastern portion of the project area is a coteau with gulches formed by tributaries of the Elm River (which eventually drains into the James River). The entire area is dotted with sloughs, small lakes, and potholes. Many of these locations either currently or historically contained large amounts of water sufficient to support local habitation. The

area generally has high to moderate potential for containing previously unrecorded cultural resources.

During the initial visit to the project area, a historic cemetery dating from at least 1915-1990 and a precontact archaeological site consisting of two flakes, two pieces of cobble, and a quartz shatter were observed in the SW¼ of T128N, R68W, Section 16. An isolated heat-treated chert flake was also observed in a cut bank in the NE¼ of T128N, R68W, Section 17. These resources were found in locations not identified in SHPO records.

Discussions with landowners revealed the possibility of a burial in the Grapevine Hills. The Grapevine Hills are a line of large hills located in the NE¼ of T129N, R66W, Section 29. Landowners also informed archaeologists of stone rings in the S½ of T129N, R66W, Section 32, and spoke of several unrecorded archaeological sites from which artifacts, including projectile points and stone tools, have been collected.

CLASS III CULTURAL RESOURCE SURVEY – IDENTIFICATION

An Archaeological Resource Protection Act (ARPA) Permit (Exhibit 2) was applied for and obtained from the U.S. Fish and Wildlife Service (USFWS). The USFWS have jurisdiction over a number of wetland and grassland easement properties within the APE. Because of the federal involvement, cultural resource work on these easement properties falls under Section 106 of the National Historic Preservation Act (NHPA).

Initially, 54 possible archaeological or historical sites were located during the Class III Survey. Upon further investigation of revised turbine and road siting plans, 33 possible archaeological or historical sites could potentially be impacted by the project (Table 3). However, the number of potentially impacted sites may change as refinements are made to site plans.

Table 3. Potentially Impacted Sites found during Class III Survey

Field Number	Artifact type	Sec/Twp/Range	Easement
FN# 4	Lithic Scatter	Sec 18-T130-R66	None
FN# 9	Lithic Scatter	Sec 7-T129-R66	None
FN# 12	Possible Cairn	Sec29-T129-R66	Wetland?
FN# 13	Possible Cairn	Sec29-T129-R66	Wetland?
FN# 14	Rock Alignment	Sec29-T129-R66	Wetland?
FN# 15	Rock Feature	Sec29-T129-R66	Wetland?
FN# 16	Possible Petroform	Sec29-T129-R66	Wetland?
FN# 17	Possible Petroform	Sec29-T129-R66	Wetland?
FN# 18	Rock Feature	Sec29-T129-R66	Wetland?
FN# 24	Historic Foundation	Sec29-T129-R66	Wetland?
FN# 26	Lithic Scatter	Sec12-T128-R68	None
FN# 27	Rock Alignment	Sec24-T129-R66	None
FN# 28	Isolated Lithic	Sec24-T129-R66	None
FN# 29	Historic Foundation	Sec33-T129-R66	None

Table 3. Potentially Impacted Sites found during Class III Survey

Field Number	Artifact type	Sec/Twp/Range	Easement
FN# 30	Rock Alignment	Sec33-T129-R66	None
FN# 31	Historic Foundation	Sec34-T129-R66	None
FN# 33	Possible Cairns/Rock Alignments/Historic Foundations	Sec24-T129-R66	None
FN# 35	Stone Circle	Sec9-T128-R68	None
FN# 36	Stone Circle	Sec9-T128-R68	None
FN# 37	Stone Circle/Cairn	Sec9-T128-R68	None
FN# 38	Stone Circles	Sec9-T128-R68	None
FN# 40	Stone Circles	Sec9-T128-R68	None
FN# 41	Possible Cairn	Sec26-T129-R66	Wetland/Grassland
FN# 42	Possible Cairn	Sec26-T129-R66	Wetland/Grassland
FN# 43	Possible Cairn	Sec14-T128-R68	Wetland
FN# 44	Historic Foundation	Sec14-T128-R68	Wetland
FN# 45	Historic Foundation	Sec14-T128-R68	Wetland
FN# 47	Possible Cairn	Sec23-T129-R69	Wetland
FN# 49	Historic Foundation	Sec34-T129-R66	Wetland/Grassland
FN# 50	Possible Cairn	Sec34-T129-R66	Wetland/Grassland
FN# 52	Lithic Scatter	Sec29-T129-R66	Wetland
FN# 53	Lithic Scatter	Sec21-T129-R66	Wetland
FN# 54	Isolated Lithic	Sec21-T129-R66	None

TRANSMISSION LINE CORRIDOR AND PROPOSED ROUTE

A pedestrian survey of the centerline of the transmission line corridor was conducted in transects no greater then 15 meters apart. High potential areas on land leased by Acciona within one-half mile of the center line were also surveyed. Two possible sites were located during this survey: FN#4 and FN#9.

A shovel test was placed at each proposed pole location within the proposed transmission line corridor. These shovel tests did not locate any previously unrecorded archaeological sites.

PROPOSED SUBSTATION LOCATIONS

The northern substation is located in a plowed agricultural field. An intensive pedestrian survey of this area was conducted in one-meter transects. The southern substation is located in grassland. A grid of nine shovel tests was excavated at 15-meter intervals in the vicinity of the proposed southern substation. All investigations at both the northern and southern substations were devoid of cultural materials, and did not locate any previously unrecorded archaeological sites.

TURBINE LOCATIONS, ACCESS ROADS, AND CABLE ROUTES

A pedestrian survey of the proposed road access and cable routes was completed. This survey was conducted in transects spaced no greater than 15 meters apart. Twenty-six possible archaeological and historical sites were located during the pedestrian survey.

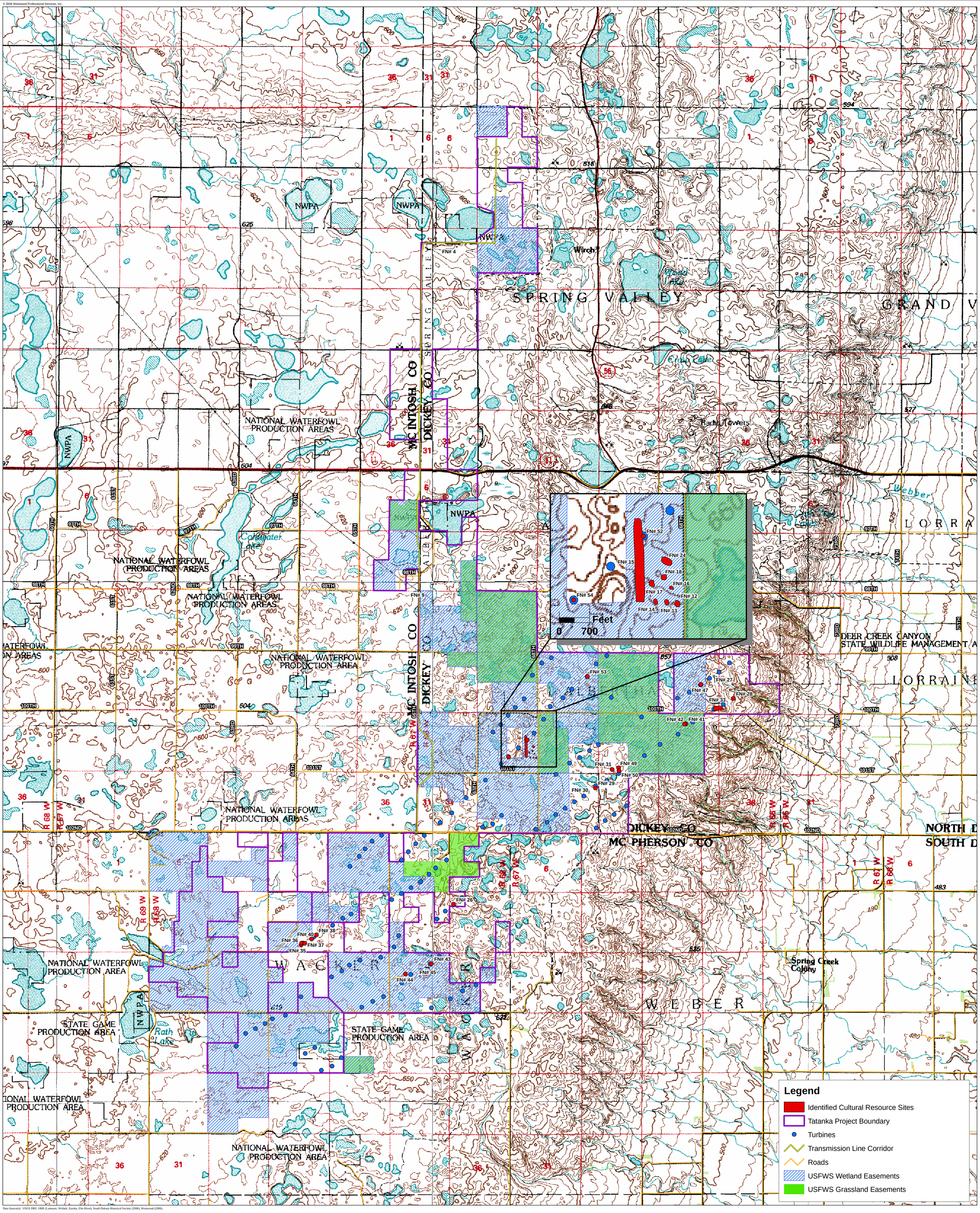
A single shovel test was also excavated within the footprint of each of the proposed turbine locations, and a pedestrian survey was conducted within the 150-foot construction radius of each of the proposed turbine locations. Five of these shovel tests located at turbines ND21, ND47, ND49, ND55, and SD38 yielded archaeological materials.

CONCLUSION

Thirty-three archaeological and historic sites could potentially be impacted by the proposed construction of the Tatanka Wind Farm. However, the number of potentially impacted sites may change as refinements are made to site plans. Archaeological and historic features should be avoided during construction, if possible. Sites containing lithics should undergo additional subsurface testing to determine the site limits and potential eligibility for the National Register of Historic Places (NRHP).

Cultural resources within the project APE and located on United States Fish and Wildlife grassland or wetland easements may require further evaluation or mitigation under Section 106 of the National Historic Preservation Act. A final Class III Cultural Resource Investigation Report with detailed analysis and formal recommendations will be forthcoming. Any new or revised turbine, road, or supporting structure locations not previously surveyed should be examined for the presence of cultural resources.

© 2006 Westwood Professional Services, Inc.



Data Source(s): USGS DRG 100K (Lamoure, Wishek, Eureka, Elm River), South Dakota Historical Society (2006), Westwood (2006).

N

0 0.5 Miles

Legend

- Identified Cultural Resource Sites
- Tatanka Project Boundary
- Turbines
- Transmission Line Corridor
- Roads
- USFWS Wetland Easements
- USFWS Grassland Easements

Tatanka Wind Farm

McIntosh and Dickey Counties, North Dakota & McPherson County, South Dakota

Identified Cultural Resource Sites

Westwood Professional Services, Inc.
7699 Anagram Drive
Eden Prairie, MN 55344
PHONE 952-937-5150
FAX 952-937-5822
TOLL FREE 1-888-937-5150
www.westwoodps.com
Westwood

Map Document: (P:\2006\25\gis\d2006259\cm\01E_PN.mxd)
12/12/2006 - 6:21:12 PM

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

IN REPLY REFER TO:

NWRS/Arts & Cultural
HB 10
Mail Stop 60130

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225-0486

STREET LOCATION:
134 Union Blvd.
Lakewood, Colorado 80228-1807

NOV 0 3 2006

RECEIVED
NOV 10 2006
WESTWOOD
PROFESSIONAL SERVICES

Mr. Steven Blondo
Westwood Professional Services, Inc.
7699 Anagram Drive
Eden Prairie, MN 55344

Dear Mr. Blondo:

Enclosed is an Archaeological Resource Protection Act (ARPA) permit for a Westwood Professional Services, Inc. project on U.S. Fish and Wildlife Service easements and Waterfowl Production Areas in McIntosh and Dickey Counties, North Dakota and McPherson County, South Dakota. The survey is for the proposed Tatanka Wind Farm and includes 120 turbines with 12 miles of transmission lines. The legal locations for the survey are:

Township 129 north, Range 66 west, Sections 17-24, 26-34
Township 129 north, Range 65 west, Section 19
Township 128 north, Range 68 west, Sections 1-18, 20-22, 29

It is the responsibility of the ARPA permit holder to obtain permission from the private landowners to access these easements.

Please sign the enclosed permit, keep the original and send us a photocopy of the signed version. Let me know if you have any questions or concerns.

Sincerely,

Meg Van Ness

Meg Van Ness
Regional Archaeologist
303-236-8103
Meg_VanNess@FWS.gov

Enclosure: ARPA Permit FWS-R5-07-003

Please use this number
when referring to this permit

No.: FWS.R6.07.003

DI Form 1991 (Rev Sept 2004)
OMB No. 1024-0037
Exp. Date (11/30/2007)

United States Department of the Interior

PERMIT FOR ARCHEOLOGICAL INVESTIGATIONS

To conduct archeological work on Department of the Interior lands and Indian lands under the authority of:

X The Archaeological Resources Protection Act of 1979 (16 U.S.C. 470aa-mm) and its regulations (43 CFR 7).
☐ The Antiquities Act of 1906 (P.L. 59-209; 34 Stat. 225, 16 U.S.C. 431-433) and its regulations (43 CFR 3).
☐ Supplemental regulations (25 CFR 262) pertaining to Indian lands.
☐ Bureau-specific statutory and/or regulatory authority: _____

1. Permit issued to
Westwood Professional Services, Inc.

2. Under application dated (received at USFWS)
27 October 2006

3. Address
7699 Anagram Drive
Eden Prairie, MN 55344

4. Telephone number
952-937-5150

5. E-mail address
StevenBlondo@westwoodps.com

6. Contact at Agency Issuing Permit
Meg Van Ness, Regional Historic preservation Officer
US Fish and Wildlife Service, Region 6, Denver
Telephone number:
303.236.8103
Email address:
Meg_VanNess@fws.gov

7. Name of Principal Investigator
Amanda Gronhovd
10,000 Lakes Archaeology, Inc.
Telephone number:
612-670-6431
Email address:
Gronhovd@10000LakesArchaeology.com

8. Name of Field Director authorized to carry out field projects
Steven Blondo
Telephone number:
952-697-5709 612-418-3831 (cell)
Email address:
StevenBlondo@westwoodps.com

9. Activity authorized
Cultural resource survey and limited testing

10. On lands described as follows
USFWS easements and WPAs administered by Sand Lake NWR and Kulm WMD:
Township 129 north, Range 66 west, Sections 17-24, 26-34
Township 129 north, Range 65 west, Section 19
Township 128 north, Range 68 west, Sections 1-18, 20-22, 29
McIntosh and Dickey Counties, North Dakota and McPherson County, South Dakota

For the following project
Tatanka Wind Farm: 120 turbines and 12 miles of transmission lines

11. During the duration of the project
Expected Fieldwork: From: November 1, 2006 To: December 31, 2006
Permit Valid: From: November 1, 2006 To: June 1, 2007

12. Name and address of the curatorial facility in which collections, records, data, photographs, and other documents resulting from work under this permit shall be deposited for permanent preservation on behalf of the United States Government.
This is a no-collection project.

13. Permittee is required to observe the listed standard permit conditions and the special permit conditions attached to this permit.

14. Signature and title of approving official
Ron Edwards
U.S. Fish and Wildlife Service, Region 6

15. Date
Oct. 27, 2006

15. Standard Permit Conditions

a. This permit is subject to all applicable provisions of 43 CFR Part 3, 43 CFR 7, and 25 CFR 262, and applicable departmental and bureau policies and procedures, which are made a part hereof.

b. The permittee and this permit are subject to all other Federal, State, and local laws and regulations applicable to the public lands and resources.

c. This permit shall not be exclusive in character, and shall not affect the ability of the land managing bureau to use, lease or permit the use of lands subject to this permit for any purpose.

d. This permit may not be assigned.

e. This permit may be suspended or terminated for breach of any condition or for management purposes at the discretion of the approving official, upon written notice.

f. This permit is issued for the term specified in 11 above.

g. Permits issued for a duration of more than one year must be reviewed annually by the agency official and the permittee.

h. The permittee shall obtain all other required permit(s) to conduct the specified project.

i. Archeological project design, literature review, development of the regional historic context framework, site evaluation, and recommendations for subsequent investigations must be developed with direct involvement of an archeologist who meets the Secretary of the Interior's Standards for Archeology and Historic Preservation; fieldwork must be generally overseen by an individual who meets the Secretary of the Interior's Standards for Archeology and Historic Preservation.

j. Permittee shall immediately request that the approving official (14. above) make a modification to accommodate any change in an essential condition of the permit, including individuals named and the nature, location, purpose, and time of authorized work, and shall without delay notify the approving official of any other changes affecting the permit or regarding information submitted as part of the application for the permit. Failure to do so may result in permit suspension or revocation.

k. Permittee may request permit extension, in writing, at any time prior to expiration of the term of the permit, specifying a limited, definite amount of time required to complete permitted work.

l. Any correspondence about this permit or work conducted under its authority must cite the permit number. Any publication of results of work conducted under the authority of this permit must cite the approving bureau and the permit number.

m. Permittee shall submit a copy of any published journal article and any published or unpublished report, paper, and manuscript resulting from the permitted work (apart from those required in items q. and s., below), to the approving official and the appropriate official of the approved curatorial facility (item 12 above).

n. Prior to beginning any fieldwork under the authority of this permit, the permittee, following the affected bureau's policies and procedures, shall contact the field office manager responsible for administering the lands involved to obtain further instructions.

o. Permittee may request a review, in writing to the official concerned, of any disputed decision regarding inclusion of specific terms and conditions or the modification, suspension, or revocation of this permit, setting out reasons for believing that the decision should be reconsidered.

p. Permittee shall not be released from requirements of this permit until all outstanding obligations have been satisfied, whether or not the term of the permit has expired. Permittee may be subject to civil penalties for violation of any term or condition of this permit.

15. Standard Permit Conditions (continued)

q. Permittee shall submit a preliminary report to the approving official within a timeframe established by the approving official, which shall be no later than 6 weeks after the completion of any episode of fieldwork, setting out what was done, how it was done, by whom, specifically where, and with what results, including maps, GPS data, an approved site form for each newly recorded archeological site, and the permittee's professional recommendations, as results require. If other than 6 weeks, the timeframe shall be specified in Special Permit Condition p. Depending on the scope, duration, and nature of the work, the approving official may require progress reports, during or after the fieldwork period or both, and as specified in Special Permit Condition r.

r. Permittee shall submit a clean, edited draft final report to the agency official for review to insure conformance with standards, guidelines, regulations, and all stipulations of the permit. The schedule for submitting the draft shall be determined by the agency official.

s. Permittee shall submit a final report to the approving official not later than 180 days after completion of fieldwork. Where a fieldwork episode involved only minor work and/or minor findings, a final report may be submitted in place of the preliminary report. If the size or nature of fieldwork merits, the approving official may authorize a longer timeframe for the submission of the final report as specified in Special Permit Condition q.

t. Two copies of the final report, a completed NTIS Report Documentation Page (SF-298), available at http://www.ntis.gov/pdf/rdpform.pdf, and a completed NADB-Reports Citation Form, available at http://www.cr.nps.gov/aad/tools/nadbform_update.doc, will be submitted to the office issuing the permit.

u. The permittee agrees to keep the specific location of sensitive resources confidential. Sensitive resources include threatened species, endangered species, and rare species, archeological sites, caves, fossil sites, minerals, commercially valuable resources, and sacred ceremonial sites.

v. Permittee shall deposit all artifacts, samples and collections, as applicable, and original or clear copies of all records, data, photographs, and other documents, resulting from work conducted under this permit, with the curatorial facility named in item 12, above, not later than 90 days after the date the final report is submitted to the approving official. Not later than 180 days after the final report is submitted, permittee shall provide the approving official with a catalog and evaluation of all materials deposited with the curatorial facility, including the facility's accession and/or catalog numbers.

w. Permittee shall provide the approving official with a confirmation that museum collections described in v. above were deposited with the approved curatorial facility, signed by an authorized curatorial facility official, stating the date materials were deposited, and the type, number and condition of the collected museum objects deposited at the facility.

x. Permittee shall not publish, without the approving official's prior permission, any locational or other identifying archeological site information that could compromise the Government's protection and management of archeological sites.

y. For excavations, permittee shall consult the OSHA excavation standards which are contained in 29 CFR §1926.650, §1926.651 and §1926.652. For questions regarding these standards contact the local area OSHA office, OSHA at 1-800-321-OSHA, or the OSHA website at http://www.osha.gov.

z. Special permit conditions attached to this permit are made a part hereof.

16. Special Permit Conditions

X a. Permittee shall allow the approving official and bureau field officials, or their representatives, full access to the work area specified in this permit at any time the permittee is in the field, for purposes of examining the work area and any recovered materials and related records.

X b. Permittee shall cease work upon discovering any human remains and shall immediately notify the approving official or bureau field official. Work in the vicinity of the discovery may not resume until the authorized official has given permission.

X c. Permittee shall backfill all subsurface test exposures and excavation units as soon as possible after recording the results, and shall restore them as closely as reasonable to the original contour.

X d. Permittee shall not use mechanized equipment in designated, proposed, or potential wilderness areas unless authorized by the agency official or a designee in additional specific conditions associated with this permit.

X e. Permittee shall take precautions to protect livestock, wildlife, the public, or other users of the public lands from accidental injury in any excavation unit.

X f. Permittee shall not conduct any flint knapping or lithic replication experiments at any archeological site, aboriginal quarry source, or non-site location that might be mistaken for an archeological site as a result of such experiments.

X g. Permittee shall perform the fieldwork authorized in this permit in a way that does not impede or interfere with other legitimate uses of the public lands, except when the authorized officer specifically provides otherwise.

X h. Permittee shall restrict vehicular activity to existing roads and trails unless the authorized officer provides otherwise.

X i. Permittee shall keep disturbance to the minimum area consistent with the nature and purpose of the fieldwork.

X j. Permittee shall not cut or otherwise damage living trees unless the authorized officer gives permission.

X k. Permittee shall take precautions at all times to prevent wildfire. Permittee shall be held responsible for suppression costs for any fires on public lands caused by the permittee's negligence. Permittee may not burn debris without the authorized officer's specific permission.

X l. Permittee shall conduct all operations in such a manner as to prevent or minimize scarring and erosion of the land, pollution of the water resources, and damage to the watershed.

X m. Permittee shall not disturb resource management facilities within the permit area, such as fences, reservoirs, and other improvements, without the authorized officer's approval. Where disturbance is necessary, permittee shall return the facility to its prior condition, as determined by the authorized officer.

X n. Permittee shall remove temporary stakes and/or flagging (not including site datum), which the permittee has installed, upon completion of fieldwork.

X o. Permittee shall clean all camp and work areas before leaving the permit area. Permittee shall take precautions to prevent littering or pollution on public lands, waterways, and adjoining properties. Refuse shall be carried out and deposited in approved disposal areas.

☐ p. Permittee shall submit the preliminary report within _____ days/weeks of completion of any episode of fieldwork.

X q. Permittee shall submit the final report within 6 months after completion of fieldwork.

☐ r. Permittee shall submit progress reports every _____ months over the duration of the project.

☐ s. Additional special permit conditions are attached.

Special Permit Conditions	
By signing below, I, the Principal Investigator, acknowledge that I have read and understand the Permit for Archeological Investigations and agree to its terms and conditions as evidenced by my signature below and initiation of work or other activities under the authority of this permit.	
Signature and title:	Date:

Paperwork Reduction Act and Estimated Burden Statement: This information is being collected pursuant to 16 U.S.C. 470cc and 470mm, to provide the necessary facts to enable the Federal land manager (1) to evaluate the applicant's professional qualifications and organizational capability to conduct the proposed archeological work; (2) to determine whether the proposed work would be in the public interest; (3) to verify the adequacy of arrangements for permanent curatorial preservation, as United States property, of specimens and records resulting from the proposed work; (4) to ensure that the proposed activities would not be inconsistent with any management plan applicable to the public lands involved; (5) to provide the necessary information needed to complete the Secretary's Report to Congress on Federal Archeology Programs; and (6) to allow the National Park Service to evaluate Federal archeological protection programs and assess compliance with the Archaeological Resources Protection Act of 1979 (16 U.S.C. 470). Submission of the information is required before the applicant may enjoy the benefit of using publicly owned archeological resources. To conduct such activities without a permit is punishable by felony-level criminal penalties, civil penalties, and forfeiture of property. A federal agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number. Public reporting for this collection of information is estimated to average one hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Departmental Consulting Archeologist; NPS; 1849 C Street, NW (2275); Washington, DC 20240-0001.

13.31

UTILITY OCCUPANCY APPLICATION AND PERMIT COPY

North Dakota Department of Transportation, Design Division
SFN 7995 (Rev. 05-2004)

Document No. _____ (FOR STATE USE ONLY) Permit No. 21297

APPLICANT INFORMATION

Owner of Facility: Tatanka Wind Power, LLC	City: Chicago	State: IL	Zip Code: 60606	
Mailing Address: 101 North Wacker Drive, Suite 610				Telephone Number: 312-673-3003
Owner's Agent	City	State	Zip Code	Telephone Number
Owner's Contractor: M. A. Mortenson Company	City: Minneapolis	State: MN	Telephone Number: 763-287-5565	

LOCATION NO. 1 (FOR STATE USE ONLY) Begin Ref. Point _____ End Ref. Point _____

Highway No. 11 ☐ Along or ☒ Across Lanes of traffic ☒ 2 ☐ 4

Direction ☐ N ☐ S ☐ E ☐ W Begin _____ feet from reference marker _____

Direction ☐ N ☐ S ☐ E ☐ W End _____ feet from reference marker _____

☐ N ☐ S ☐ E ☒ W from city of _____ or 1 miles from junction highway 56

TYPE OF FACILITY (Complete appropriate spaces only.)

Description of Proposed Facility

230 kV Electric power transmission line from the Tatanka Wind Energy project. The power lines cross at about 50 feet above the surface of the road at Highway 11, NEAR 66TH AVE. IN DICKEY COUNTY.

Size of Facility	Number of Cables	Length of Down Guys
Pipeline Pressure	Size of Casing	Length of Casing
Location of Pole(s)	Location of Appurtenances	Location - Others

TERMS AND CONDITIONS: Installation and maintenance of said facilities on highway right of way shall be subject to the North Dakota Department of Transportation's (NDDOT's) "*A Policy for Accommodation of Utilities on State Highway Right of Way*", current edition, and the following terms and conditions, attached hereto and made a part hereof.

(A) Installation/maintenance of said facilities shall be done in a manner satisfactory to the NDDOT district engineer.
(B) Owner shall notify the NDDOT district engineer forty-eight (48) hours prior to installing, maintaining, relocating, or removing said facilities. All disturbed areas shall be restored to their original condition in a manner satisfactory to the NDDOT district engineer.
(C) The Risk Management Appendix, attached, is hereby incorporated and made a part of this agreement.
(D) Owner shall repair or replace highway structures and appurtenances, and any existing facilities located on, over, or under highway right of way, which may be damaged as a result of the installation and maintenance of said facilities on highway right of way.
(E) Owner shall promptly remove said facilities from highway right of way, or shall relocate or adjust said facilities, at its sole cost and expense when requested to do so by NDDOT.
(F) NDDOT specifically reserves the right to revoke, or change the terms and conditions of, this Permit with or without cause and upon notice to the Owner.
(G) The installation shall be completed on or before Nov 15, 2007

5/11/2007
DATE

OWNER'S SIGNATURE

The Owner is hereby granted permission to install and maintain the facilities applied for, as shown on the plans attached hereto and made a part hereof. Approved by NDDOT this 6th day of June, 2007.

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

John E. Thompson
DISTRICT ENGINEER (TYPE OR PRINT)

SIGNATURE

RECEIVED
MAY 29 2007
VALLEY CITY DIST.
ND DOT

STATE OF NORTH DAKOTA

PUBLIC SERVICE COMMISSION

Tatanka Wind Power, LLC
230 kV Transmission Line/Dickey & McIntosh Counties
Siting Application

Case No. PU-06-443

FINDINGS OF FACT, CONCLUSIONS OF LAW, AND ORDER

March 21, 2007

Appearances

Commissioners Susan E. Wefald, Tony Clark and Kevin Cramer.

John W. Morrison, Attorney-at-Law, Fleck, Mather & Strutz, Ltd., 400 East Broadway, Suite 600, Bismarck, North Dakota 58502, on behalf of Tatanka Wind Power, LLC.

Annette Bendish, Public Service Commission, State Capitol, 600 E Boulevard Ave., Bismarck, North Dakota 58505, on behalf of the Public Service Commission.

Allen C. Hoberg, Administrative Law Judge and Director, Office of Administrative Hearings, 1701 North Ninth Street, Bismarck, North Dakota 58501-1882.

Preliminary Statement

On October 13, 2006, Tatanka Wind Power, LLC ("Tatanka") filed a letter of intent indicating its intention to construct a transmission line to connect a wind project straddling the North Dakota/South Dakota border in Dickey County, North Dakota and McPherson County, South Dakota, known as the Tatanka Wind Farm, to an existing 230kV transmission line in Dickey County, North Dakota. Tatanka requested a waiver of the requirement that a letter of intent be filed one-year in advance of an application. By motion dated October 25, 2006, the Commission acknowledged receipt of the letter of intent, granted the waiver from the one-year filing requirement, and assessed an application fee of $36,500.00.

On November 2, 2006, Tatanka filed an application for a waiver of procedures and time schedules, and consolidated applications for a certificate of corridor compatibility and a route permit authorizing construction of approximately 12 miles of 230 kV transmission line from a point on the South Dakota border in Section 31, Township 129 North, Range 66 West, Dickey County to a proposed interconnection with an existing Montana-Dakota Utilities 230kV transmission line in Dickey County, North Dakota. The proposed route is located primarily in Dickey near the McIntosh County border, but crosses into McIntosh County for a portion of the route.

Tatanka requested the Commission waive procedures to allow for a single consolidated application for corridor certificate and route permit and waive the requirement that the width of the corridor be 10% of the length of the route.

On November 22, 2006 the Commission deemed the application complete and issued a Notice of Filing and Notice of Hearing scheduling a public hearing in McIntosh County for January 18, 2007.

The Notice of Hearing identified the following issues to be considered:

1. Will the location, construction and operation of the proposed electric transmission line produce minimal adverse affects on the environment, natural resources, and upon the welfare of the citizens of North Dakota?

2. Is the proposed electric transmission line compatible with the environmental preservation and the efficient use of resources?

3. Will the proposed electric transmission line corridor and route minimize adverse human and environmental impact while ensuring continuing system reliability and integrity and ensuring that energy needs are met and fulfilled in an orderly and timely fashion?

4. Is it appropriate for the Commission to waive the procedures as requested in the application including the request for a single consolidated application for Corridor Certificate and Route Permit?

A public hearing was held in Ashley, North Dakota, on January 18, 2007 at 11:00 a.m. CDT. Numerous members of the public attended both hearings, but none entered appearances, presented testimony or comments, or asked any questions of Tatanka's witnesses. At the conclusion of the hearing the Commission determined to leave the record open for certain late filed exhibits, and also determined that additional public comment may be received on late filed exhibits.

Subsequent to the hearing, the Commission received correspondence from two interested parties. Mr. Gary Hoffman, from Ashley, North Dakota, raised a concern that the transmission line was in close proximity to two cemeteries and that any noise generated by the transmission line would affect the cemeteries. Mr. Nick E. Davis, a resident of Rochester, Minnesota, indicated that he owned a "residence" in the vicinity of the transmission line at which he intended to retire and that he was concerned about the noise. Neither Mr. Hoffman nor Mr. Davis formally intervened as parties in this proceeding.

Tatanka supplemented the record with late filed exhibits responding to questions raised by the Commission at the hearings. Tatanka also supplemented the record with late filed exhibits responding to the questions raised by the correspondence identified above.

The Commission held an informal hearing on March 7, 2007 at 1:30 p.m. in the Commission hearing room in Bismarck. The informal hearing was attended by Tatanka's counsel and several witnesses.

Having allowed all interested persons an opportunity to be heard and having heard, reviewed and considered all testimony and evidenced presented, the Commission makes the following:

Findings of Fact

1. Tatanka is a Delaware Limited Liability Company headquartered in Schenectady, New York. Tatanka is currently jointly owned by Acciona Wind Energy USA, LLC and Global Winds Harvest, Inc., although Acciona is in the process of acquiring the interest of Global Winds in Tatanka.

2. Tatanka plans to construct its Tatanka Wind Farm at a location straddling the North Dakota/South Dakota border in Dickey County, North Dakota and McPherson County, South Dakota. The portion of the Wind Farm located within the state of North Dakota will be capable of generating less than 100 megawatts of electricity. By letter dated November 8, 2006, the Commission determined that such a project was not subject to the Commission's siting jurisdiction under Chapter 49-22 of the North Dakota Century Code. The transmission line and interconnection tap which are the subject of this application are necessary in order to transmit the power produced at the Wind Farm to Montana-Dakota's transmission line. Tatanka plans to sell the electricity on the regional grid operated by the Midwest Independent System Operator ("MISO").

3. Electricity generated at the Wind Farm will be collected by a series of 34.5 kV lines to a collection point in McPherson County, South Dakota. The proposed transmission line will extend approximately 1200 feet in South Dakota to the North Dakota border and then will run principally along the Dickey/McIntosh County border approximately 12 miles to an interconnection tap Tatanka plans to construct adjacent to the existing Montana-Dakota transmission line. More specifically, the line will enter North Dakota at a location near the southwest corner of Section 31, Township 129 North, Range 66 West and then proceed approximately 10 miles in a northerly fashion several feet outside the 33-foot section line right-of-way along the boundary between Range 66 and Range 67, which is also the boundary between Dickey and McIntosh counties. The line will be located primarily on the east side of the boundary in Dickey County, but will cross over into McIntosh County for a portion of the route to accommodate a surface owner on the Dickey County side who chose not to grant an easement for the transmission line to Tatanka. In Section 18, Township 130 North, Range 66 West, the transmission line will jog approximately 1 ½ miles to a point in the NW/4 of Section 17 or the same township, then proceed northerly for several additional miles to a point in Section 5 of the same township where Tatanka plans to construct the interconnection tap.

4. The transmission line will be constructed using H-frame tangent variety structures with an average height of 70 feet. The average span between poles will be approximately 700 feet, or approximately 7.5 structures per mile. The interconnection tap will be a fenced yard, approximately 300 feet by 600 feet, containing power circuit breakers and associated switches and transformers.

5. No transmission facility exclusion areas have been identified within either the proposed corridor or proposed route.

6. There are several wetlands within the corridor but none of them will be impacted by construction of the transmission line along the proposed route. The U.S. Army Corps of

Engineers has determined that a Section 404 permit will not be required for the transmission line.

7. Tatanka has caused to be completed both a Class I files and record search, and a Class III pedestrian survey of the entire proposed route and interconnection tap for archeological and cultural resources. In addition, consultation was made with Indian tribes located within the State of North Dakota. Neither the Class I nor Class III searches revealed any protected sites along the proposed route; several small sites were identified by the Class III survey within the corridor but they will not be impacted by construction along the proposed route. Tatanka received conditional approval from the North Dakota State Historic Preservation Office (SHPO) and is awaiting final approval from SHPO.

8. There are no permanently-occupied residences located within 500 feet of the proposed line. There is a house located in the SE 1/4 SE 1/4 of Section 12, Township 129 North, Range 67 West which was at one time a permanently-occupied residence. The house is now owned by Mr. Nick Davis, who resides in Rochester, Minnesota. As originally planned, the transmission line would have been located approximately 460 feet from the house. Tatanka tried, but was unable to obtain a waiver from Mr. Davis. At the informal hearing, Tatanka presented testimony and exhibits indicating that a tree row was located slightly more than 500 feet east of the Davis house. In order to locate the transmission line at least 500 feet from the house, Tatanka would be required to locate the line, including several poles, in a corn field owned by Mr. Barry Holmes. Mr. Holmes told Tatanka that he would personally remove the tree row to prevent the line being placed in his corn field. Tatanka presented additional testimony which indicated that it could move the line east of the original location to a point where, subject to any construction conditions, the center line of the transmission line would be 500 feet from the Davis house. Such relocation would require the use of a single-pole structure with all of the wires and conductors placed on one side of the structure. The actual wires would be approximately 7 feet closer than 500 feet, or 493 feet, from the house. Tatanka indicated that the actual location might move due to conditions encountered during construction activities.

Tatanka has asserted that the Davis house is not a "residence" within the meaning of Section 69-06-08-02 of the North Dakota Administrative Code. Because of the way the Commission is resolving this issue, the Commission has determined that it is not necessary to determine whether the house is or is not a residence. The Commission finds that any intrusion into the 500-foot setback which would be required by Section 69-06-08-02 if the house is a "residence" is *de minimis,* particularly in light of Tatanka's willingness to move the transmission line as close to the west side of the tree row as possible and use single-pole structures for this portion of the line. The Commission further finds that there is no reasonable alternative to such a location, since moving the transmission line to the east of the tree row would interfere with Mr. Holmes' farming operation or result in the loss of a tree row.

9. With the exception of the intention of Mr. Holmes to personally remove trees to prevent locating the line in his corn field, there is no anticipated significant tree removal as a result of the line. Tatanka may need to remove and/or trim trees and limbs after the line is installed to prevent damage to the lines from wind and ice and ensure reliable operation. Tatanka does not object to replacing any tress that are removed on a ratio of two to one.

10. Tatanka provided the Commission with information indicating that the noise generated from the transmission would be noise generated from corona discharge, which is generally a hissing or crackling sound that, under certain circumstances, may be accompanied by a hum. The noise is most noticeable when the conductors are wet. Other siting agencies in the United

States have found that the audible noise from a 230 kV line would be between 17 and 45 dBA. The sound level in a bedroom at night is approximately 25 dBA and the sound level of a refrigerator is approximately 40 dBA.

11. The cemeteries referred to in Mr. Hoffman's letter are the Cemetery of Salem, located in the southeast corner of Section 36, Township 130 North, Range 66 West, and the St. Peter's Cemetery located in the SE 1/4 of Section 30, Township 129 North, Range 66 West. The Cemetery of Salem is bounded by County Road 9A on the east and State Highway 11 on the south. It is across the road from a current substation for an existing power line, and an existing power line runs through the cemetery. The proposed transmission line will be located on the east side of County Road 9A. The St. Peters Cemetery is located approximately 1500 feet from the proposed location of the transmission line. Under these circumstances, the Commission finds that the noise generated by the transmission line will not have any significant adverse human or environmental impact.

12. Tatanka has obtained all easements necessary for construction of the transmission line and interconnection tap.

13. Tatanka has contacted all county and township governing boards and has been assured that no additional local permits or approvals will be required for construction or operation of the transmission line and interconnection tap.

14. The estimated cost of the transmission line and related facilities is $6,000,000.00; and the estimated cost of the interconnection with Montana-Dakota is $1 million.

15. Prior to filing its application, Tatanka contacted all of the state and federal agencies required by the Commission's rules. Tatanka has addressed the concerns raised by the state and federal agencies. Tatanka is still waiting to receive final clearances from the United States Fish and Wildlife Service and the State Historic Preservation Office, but neither of those agencies has raised any concerns to date with the transmission line or the Montana-Dakota interconnection, which are the subject of this hearing.

16. The construction and operation of the transmission line will conform to the requirements of the National Electric Safety Code.

17. H-frame tangent structures will be used for construction of the transmission line, with the exception of the single-pole structures in the vicinity of the tree row discussed above. .

From the foregoing Findings of Fact, the Commission now makes its:

Conclusions of Law

1. The Commission has jurisdiction over this proceeding under North Dakota Century Code Chapter 49-22.

2. The transmission line and interconnection facility proposed by Tatanka are transmission facilities as defined in North Dakota Century Code Section 49-22-03(11).

3. The proposed project is of such design, location and purpose that it will produce minimal adverse effects, as defined under North Dakota Century Code Section 49-22-05.2.

4. The Application submitted by Tatanka meets the corridor and route evaluation criteria required by North Dakota Century Code Chapter 49-22.

5. The location, construction and operation of the proposed transmission line and collection substation will produce only minimal adverse effects on the environment and upon the welfare of the citizens of North Dakota.

6. The proposed transmission line and collection substation is compatible with the environmental preservation and the efficient use of resources.

7. The proposed transmission line corridor and route will minimize adverse human and environmental impact while ensuring continuing system reliability and integrity and ensuring that energy needs are met and fulfilled in an orderly and timely fashion.

8. The proposed transmission line corridor and route will allow for the transmission of environmentally friendly wind power.

9. The proposed transmission line corridor and route are of such length, design, location and purpose that they will produce minimal adverse effects.

10. The requested waivers of procedures and time schedules are justified based upon: the minimal length of the transmission line; minimal impacts on the environment and the welfare of the citizens of North Dakota; the lack of objection to the proposed route by federal, state and local governmental bodies and agencies or by area landowners.

From the foregoing Findings of Fact and Conclusions of Law, the Commission now makes it:

Order

The Commission orders:

1. Tatanka's Application for Waiver of Procedures and Time Schedules is granted.

2. Certificate of Site Compatibility Certificate Number 96 designating a transmission facility corridor is issued to Tatanka.

3. Route Permit Certificate Number 106 designating a transmission facility route is issued to Tatanka.

4. Tatanka Power shall conduct a preconstruction conference prior to commencement of any construction, and must include a Tatanka representative, its construction supervisor, and a representative of the Commission staff in order to ensure that Tatanka fully understands the conditions set forth in this Order.

5. Tatanka shall comply with the rules and regulations of all of their agencies having jurisdiction over any phase of its proposed transmission line, and it shall obtain all other necessary licenses and permits; and shall provide copies of all licenses and permits to the Commission which were not included in its application or which have not otherwise been provided to the Commission as of the date of this order prior to the construction of the transmission line.

6. Tatanka shall inform the Commission of its intent to start construction on the transmission line and associated collection substation prior to the commencement of construction, and, once construction has started, Tatanka shall keep the Commission updated of construction activities on a weekly basis. Tatanka shall also inform the Commission if the location of the line in the vicinity of the Davis house is moved west of its anticipated reroute as a result of any conditions encountered during construction.

7. Tatanka shall construct and operate the transmission line in the manner described in its Application and at the hearing, and in accordance with all applicable safety requirements.

8. Tatanka shall promptly report to the Commission the presence in the permit area of any critical habitat of threatened or endangered species, or of bald or golden eagles that Tatanka becomes aware of and which were not previously reported to the Commission.

9. If any cultural resource, paleoentological site, archeological site, historical site, or gravesite is discovered during construction, it shall be marked, preserved and protected from any further disturbance until a professional examination can be made by the State Historical Society, a report of such examination is filed with the Commission, and clearance to proceed is given by the Commission.

10. All pre-existing roads and lanes used during construction must be restored to a condition that will accommodate their previous use, and areas used as temporary roads during construction must be restored to their original condition.

11. Construction must be suspended when weather conditions are such that construction activities will cause irreparable damage, unless adequate protection measures approved by the Commission are taken.

12. Reclamation along the right-of-way shall be continuous and coordinated with construction.

13. Reclamation, fertilization and reseeding is to be done by Tatanka according to the Natural Resource Conservation Service and County Farm Service Agency recommendations for CRP, native prairie and other lands unless otherwise specified by the landowner and approved by the Commission.

14. Tatanka's obligations for reclamation and maintenance of the right-of-way shall continue throughout the life of the transmission line.

15. Trees and other wooded vegetation must be replaced at a rate of two for every one removed along the route. Landowners shall be given the option of having replacement trees/shrubs planted off the right-of-way on the landowners' property or waiving that requirement in writing and allowing Tatanka to plant replacement trees/shrubs elsewhere. Tatanka shall inspect tree replacements once a year for three years and send a report on or shortly before October 1 of 2008, 2009 and 2010 to the Commission documenting work completion and condition of woodlands planting. The Commission may order additional plantings if survival rates are less than 75% of the required ratio of two for one.

16. Tatanka shall provide the Commission with copies of design specifications for construction of the transmission line and associated collection substation showing the location as built.

17. Tatanka shall work with landowners and residents to mitigate any increase in television and residential radio interference that results from the transmission line.

18. Tatanka shall work with landowners to determine and implement appropriate damage mitigation measures.

19. Tatanka shall obtain approval from the Commission or Commission staff prior to any changes in structure locations.

20. The authorizations granted by the corridor certificate and route permit are subject to modification by order of the Commission if deemed necessary to further protect the public or the environment.

21. After the corridor and route certificates have been issued and all costs of hearings, publication, and any other related expense have been paid from the application fee, the Commission shall refund all but $5,000.00 of the remaining application fee. If the balance of the application fee at that time is less than $5,000.00 the Commission shall retain the entire amount. When construction and reclamation are complete and when the Commission has concluded that Tatanka's tree mitigation project is satisfactory, the remaining balance of the application fee shall be refunded.

PUBLIC SERVICE COMMISSION

Tony Clark	Susan E. Wefald	Kevin Cramer
Commissioner	President	Commissioner

CONCURRING OPINION
Commissioner Susan E. Wefald

March 21, 2007

Tatanka Wind Power, LLC
223 kV Transmission Line/Dickey &
McIntosh Counties
Siting Application

Case No. PU-06-443

I concur with this order, except that an important safety issue has not been addressed by the Commission in this order. This is the issue of Tatanka placing safety "markers" on transmission structure guy wires.

Markers are "plastic sleeves" which are placed on transmission structure guy wires to make them visible to the public. The plastic sleeves are about 6 feet long and are placed at ground level. These markers make it easier for pilots doing crop spraying to identify guy wires. Also, the markers make it easier for the ground traveling public, including snowmobile riders and farm equipment operators to spot the lines. The markers are **very** inexpensive to purchase and install, if they are put in place at the time of construction.

My fellow commissioners did not want to require Tatanka to put these markers in place, since the National Electric Safety Code only requires them in *areas exposed to pedestrian traffic and established parking areas.* I disagree with this decision. Other utilities in the state are putting them in place on transmission structures in rural as well as urban areas to enhance safety of the lines.

I encourage Tatanka, even though this issue is not addressed in the Commission Order, to voluntarily put markers on all guy wires as they construct this transmission line and supporting facilities. As the first independent power producer to be building a transmission line in this state, it would set good precedent for Tatanka to address this safety issue.

Susan E. Wefald, Commissioner

CONCURRING OPINION
Commissioner Tony Clark

March 21, 2007

Tatanka Wind Power, LLC
230 kV Transmission Line
Dickey – McIntosh Counties
Siting Application

Case No. PU-06-443

I had not intended to write this concurring opinion, so I did not state my intentions to do so in accordance with Public Service Commission Policy 1-23-98(0). If need be, I will move that the policy be waived in this instance so that my thoughts can be recorded.

The reason I only now feel compelled to write this is in response to Commissioner Wefald's significant misrepresentation of my rationale for deciding to not include the following language in the order:

Tatanka shall mark all the guy wires on structures unless Tatanka receives a signed waiver from the owner of the property on which the structure will be placed."

Commissioner Wefald states in her concurring opinion filed after the commission meeting that, "My fellow commissioners did not want to require Tatanka to put these markers in place, since the National Electric Safety Code only requires them in *areas exposed to pedestrian traffic and established parking areas.*"

This is an interesting, though incorrect, bit of mind-reading considering I have never said that in any setting. While written opinions attached to orders can provide insight into a commissioner's own decision making process, they are a wholly inappropriate vehicle for speaking on behalf of others. In the future I would hope all commissioners would refrain from speculatively assigning motives or rationale to his or her colleagues via any venue, but especially through formal concurrences or dissents.

So I submit the following solely to correct the public record. I will confine my comments to my own thoughts in relation to the proposed language.

It should go without having to note, but perhaps it bears repeating in light of the discussion on this matter: The Public Service Commission must issue its decisions based on the record before it. In this case, the record contains a lack of reference to interveners, landowners, affected citizens, regulatory agencies, public interest groups or other entities demonstrating that guy lines for this transmission project should be marked in a manner inconsistent with existing safety regulations or existing siting orders.

Rather, the proposal to add a separate and new marking regulation to this order was presented to me less than an hour before our business meeting.

In the few minutes I had to consider the proposal, some substantial questions about the language struck me. As written, it contains no guidance to the applicant on what type of markers should be installed. Should they be ground markers? Should they be aerial markers? Maybe both? To what standards and specifications should they be built and installed?

Commission orders already require the applicant to meet all safety regulations (ordering clause no. 7), so how would this requirement differ? How many guy lines are there in total that would be affected by the proposed language?

One particularly vexing question for me is what impact this proposal could have on landowner liability. For example, let us suppose a landowner wishes to waive the marking of the line on his property for purely aesthetic reasons, as would be allowed under the proposal. Now let us suppose that a snowmobile operator chooses to trespass on that landowners' property without permission. The snowmobile operator proceeds to cause bodily injury to him or her self and property damage to a guy wire. Despite the fact the snowmobile operator was there without permission, I can imagine a plausible scenario wherein an attempt would be made to hold the landowner liable for injuries or damage due to the landowner exercising his or her option to waive the guy line marker requirement. Such could be an unintended consequence of this proposed regulation.

There can be no doubt that the reason these questions are left unanswered is because such information was not discussed in any detail in our public hearing or in other public meetings associated with this case. Proposing new, rather vaguely defined regulations literally minutes before a commission meeting without a thorough vetting of the issue is no way to handle regulatory policy. The Commission needs to gather testimony and hold discussions on such scenarios through a public, deliberative process. Parties need to be given an opportunity to respond. This has not been done in this instance, and absent such due process and deliberation I am unwilling to depart from past commission precedent or existing safety regulations regarding requirements for guy line marking.

Tony Clark, Commissioner

PUBLIC SERVICE COMMISSION

STATE OF NORTH DAKOTA

Certificate of Site Compatibility

Certificate Number 96

This is to certify that the Commission has designated a transmission facility corridor for Tatanka Wind Power, LLC, which is described as follows:

In Dickey and McIntosh Counties, North Dakota, a corridor either one or two miles wide and 13 miles long, running along or near the western boundary of Dickey County from the North Dakota/South Dakota border in Section 31, Township 129 North, Range 66 West, to an interconnection with the existing Montana Dakota Utilities Wishek-Ellendale 230 kV transmission line in Section 5, Township 130 North, Range 66 West.

This certificate is issued in accordance with the Order of this Commission dated March 21, 2007 in Case No. PU-06-443 and is subject to the conditions and limitations noted in the Order.

Bismarck, North Dakota, March 21, 2007.

ATTEST: ***PUBLIC SERVICE COMMISSION***

Executive Director ***Commissioner***

PUBLIC SERVICE COMMISSION
STATE OF NORTH DAKOTA
Route Permit

Certificate Number 106

This is to certify that the Commission has designated a transmission facility route for Tatanka Wind Power, LLC, which is described as:

In Dickey and McIntosh Counties, North Dakota, a 230 kV transmission line approximately 12 ½ miles in length from a point in the southwest corner of Section 31, Township 129 North, Range 66 West, thence north roughly along the boundary between Dickey and McIntosh Counties a distance of approximately 9 ¾ miles to a point in Section 18, Township 130 North, Range 66 West, thence east approximately 1 ¼ miles to a point in the NW 1/4 of Section 17, Township 130 North, Range 66 West, thence north a distance of approximately 2 miles to a point in the W 1/2 of Section 5, Township 130 North, Range 66 West.

This certificate is issued in accordance with the Order of this Commission dated March 21, 2007 in Case No. PU-06-443 and is subject to the conditions and limitations noted in the Order.

Bismarck, North Dakota, March 21, 2007.

ATTEST: ***PUBLIC SERVICE COMMISSION***

Executive Director ***Commissioner***

APPROVED
DATE: 3-21-07
SAB

MOTION

March 21, 2007

Tatanka Wind Power, LLC
230 kV Transmission Line/Dickey &
McIntosh Counties
Siting Application

Case No. PU-06-443

I move the Commission adopt the Findings of Fact, Conclusions of Law and Order issuing a corridor certificate and route permit authorizing construction of Tatanka Wind Power, LLC's 230 kV Transmission Line in Dickey and McIntosh Counties of North Dakota, Case No. PU-06-443.

AB

APPENDIX C
Approved Seeding Specifications & Seed Tags

NATIVE PRAIRIE SEED MIX AND SEEDING NOTES
Tatanka Wind Farm
Dickey and McIntosh Counties, North Dakota
McPherson County, South Dakota

Prepared by **Westwood** Professional Services July 25, 2007

SEED MIXTURE SUPPLIER AND APPROVAL

1. THE SEED MIX SPECIFIED BELOW SHALL BE ACQUIRED FROM CHESAK SEED HOUSE OF BISMARCK, NORTH DAKOTA (PHONE: 701-223-0391).
2. THE CONTRACTOR SHALL OBTAIN ENOUGH SEED TO COVER DISTURBED AREAS AT THE SPECIFIED APPLICATION RATE.
3. THE CONTRACTOR SHALL SUBMIT SEED TAGS AND WRITTEN CERTIFICATION OF NATIVE SEED MIX CONTENTS AND SUPPLIERS FOR APPROVAL BY THE ENVIRONMENTAL SCIENTIST PRIOR TO INSTALLATION.

SEEDBED PREPARATION

4. AFTER FINAL GRADING, THE SEEDBED SHALL BE PREPARED AND SMOOTHED TO BREAK UP ROOT SYTEMS AND SOIL CLODS SO THAT THE AVERAGE CLUMP IS LESS THAN 2 INCHES IN DIAMETER.
5. PRIOR TO SEEDING, THE CONTRACTOR SHALL KILL NEWLY GROWN WEEDY VEGETATION THAT COVERS MORE THAN 25 PERCENT OF THE GROUND IN THE AREA TO BE SEEDED.
6. THE SEEDBED SHALL BE PREPARED BY LOOSENING TOPSOIL TO A MINIMUM DEPTH OF 3 INCHES.
7. FOR AREAS TO BE SEEDED THAT ARE PARTIALLY DISTRURBED, SUCH AS CRANE WALKS, THE EXISTING PRAIRIE SOD SHALL BE LEFT IN PLACE. SUCH SOD SHALL NOT BE TILLED OR SPRAYED.
8. THE CONTRACTOR SHOULD AVOID SEEDING BETWEEN JULY 10 AND AUGUST 20 IF POSSIBLE.

SEED MIXTURE AND RATES

9. THE CONTRACTOR SHALL SEED THE NATIVE PRAIRIE SEED MIX AT A RATE OF 16.44 POUNDS OF PURE LIVE SEED (PLS) PER ACRE ON SOIL DISTURBANCE ZONES ASSOCIATED WITH ROADS, CABLES, TURBINES, CRANE WALKS, AND TRANSMISSION LINES.
10. THE SEED MIX COMPOSITION AND APPLICATION RATE SHALL BE AS SPECIFIED BELOW:

Tatanka Wind Farm Native Prairie Seed Mix			
Common Name	**Scientific Name**	**% of Mix**	**Rate (Lbs. PLS/Acre)**
Big bluestem	*Andropogon gerardii*	15	2.22
Blue grama	*Bouteloua gracilis*	10	0.46
Green needlegrass	*Nassella viridula*	20	2.9
Indiangrass	*Sorghastrum nutans*	10	1.36
Little bluestem	*Schizachyrium scoparium*	15	1.38
Maximilian sunflower	*Helianthus maximilianii*	3	0.26
Prairie coneflower	*Ratibida columnifera*	3	0.08
Purple prairie clover	*Dalea purpurea*	5	0.38
Sideoats grama	*Bouteloua curtipendula*	15	2.18
Switchgrass	*Panicum virgatum*	15	1.34
Western wheatgrass	*Agropyron smithii*	20	3.88
Total		**131**	**16.44**

11. SUBSTITUTIONS OF SIMILAR SPECIES OR MIXES MUST BE APPROVED BY THE ENVIRONMENTAL SCIENTIST.

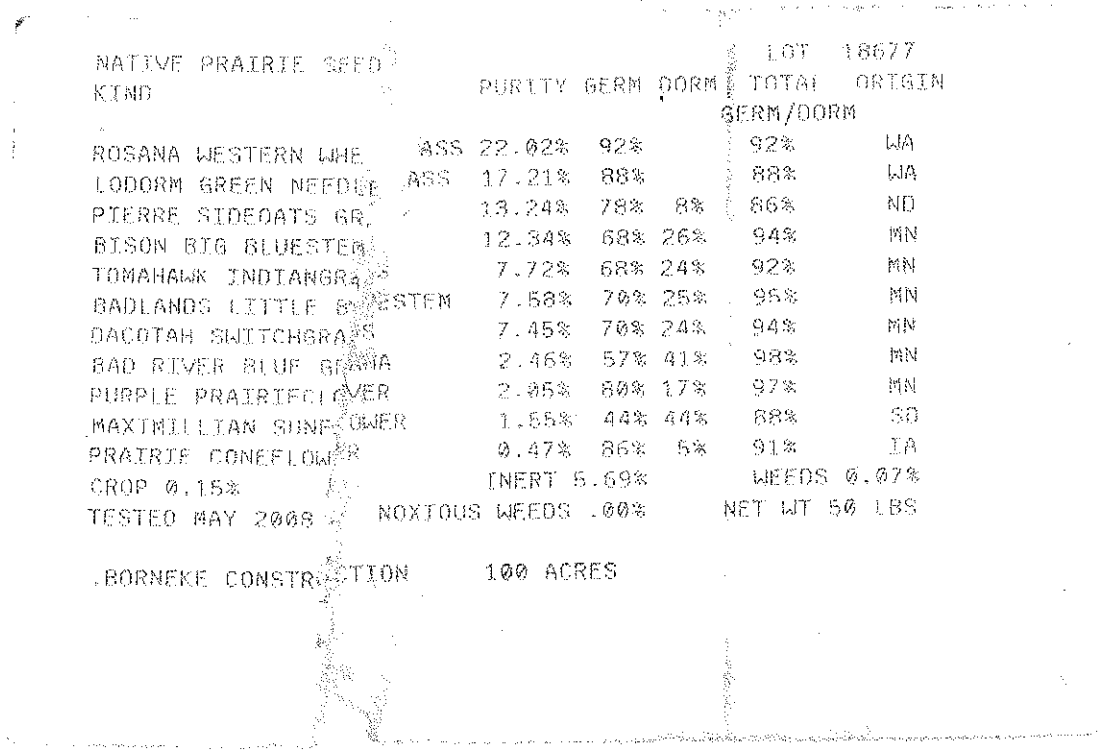
SEEDING METHODS

12. SEED SHALL BE SOWN WITH A DRILL SPECIALLY DESIGNED FOR PLANTING NATIVE GRASS SEED SUCH AS A TRUAX NATIVE GRASS DRILL OR A JOHN DEERE 1550 POWER-TILL SEEDER.
13. IF A NATIVE GRASS DRILL IS NOT AVAILABLE, SEED MAY BE SOWN WITH A MECHANICAL "CYCLONE" BROADCAST SEEDER THAT IS EQUIPPED WITH AN AGITATOR TO PREVENT NATIVE GRASS SEED FROM BRIDGING.
14. SEEDED AREAS SHALL BE FIRMED WITH A ROLLING-TYPE PACKER WITHIN TWO DAYS AFTER SEEDING.
15. SEEDED AREAS SHALL NOT BE FERTILIZED.
16. SEEDED AREAS PRONE TO EROSION SHALL BE MULCHED WITH CERTIFIED WEED-FREE MULCH AT A RATE OF 2 TONS PER ACRE AND THE MULCH SHALL BE ANCHORED WITH A DISC OR TACKIFIER.
17. THE CONTRACTOR IS ENCOURAGED TO REVIEW THE FOLLOWING PUBLICATIONS FOR ADDITIONAL GUIDANCE ON NATIVE GRASS SEEDING METHODS:
    - *Mn/DOT SEEDING MANUAL, 2007 EDITION* (MINNESOTA DEPARTMENT OF TRANSPORTATION OFFICE OF ENVIRONMENTAL SERVICES, 2007 [see www.dot.state.mn.us/environment/pdf_files/**seedingmanual**.pdf]), AND
    - *STANDARD SPECIFICATIONS FOR CONSTRUCTION, 2005 EDITION* (MINNESOTA DEPARTMENT OF TRANSPORTATION, 2005).

ACCEPTANCE

18. THE SEEDING SHALL BE ACCEPTED AFTER APPROVAL BY THE ENVIRONMENTAL SCIENTIST OR THE U.S. FISH AND WILDLIFE SERVICE CONTRUCTION MONITOR.

Borneke Construction Seed Tags



NATIVE PRAIRIE SEED

KIND		PURITY	GERM	DORM	LOT 18677 TOTAL GERM/DORM	ORIGIN
ROSANA WESTERN WHE	ASS	22.02%	92%		92%	WA
LODORM GREEN NEEDLE	ASS	17.21%	88%		88%	WA
PIERRE SIDEOATS GR		13.24%	78%	8%	86%	ND
BISON BIG BLUESTEM		12.34%	68%	26%	94%	MN
TOMAHAWK INDIANGRA	S	7.72%	68%	24%	92%	MN
BADLANDS LITTLE BL	ESTEM	7.58%	70%	25%	95%	MN
DACOTAH SWITCHGRAS	S	7.45%	70%	24%	94%	MN
BAD RIVER BLUF GR	NA	2.46%	57%	41%	98%	MN
PURPLE PRAIRIECLOVER		2.05%	80%	17%	97%	MN
MAXIMILLIAN SUNF	OWER	1.55%	44%	44%	88%	SD
PRAIRIE CONEFLOWER		0.47%	86%	5%	91%	IA
CROP 0.15%		INERT 5.69%			WEEDS 0.07%	
TESTED MAY 2008	NOXIOUS WEEDS .00%				NET WT 50 LBS	

BORNEKE CONSTR TION 100 ACRES

Muth Electric, Inc
Seed Tags

Customer Name: Hopkinson County
Mix Lot Number: 12398
Job number: Windflower Mix with Oats

Acres: 20

Species	Lot #	% Mix	Actual Purity	Germ	Hard/ Dormant	Total Germ/H	Origin	$/Bag	PLS/Bag
Renvee Oats	7944	46 20	99 75	98	0	98	SD	23 15	22 64
Bison Big Bluestem	h5524	7 50	95 99	52	36	88	MN	3 80	3.21
Bad River Blue Grama	h5517	1 97	98 66	44	53	97	MN	0 70	0 67
Lodora Green Needle Grass	8045	8 56	99 27	32	66	98	MT	4 91	4.20
Tomahawk Indiangrass	h5060	4 52	89 93	45	42	87	MN	2.50	1.97
Itasca Little Bluestem	h5542	4 54	79 11	55	33	88	MN	2 87	2.00
Pierre Sidoats Grama	h5510	6.50	81 87	96	41	97	MN	3 54	3 15
Dacotah Switchgrass	g7580	3 93	99 80	88	11	99	MN	1.96	1.94
Rosana Western Wheatgrass	nbslhBreed	11 57	95 70	97	0	97	WA	6 05	5.61
SD Native Maximilian Sunflower	6800	0 30	93.81	50	45	95	SD	0 16	0.14
Variety Not Stated Prairie Coneflowerg	11297	0 24	95 95	64	32	97	NE	0.12	0 12
MN Native Purple Prairieclover	g75002	1.15	99 96	76	20	96	MN	0 57	0 55
False Sunflower	4082	0 47	99 73	56	42	98	IA	0 24	0.23

Other Crop:	0 02		
Inert Matter	3 32	Totals/Bag	50 00 48 40
Weed	0 81		
Test Date:	May-08		
Noxious Weed Seeds	None Found	PLS Factor	0 9268
Net Weight	50 00 Bulk Pounds		
Total PLS	46 49 Pounds of Pure Live Seed		

Milborn Seeds, Inc - 3127 Hwy 14 Bypass - Brookings, SD - AMS #704
The seller warrants that this seed conforms to the label description as required by federal and state seed laws. We make no other warranties, expressed or implied. Liability for any damages with respect to the sale of this seed is limited to the purchase price of the seed. This remedy is exclusive. In no event shall the seller be liable for any incidental or consequential damages or losses.

TATANKA WIND FARM NATIVE MIX LOT 19543

KIND	PURITY	GERM	DORM	TOTAL DORM/GERM	ORIGIN
ROSANA WESTERN WHEATGRASS	23.61%	85%		85%	CAN
LODORM GREEN NEEDLEGRASS	15.96%	94%		94%	ND
BUTTE SIDEOATS GRAMA	12.67%	76%	13%	89%	MN
MN NATIVE BIG BLUESTEM*	12.22%	72%	22%	94%	MN
TOMAHAWK INDIANGRASS	7.82%	58%	32%	90%	MN
ITASCA LITTLE BLUESTEM	7.51%	53%	42%	95%	MN
FORESTBURG SWITCHGRASS	7.30%	74%	21%	95%	MN
BAD RIVER BLUE GRAMA	2.45%	53%	44%	97%	MN
PURPLE PRAIRIECLOVER	2.03%	94%	3%	97%	MN
MAXIMILLIAN SUNFLOWER	1.49%	10%	80%	90%	MN
PRAIRIE CONEFLOWER	0.43%	72%	24%	96%	MN

CROP 0.34% INERT 5.96% WEEDS 0.21% TESTED MAY 2009

NOXIOUS WEEDS.00% NET WT 50 LBS*DENOTES VARIETY NOT STATED

Archaeological Data Recovery Excavation

32DI0095, The Gabriel Site

Albertha Township, Dickey County, North Dakota

February 15, 2008



Prepared for:

Tatanka Wind Power LLC
A wholly-owned subsidiary of
Acciona Wind Energy USA LLC

10,000 Lakes Archaeology, LLC

Westwood

ARCHAEOLOGICAL DATA RECOVERY EXCAVATIONS OF 32DI0095, THE GABRIEL SITE, ALBERTHA TOWNSHIP, DICKEY COUNTY, NORTH DAKOTA

By
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Prepared for
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February 15, 2008

Management Summary

Tatanka Wind Power, LLC. (Tatanka) constructed a wind farm in Dickey County, North Dakota and McPherson County South Dakota. Although Section 106 review was required on only a small portion of the project area, Tatanka retained Westwood Professional Services (Westwood) for a Class III Survey of the entire project area as a matter of due diligence. Westwood teamed with 10,000 Lakes Archaeology, LLC (10,000 Lakes) for this project. Amanda Gronhovd of 10,000 Lakes served as Principal Investigator. One site located within the project area, the Gabriel Site (32DI0095), was evaluated for significance and integrity. Following the evaluation, Westwood and 10,000 Lakes recommended the site as eligible for listing on the National Register of Historic Places. Paul Picha, Chief Archaeologist for the State Historical Society of North Dakota, concurred with the recommendation.

The Gabriel Site is located in the SE ¼, SE ¼, SE ¼ of Section 23, and the SW ¼, SW ¼, of Section 24, Township 129 N, Range 66 W, Albertha Township, Dickey County, North Dakota. This location is in the James River Study Unit, and the assumed site area is 24.3 acres.

Tatanka determined that it would be unable to avoid the Gabriel Site during construction. An area of approximately 4.6 acres of the site would be disturbed by the construction activities. Although under no legal obligation, Tatanka agreed to sponsor a data recovery mitigation of the affected areas of 32DI0095.

Following submission of a research design and data recovery plan to the State Historical Society of North Dakota, Westwood conducted a data recovery mitigation of the affected area of the Gabriel Site between June 18th and July 10th, 2007. Forty-nine 1-x-1-m test units were placed across the site during the data recovery. A portion of these units were placed to mitigate a stone circle which would be impacted by construction. All other surface features were avoided by construction including six stone circles, two cairns, two rock-lined depressions, a rock alignment, and a petroform. No subsurface features were identified during the investigations, but 1,798 lithics were recovered including 82 tools and 8 projectile points. Twenty-seven undiagnostic grit tempered ceramic sherds/crumbs and 20 faunal fragments were also recovered. Through point typology and the application of a new model of lithic raw material use patterns, the site appears to contain a Plains Archaic component and a Plains Woodland component.

Despite the disturbances to the site caused by construction of the wind farm, Westwood and 10,000 Lakes recommended that the site remains eligible for listing on the National Register of Historic Places under Criteria D, "may be likely to yield, information important in prehistory."

Acknowledgements

Many individuals and agencies are deserving of recognition and thanks for their assistance with the data recovery investigations at 32DI0095, Dickey County, North Dakota.

First we want to thank Tatanka Wind Power, LLC. and Acciona Energy USA for sponsoring the investigations and data recovery mitigation. Their support has allowed information from this significant site to be preserved.

Special thanks to Pete Nelson and Mortenson Construction for their willingness to work closely with us in order to preserve the majority of features at 32DI0095 and limit the disturbances to the site to the extent possible.

The authors would also like to express gratitude to Dr. John Soderberg of the University of Minnesota for his faunal analysis, Mr. Paul Picha, Chief Archaeologist with the State Historical Society of North Dakota for his advice throughout the project, and Mr. Bruce Koenen, Research Archaeologist with the Office of the State Archaeologist – Minnesota, for his assistance with research.

Finally, we would like to thank the following individuals who gave assistance during the completion of this project: Mr. Marcus V. da Cunha, Mr. Aaron Tippie, Mr. Steven Blondo, Mr. Ron Peterson, Dr. Michael G. "Buck" Michlovic, Mr. David Mather, Mr. Joe Artz, Ms. Meg Van Ness, Mrs. And Mr. Lisa and Russell Zahn, Mr. John Jameson, Ms. Adele S. Murray, Ms. Stella Hamms, Mr. Robert Thompson and Mr. Gabriel Ross.

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EXHIBIT 7: Surface Features, Test Units, and Area of Potential Effects

1.0 Introduction

Westwood Professional Services, Inc. (Westwood) was retained by Tatanka Wind Power, LLC (Tatanka) to conduct a cultural resource assessment for the Tatanka Wind Power Project in Dickey and McIntosh Counties, North Dakota and McPherson County, South Dakota (Exhibit 1). Westwood teamed with 10,000 Lakes Archaeology, LLC (10,000 Lakes). Westwood and 10,000 Lakes identified and evaluated 32DI0095 (the Gabriel Site) located in the SE ¼, SE ¼, SE ¼ of Section 23, and the SW ¼, SW ¼, of Section 24, Township 129 N, Range 66 W, Albertha Township, Dickey County, North Dakota (Exhibit 2). The site was recommended as eligible for listing on the National Register of Historic Places (NRHP) under Criteria D, "may be likely to yield, information important in prehistory." Paul Picha, Chief Archaeologist for the State Historical Society of North Dakota, concurred with the recommendation.

An estimated 4.6 acres (19 percent) of 32DI0095 will be disturbed by construction of wind turbine generators, associated access roads, and collection cables (Exhibit 3). This portion of the Tatanka Wind Power Project area was not on federal land and so was not required to be considered under Section 106 of the National Historic Preservation Act. However, because the Gabriel Site appears to be a significant archaeological site, Tatanka voluntarily agreed to support and finance a data recovery mitigation of the site. This report details the results of the data recovery mitigation of the impacted areas of 32DI0095 which was conducted June 18th through July 10th, 2007.

Amanda Gronhovd of 10,000 Lakes, who meets the Secretary of the Interior's professional qualification standards in archaeology as outlined in 36CFR800, acted as Principal Investigator for the project. Project Manager was Senior Cultural Resource Specialist Steven Blondo, and Crew Chief was Cultural Resource Specialist Ryan Grohnke, both of Westwood. Field crew consisted of Westwood Cultural Resource Specialists and field technicians Anne E. Anderson, Laura Kennedy, Tom Ross, Molly Sandgren, Austin Jenkins, Gabe Ross, Mario Uribe, Heather Hoffman, Kristen Ross, Kevin Mieras, Kirsten Holt, and Alissa Bergen.

2.0 Background Research

A Class I: Literature Search of the Gabriel Site (32DI0095) area revealed that no previous surveys have been conducted within one mile of 32DI0095, however, three site leads have been reported. Hart's Gulch Old Trail (32DIX0001), Hart's Gulch Indian (32DIX0014), and Hart's Gulch Remains (32DIX0015) are reportedly in the SW ¼, Section 19, Township 129 N, Range 65 W. These sites were first reported by early settler Thomas Shimmin and recorded by Dana Wright in 1925. Hart's Gulch Indian is a Native American burial, and Hart's Gulch Old Trail and Hart's Gulch Remains are historic foundations and fortifications. The structures of these foundations were in ruins when first observed by settlers in 1883. Dana Wright also recorded a structure approximately 20 feet square with a two-foot wide and three-foot deep trench along the inside walls of the building. The dirt was piled outside the structure against a retaining wall of stones which were set against the logs of the structure. South of the structure was a semi-circular trench approximately 15 feet long from tip to tip and five feet deep. This trench was created by removing the earth and placing it outside of a retaining wall of stone. Westwood Cultural Resource Specialists verified the existence of these historic sites in May 2007.

In addition to the previously reported sites, Westwood located four sites within one mile of the Gabriel Site during the Class III survey of the proposed Tatanka Wind Farm. These sites included: 32DI0096, a historic site consisting of two foundations, which is located immediately adjacent to and slightly overlaps with the Gabriel Site; 32DI0094, a 200 meter long north-south rock alignment made of various groupings and clusters of stones, which lies just over ¼ mile north of the Gabriel Site; 32DI0099, a precontact site consisting of two 3-x-3-meter stone cairns, which is approximately ½ mile southwest of the Gabriel Site; and WPS-I3, a sparse lithic scatter, which is approximately 1/8 mile east of the Gabriel Site.

3.0 Identification and Evaluation

The Gabriel Site was identified during the Class III Intensive Survey of the Proposed Tatanka Wind Farm in the fall of 2006 in the vicinity of proposed wind turbines ND 19 and ND 20. The Area of Potential Effect (APE) for archaeology included all areas where ground disturbing activities would take place. When first encountered, multiple rock features, including two large cairns, two rock-lined pits, four complete stone circles, three partial stone circles, and a rock alignment, were recorded at the site (Exhibit 4). Archaeologists excavated single shovel tests in the vicinity of proposed turbines ND 19 and ND 20. No artifacts were located.

Further investigation took place at the Gabriel Site in April of 2007. At this time, lithic debitage was observed on the surface in the exposed earth of a two-track field road. Due to the potential for intact subsurface deposits, 43 shovel tests were excavated within the APE in the vicinity of proposed turbines ND 19, ND 20, and ND 21. Thirteen of these shovel tests yielded cultural materials. The shovel testing at the Gabriel Site allowed researchers to determine the horizontal and vertical site limits within the APE.

After the site boundaries within the APE were defined, four test units were excavated within the APE. The test units measured 1-x-1-meter and were excavated in 5 cm levels. All soil was screened through ¼ inch hardware mesh. Excavation continued until two consecutive sterile levels were completed. Upon completion of the excavation of a test unit, two walls were profiled and photographed.

Three hundred and thirty-four artifacts were recovered during the evaluation of the Gabriel Site; 38 artifacts from 13 shovel tests, 239 artifacts from four test units, and 57 artifacts collected from the surface. With the exception of one full-grooved groundstone maul, all artifacts were chipped stone lithic tools and debitage. Eight tools and debitage from all stages of reduction were recovered during the evaluation, including the groundstone maul, a Knife River Flint (KRF) Duncan point, a KRF drill fragment, a fusilinid chert Besant point, and four bifaces or biface fragments.

Due to the high artifact count, number of surface features, and excellent soil integrity, Westwood and 10,000 Lakes Archaeology recommended that the site was eligible for listing on the NRHP under Criteria D, "may be likely to yield, information important in prehistory." Paul Picha, Chief Archaeologist with the State Historical Society of North Dakota, and on behalf of Merlan E. Paaverud, the ND State Historic Preservation Officer, concurred with the recommendation of eligibility.

Because of the significance of the site, Tatanka Wind Power agreed to sponsor a mitigation of the site and avoid surface features to the best extent possible.

3.1 Data Recovery Research Questions

The goals of the data recovery efforts at 32DI0095 were to mitigate the adverse effects of the construction of the wind farm upon the site. It was hoped that these efforts would give basic information about the Gabriel Site in order to lay the

groundwork for further, more in-depth research and investigations on the remaining undisturbed areas of the site in the future.
The following specific research questions were considered during the data recovery and are addressed (in order) in this report:

1. Is the Gabriel Site part of the McKean Complex? Are other components present? What are more precise dates for the McKean and/or other complexes at 32DI0095?

2. Are the stone circles located at 32DI0095 associated with the McKean complex? Are the stone circles the only remaining portions of habitation structures (tipi rings) or did the stone circles serve some other purpose? What additional surface features are associated with this site?

3. What can the raw material profiles at 32DI0095 tell us about the site? Can they help ascertain whether the site is single component or multicomponent, or whether any stratigraphic trends occur? What do they suggest about the age of any components that are present? What do the nonlocal and exotic raw materials indicate about contact with other regions?

4. What were the subsistence practices at 32DI0095? What was the site's function? Through subsistence practices and settlement behavior can the sites seasonality be inferred?

4.0 Environmental and Cultural Background

4.1 Topography

The project area is within the Missouri Coteau physiographic region of the Great Plains. This region has a hilly to rolling terrain with many lakes and sloughs. The topography consists of a dead-ice moraine with landforms including collapsed glacial sediments, ice-disintegration features, flood plains and lake plains. It was created from collapsing glacial sediment during the retreat and melting of the last Wisconsinan glacier between 9,000 and 12,000 years ago. The average thickness of glacial sediment is 300 to 400 feet thick with a range of 200 to 500 feet (Bluemle 1979). The area has poorly-integrated drainage with water runoff coming from areas of higher elevation into small depressions (prairie potholes). The drainage which does occur, especially near the Missouri Escarpment, drains into the James River via the Elm River.

4.2 Climate

Bluemle summed up the areas historical climate of the last 10,000 years in Geology of Dickey and LaMoure Counties (1979). Between 10,000 and 8,500 years ago the area was cool and humid. The forests disappeared and the lakes became sloughs due to a warming trend that began 10,000 years ago. The area was drier and warmer than present conditions from 8,500 years ago until 5,000 years ago. More lakes became sloughs and less grass covered the land causing more erosion. The grass cover returned approximately 4,000 years ago as precipitation increased once again. The present climate of the project area is a sub-humid continental climate. This climate has short summers, long winters, and rapidly changing temperatures with large, sometimes extreme, variations. The annual precipitation is approximately 15 to 19 inches. Average temperatures in January are -3 degrees Fahrenheit for a low, and 16 degrees Fahrenheit for a high. Average temperatures in July are 57 degrees Fahrenheit for a low, and 84 degrees Fahrenheit for a high (United States Geological Survey [USGS] 2006).

4.3 Vegetation

The presettlement vegetation consisted mostly of a mixed grass prairie following the disappearance of the boreal forest due to climate change. This boreal forest contained spruce and various deciduous trees. The vegetation of the mixed grass prairie includes western wheatgrass, bluestem, needle and thread, and green needle grass (USGS 2006). The native mixed-grass prairie remains. Man-made fires on the prairie inhibited the return of woodlands (SHSND 1990). Present use of the land is almost completely pastureland.

4.4 Wildlife

Wildlife that prehistorically occupied the area includes bison, wooly mammoth, grizzly and black bear, and elk. These animals have since been extinct in the project area. The current environment of the area is home to diverse wildlife. Mammals include white-tailed deer, cottontail and jackrabbit, beaver, badger, coyote, fox, skunk, raccoon, mink, and many small mammals. Birds include raptors, songbirds,

goose, and duck. (American Society of Mammologists 1999; SHSND 1990; USGS 2006).

4.5 Soils

The soils in the area of 32DI0095 are Typic Calciborolls of the Zahl-Williams Association. These are deep, nearly level to very steep, well drained, loamy soils (USGS 2006). These soils formed in glacial till and have a 6 to 25 percent slope. The stones in the glacial till, also known as glacial erratics, were used by American Indians for boiling stones, sweat lodges, groundstone, pertroforms and petroglyphs, weights for tipis, and flintknapping (SHSND 1990).

During the excavations at the Gabriel Site, archaeologists described the soils including color and texture. Color was determined using the Munsell Soil Color chart, and soil textures were determined by feel. Four strata or deposits were identified at the Gabriel Site. These have been designated A-D, from top to bottom. Although some slight differences exist across the site in regards to soil color and texture, and not all units contain all strata, the strata remain generally consistent, with the exception of one block of units located in a depression. As one would expect, excavations in the depression area showed thicker strata, while conversely excavations conducted on high areas showed thinner, deflated soils. Although archaeologists recovered artifacts in all strata, totals decrease within Stratum C. The four strata and depression are described as follows:

4.5.1 Stratum A

Stratum A is an AO horizon with an average thickness of five centimeters. The soil color is dark brown 10YR 2/1, and the texture is silt loam. This stratum also contains glacial cobbles and large amounts of roots and other organic material.

4.5.2 Stratum B

Stratum B, an A horizon, varies in thickness from 0 to 45 centimeters with an average thickness of 11.5 centimeters. The color of this horizon is dark brown 10YR 2/2. The texture is silt loam with increasing amounts of gravel.

4.5.3 Stratum C

Stratum C is a B horizon with an average thickness of 26.25 centimeters, and varies from 0 to 40 centimeters thick. This stratum is potentially thicker, but excavations rarely reached the bottom of this stratum. Stratum C is a medium brown 10YR 3/3 sandy silt loam with the amounts of gravels and large cobbles continuing to increase.

4.5.4 Stratum D

Stratum D is a C horizon. Sediment thickness is difficult to discern because soils removed from the stratum were usually culturally sterile and thus excavations ceased before reaching the bottom of Stratum D. In fact, excavations generally encountered culturally sterile soil within Stratum C, thus Stratum D is not well

defined. The color of this horizon is a medium to light brown 10YR 4/6. In this stratum gravels and glacial cobbles increase.

4.5.5 Depression

Approximately within the center of the site, within a shallow depression, a large block unit was excavated. The units within this block included TUs 10, 11, 26, 27, 42, 43, 45, 47 and P2-2 (a unit excavated during the evaluation of the site). The soils in this block unit did not follow the same stratigraphic patterns as found over the rest of the site. Large mottles were located throughout the units. Some units had very deep layers of Stratum A and B, while others did not.

It is possible that this depression was formed by a glacial ice block "collapse" similar to what created many of the prairie potholes throughout the region. Historically, this depression may also have been a prairie pothole, but due to its small size has filled in over the last 10,000 years by deposition from the higher areas around it. Different depositional episodes may be responsible for the mottles and unusual stratigraphy within this block unit.

In addition to the variations in the stratum thicknesses, excavations in three of the units (TUs 10, 11, and 45) stopped at approximately 55 centimeters below surface (cmbs) due to a layer of large rocks. Test units (TUs) 26, 27, and 45 also showed a re-emergence of the organic-rich Stratum B at approximately 50-55 cmbs. Initially it was thought that this indicated a buried A Horizon or paleosol, however upon further examination it appears as though it might have caused by soil eroding from higher points around the depression into the depression.

Another piece of evidence can be seen in TU 48. This unit was placed on a ridge above the depression in an area that seemed a likely location from which soils would erode from into the depression. Excavations of this unit revealed that both Stratas A and B were indeed eroded away.

5.0 Cultural History

5.1 Paleo-Indian Tradition (9,500 to 5,500 B.C.)

The Paleo-Indian Tradition refers to the period of time at the close of the Pleistocene era and into the Holocene era, when American Indian communities were small, mobile and focused on hunting. This period is marked by the retreat of glacial ice, the decline of the megafauna (e.g. wooly mammoth, mastodons, and camels), and the growth of modern vegetation. The small number of artifacts found at Paleoindian sites indicates that these communities hunted a limited number of large animals in a variety of environmental settings. As the Pleistocene era ended and the Holocene era began, the megafauna gradually died out. This caused the Paleoindian people to shift their focus from hunting animals such as the mammoth to the largest remaining species, bison. In addition to bison, it is likely that gathering wild plant foods and hunting smaller animals also contributed significantly to the diet of the Paleo-Indian people (SHSND 1990).

Artifacts and features associated with the Paleo-Indian Tradition are rare within the James River Study Unit. Distinctive stone tools made by the Paleo-Indians included large lanceolate projectile points. Folsom, Agate Basin, Hell Gap, and Cody complex points have been identified in private collections from the area. A collector found a Scottsbluff point near the town of Dickey. Also, a surface survey identified a Knife River flint blade of the Paleo-Indian Tradition south of LaMoure (SHSND 1990). As of 1990, no Paleo-Indian sites with intact subsurface deposits had been identified in the James River Study Unit. The lack of recorded Paleo-Indian sites may be due to the characteristics of those areas that have been surveyed. Specifically, many survey areas are located in places with deeply buried deposits or areas that were underwater during the Holocene period (SHSND 1990).

5.2 Plains Archaic Tradition (5,500 to 400 B.C.)

The Plains Archaic Tradition is divided into Early, Middle, and Late components. The people of the Plains Archaic Tradition remained hunters and gatherers as their Paleo-Indian forbearers. However, shifts in diet and settlement patterns define the transition to the Archaic Tradition. It seems that native people were adapting to environmental changes by using more diverse plant and animal resources

During this period, Plains Archaic people began developing regional differences within their material culture, interaction between different populations became less common, and the quality of craftsmanship exhibited by their lithic tools diminished. As with Paleo-Indian sites, Archaic sites are relatively small and ephemeral. Similarly, with Paleo-Indian sites, it is believed that Archaic sites are likely deeply buried in the floodplains.

Many Archaic projectile points have been collected by amateur archaeologists and multiple Archaic Sites have been located within the James River Study Unit. These sites included isolated projectile points, artifact scatters, and a burial (SHSND 1990).

Examples of Archaic sites within the Study Unit include the Naze Site (32SN0246), Akata Site (32SN121), and Nelson Site (32SN111). The Naze Site is a small artifact scatter located in buried soils with a radiocarbon date of 3405 ± 85 BP (SHSND 1990). The Akata Site is very deeply buried (180-220 centimeters below datum) and yielded flaking debris, fire-cracked rock, and burned and butchered bone from various animals such as bison and rabbit, and produced radiocarbon dates of 2721 ± 31 BP and 2566 ± 30 (SHSND 1990). The Nelson site yielded projectile points, various stone tools, groundstone tools, bone, and bone tools, and was radiocarbon dated at 2380 ± 70 BP and 2923 ± 40 BP (SHSND 1990).

This report discusses the Gabriel Site (32DI0095) which is a large multi-component site located on the Missouri Escarpment in southwest Dickey County, North Dakota. Through point typology at least two components have been identified: Archaic (McKean) and Woodland (Besant). The McKean complex of the Middle Plains Archaic dates from 2500 – 1000 B.C., and is the dominant culture of the Middle Plains Archaic. Three point types make up the named point typology of the McKean complex; the McKean Lanceolate, Duncan and Hanna.

Archaeologists continue to debate the point typology of the McKean complex. Specifically whether the three point types are variations of a single type or if they represent three distinct, separate but connected cultural groups (Frison 1991). Wheeler (1952, 1954) defined the three points based on excavations at the McKean site and sites in the Keyhole Reservoir of Wyoming. Mulloy (1954), however, grouped the point types together as variations of a single type based on his work at the McKean site. Other researchers feel that the McKean Lanceolate point is simply a resharpened Duncan point, while Davis and Keyser (1999) have attempted to show that Duncan and Hanna are a single projectile point, separate from the McKean Lanceolate.

Several points found at the Gabriel Site relate to the McKean complex. These include the base of a McKean Lanceolate point, a complete but broken Duncan point, and a broken side-notched point with a slightly concave base that fits into the Hanna typology.

5.3 Plains Woodland Tradition (400 B.C. to A.D. 1850)

Throughout the Midwest, the Woodland Tradition is generally divided into three periods: Early, Middle, and Late. The transition to the Woodland Tradition occurred when American Indians began manufacturing ceramic vessels, using bows and arrows, constructing earthen burial mounds, cultivating various plant species, and harvesting select plant species. Notwithstanding these developments, life for communities during the Woodland Tradition in many ways remained similar to that of the Archaic period.

Despite some similarities between Initial Woodland and Archaic period community size, populations began to grow during the Late or Terminal Woodland period. One possible reason is that American Indians became increasingly efficient in how they

acquired food toward the end of the Woodland period. Site types assigned to the Woodland Tradition throughout the region range from cemeteries and small limited use sites to extensive village and habitation sites. Woodland period communities were situated in locations that ranged from focusing on a specific resource to general environments capable of sustaining a large community for a long time.

Ceramics recovered from the Kirschenmann III Site (32SN427), Peterson Site (32LM22), and Beeber Site (32LM235), resemble those of Blackduck, Sandy Lake, and St. Croix. Artifacts recovered from these sites include side notched, corner notched, and triangular projectile points that are predominantly knapped out of Knife River flint (SHSND 1990).

Very few burial mounds have been tested in the James River Study Unit as of 1990. Two mounds sites tested include the Kropp Site (32SN8) and Birks Site (32SN28). The Kropp Site contains three linear mounds and one large conical mound (referred to as the Great Mound). The Great Mound contained approximately 20 individuals in three different levels. The Birks Site consists of 21 conical mounds. One of the mounds excavated contained the bones of five individuals as well as bison remains, a single ceramic body sherd, and a small amount of lithic material (SHSND 1990).

The second component identified through point typology at the Gabriel Site is the Besant culture of the Plains Woodland. While the Besant culture is normally given a temporal range of 100 B.C. – 750 A.D. (Gregg 1985), there is also evidence of Besant being used in the Early Plains Woodland (i.e. the Naze site), 700 B.C. – 100 B.C. and some points with similar morphological attributes could potentially be dated to the Late Plains Archaic (Michlovic 2008). The Besant point found at the Gabriel Site may have attributes similar to other point styles of the Early Plains Woodland, but without other points, artifacts, or absolute dates it may be better to date this component to the Initial Plains Woodland. Although fragments of ceramics were located at the Gabriel Site, they were of such poor condition researchers could not determine if they related to the Besant.

5.4 Plains Village (A.D. 1000-1850)

Significant changes in subsistence and settlement patterns characterize the shift to the Plains Village Tradition. Ceramic vessels differ from previous types in form as well as decoration, and settlement patterns shift to larger, more permanent villages typically located in riverine settings. The subsistence strategies of these populations appear to incorporate hunting and gathering with limited agriculture focusing on specific plants. The Plains Village primary adaptation was "...the production of a dependable storable surplus food supply primarily in the form of dried corn" (SHSND 1990). Evidence indicates that the Plains Village complex relied heavily on bison hunting and intensive corn horticulture.

The Hendrickson III village site consists of six to seven circular lodges with an average radiocarbon date of A.D. 1317-1414. Knife River Flint and jasper projectile points were recovered, and the faunal material suggested that the villagers continued

to exploit bison as well as small game animals, wild plants, and cultivated corn (SHSND 1990).

5.5 Equestrian Nomadic Tradition (mid 1700's-1851)

The introduction of the horse is the primary characteristic of the Equestrian Nomadic Tradition. This period is also referred to as protohistoric; a time when the indigenous people were coming into contact with and being influenced by European culture. This contact was not always direct interaction between Native and Euro-American peoples, but sometimes through contact with items of Euro-American cultural material being traded throughout the area.

The Hintz Site (32SN3), a Hidatsa Village, yielded metal knife blades, while the Naze (32SN246), Beeber (32LM235), Peterson (32LM22), and Winitipi Sites (32LM9) yielded glass trade beads, scraps of brass, and gun parts. The presence of these materials at the sites suggests either direct or indirect trade with Euro-Americans (SHSND 1990).

5.6 Historic Period

The Historic Period refers to the time when the Euro-American presence and influence became unavoidable. During the Historic Period, Euro-Americans pushed westward and increasingly settled in the Dakotas. Although North and South Dakota were initially within the Missouri Territory, the Dakota Territory was eventually established in 1861 and encompassed South Dakota, North Dakota, and much of Montana and Wyoming. Dakota Territory was opened to homesteaders in 1862. Following the opening of the Dakota Territory several railroads that served the territory, including the Dakota Southern and Manitoba (known later as the Great Northern) Railways, were built, and the Gold Rush of 1876 began. These events led to massive Euro-American settlement of the Dakota Territory between 1872 and 1887. This period is known as the Great Dakota Boom. A severe drought brought the Boom to an end between 1886 and 1887.

In 1889 North and South Dakota were admitted to the Union as the 39th and 40th states, in no particular order. The states were the leading producers of wheat until the drought and Great Depression in the 1930s, and railroads continued to expand and run until the collapse of the farming industry in the 1980s. Significant events witnessed by residents of North and South Dakota throughout the 20th century include discovering oil in 1927 and 1951, enduring record blizzards, creating numerous military bases and nuclear missile silos, and constructing dams.

5.6.1 Dickey County, Albertha Township

The Gabriel Site lies in southern Dickey County within Albertha Township. William Dickson of the Nicollette-Fremont expedition explored the Dickey County area in 1839 (Black 1930). The Homestead Act of 1862 encouraged white settlement in the Dakotas, while the 1881 construction of the Milwaukee Railroad further facilitated colonization of Dickey County (Dickey County Historical

Society). The county was established on March 7, 1881 with the county seat of Ellendale being formed in 1882.

Albertha Township was originally the southern half of a 12 mile by 12 mile township called Spring Valley. Albertha was organized as a separate township on June 7th, 1909. The township's name came from the names of a teacher, Bertha Dickie, and a poet, Al Town. These individuals were staying at the home of early settler T. R. Shimmin where the township organizational meeting occurred.

The first settlers of European descent in Albertha Township were Orville Childs Hart and his wife. The Harts moved into a gulch in the eastern portion of the township in 1882 (Black 1930:295-301). Several months later, Orville's son James came to visit his parents and found they were still living in a tent as Orville's horse and oxen had been injured and unable to haul wood. With winter coming, James quickly brought loads of lumber from Frederick, South Dakota and built his parents a house. James then moved his family to the gulch to help take care of his parents (Hart to Hart n.d.).

The primary immigrants that settled in Dickey County were Scandinavian, German, Russian, and Finnish. According to the 2000 census, the population of Dickey County is 5,757, approximately 41% of German heritage, 14% of Norwegian heritage, and the remainder of ancestries of various other, primarily European, countries (ePodunk 2007a). As of the 2000 census, Albertha Township had a population of 20 people; 12 of which were of German heritage and eight of which were of Norwegian heritage. (ePodunk 2007b).

6.0 Excavation Methods and Results

The data recovery began with the excavation of a series of 1-x-2-meter units (stratigraphy maintained as 1-x-1-m units) placed approximately every 30 meters throughout the construction corridor. This was done in an attempt to learn about the soil profiles across the site and determine where the highest concentrations of artifacts were located. Based on the artifact counts and soil stratigraphies in these excavation units, additional units were placed and excavated (Exhibits 5 & 6).

A 2-x-2-meter block unit was also excavated within the stone circle which would be impacted by construction. An additional 1-x-1-meter unit was excavated on the stone ring and a final 1-x-1-meter unit was excavated outside the feature as a "control" unit.

Formal test units were excavated in 5 cm levels by shovel skimming and trowel. All soil was screened through ¼ inch hardware mesh. Artifacts and soil information were recorded for each level. Excavation of a unit ceased after two sterile levels unless an adjacent unit had archaeological deposits extending to a greater depth. Units were excavated to a maximum of a 5 cm difference to an adjacent unit with both units having at least two sterile levels. Soil profiles and photographs were taken for two walls of each unit. Forty-nine 1-x-1-meter units were excavated across the site during the data recovery excavations.

In addition to the excavations, a pedestrian survey was conducted across the site to make certain all surface features had been located. Although this task proved difficult due to dense vegetation, what appeared to be a new rock alignment and several stone circles were recorded.

Finally, steps were taken to clarify the rock alignment and the newly recorded stone circles. These efforts included trimming the grass and using a grid to accurately map individual rocks. With the vegetation cleared, researchers realized that the stone circles were actually natural rock (not circles). However, the rock alignment appeared to be cultural with additional placed rocks near the southern end of the line. To further clarify this feature, the sod was removed from around the rocks, revealing many additional, smaller rocks which seemed to be sodded to approximately the same depth as the larger rocks. Removal of the vegetation and sod from around the rocks revealed a petroform, possibly zoomorphic in nature.

Upon completion of the Gabriel Site data recovery excavations, archaeologists had excavated 53 square meters; four in the assessment and 49 in the data recovery, Through all phases of investigation, a total of 1844 artifacts, including ceramics, lithic debitage and tools, a groundstone tool, and faunal remains were recovered. In addition to artifacts, 13 features, including seven stone circles, two cairns, two pits or depressions, one rock alignment, and one petroform were identified (Table 7; Exhibit 7; Appendix D).

6.1 Monitoring

In addition to completing the data recovery excavations, Westwood and 10,000 Lakes recommended that archaeologists monitor construction in the vicinity of the Gabriel Site. Between August 28th and August 30th, 2007, soil stripping and construction activities were conducted at the Gabriel Site. Westwood Cultural Resource Specialists Ryan Grohnke and Anne E. Anderson were on site to monitor for inadvertent discoveries including human remains or significant subsurface features. All surface features, with the exception of the previously excavated stone circle were avoided by construction activities.

No human remains or significant subsurface features were observed during the monitoring. One bone fragment was recovered and later identified by Minnesota SHPO National Register Archaeologist, David Mather, as the radial carpal of a large hoofed mammal.

7.0 Artifact and Feature Descriptions

Artifacts recovered from the Gabriel Site included lithic, ceramic and faunal material. (Table 1). A number of projectile points and tools are present, though the majority of the lithic artifacts were classified as debitage. The ceramics, which are all undiagnostic and unremarkable in style, were grit-tempered. The sparse assortment of faunal fragments was composed of highly fragmented remains of large ungulates. Artifacts were recovered from the surface, shovel tests and test units during the evaluation and data recovery of 32DI0095.

Table 1:
Artifact Assemblage Classes divided into Categories

class	**Lithic**			**Ceramic (grit)**		**Faunal**		**Total**
n=	1798			27		20		1844
% of assemblage	97.5%			1.5%		1.1%		100.0%
category	Debitage	Tools	Points	Decorated	Undecorated	Diagnostic*	Non-Diagnostic	
n=	1708	82	8	7	20	5	15	
% of assemblage	92.6%	4.4%	0.4%	0.4%	1.1%	0.3%	0.8%	
% of class	95.0%	4.6%	0.4%	25.9%	74.1%	25.0%	75.0%	

**Identifications of faunal remains are speculative due to highly fragmented nature of the material.*

7.1 Lithics

Lithic artifacts constituted 97.5% of all artifacts recovered from the Gabriel Site. The 1,798 lithic artifacts were categorized broadly as debitage, points, and tools, with the tools and points comprising 5% of the total lithics (Table 2; Appendix F). The remaining 95% was made up of various types of debitage from tertiary flakes to cobbles tested for raw material (Table 3; Appendix E). The most common raw materials recovered, in descending order of abundance were: Knife River Flint; Swan River Chert; Tongue River Silica; Chalcedony; and Red River Chert. Artifacts were primarily crafted by flaking stone though one example of ground stone was present.

Table 2:
Lithic Debitage Subcategories from the Gabriel Site (32DI0095)

subcategory	**Tertiary**	**Secondary**	**Primary**	**Shatter**	**Core**	**Tested Cobble**	**Total**
n=	**1214**	**192**	**51**	**238**	**11**	**2**	**1708**
% of Lithics	67.5%	10.7%	2.8%	13.2%	0.6%	0.1%	95.0%
% of Debitage	71.1%	11.2%	3.0%	13.9%	0.6%	0.1%	100.0%

There was a fair range of tool types recovered from 32DI0095 (Table 3). If an artifact could be categorized under more than one heading, it was placed in the category and subcategory of its most distinctive or useful feature. For example, a utilized secondary flake was listed only as a utilized flake under tools instead of a secondary flake under debitage.

Table 3:
Lithic Tools Subcategories from the Gabriel Site (32DI0095)

subcategory	Utilized Fl.	Retouched Fl.	Scraper	Tool	Biface	Hammerstone	Total
n=	**37**	**9**	**12**	**16**	**6**	**2**	**82**
% of Lithics	2.1%	0.5%	0.7%	0.9%	0.3%	0.1%	4.6%
% of Tools	45.1%	11.0%	14.6%	19.5 %	7.3%	2.4%	100.0%

7.1.1 Stone Tools

A variety of materials were represented in the collection of bifaces recovered from the Gabriel Site and include two Swan River Chert, two Tongue River Silica, one Red River Chert, one porcellanite and one fusilinid chert (Appendix G2). Most of these bifaces were too fragmented or were in too early a stage of reduction to determine their intended use or morphology. Interestingly, the fusilinid chert biface (recovered from TU19, L3) was not in close proximity to the Besant projectile point (TU P2-2) of the same material which lies 135 meters to the northeast. There were only five other pieces of debitage of fusilinid chert. The biface fragment of porcellanite is one of two artifacts of the material at the Gabriel Site.

Scrapers were the most prevalent identifiable tool type after expedient tools (Appendix G3). Nine scrapers in this assemblage were made of Knife River Flint, two were made of Tongue River Silica, and one was made of jasper. Almost all scraper forms fall roughly within endscraper morphology except for one sidescraper (TU 25, level 5) and one concave scraper (TU 18, level 3).

Two hammerstones were recovered, both of which were quite large (1276.0 and 562.0 grams), evidence of pecking on each end, and have a flat surface which could have been used for smoothing (Appendix G5).

The 'Tool' subcategory counts fragments of tools where form or purpose cannot be identified beyond the fact that they have been crafted and used (Appendix G4). The grooved maul (recovered from TU P2-1, level 6) was listed within this subcategory for lack of a more suitable available grouping. This maul was the only groundstone artifact in the assemblage. There were a number of working surfaces on the maul which appeared to have been used primarily for pecking and pounding. The rounded end of the maul showed heavier wear than the opposite, flatter end. This flat surface appeared to also have evidence of grinding, as well as pecking. Wear on the groove, which was ground into the entire circumference of the maul, does not clearly indicate whether hafting did or did not occur. The groove was on average about 2.75 cm wide and 0.5 cm deep.

Utilized flakes were the most common tool type. Of 82 tools, 45.1% were flakes with signs of use on one or more edges. Retouched flakes are essentially utilized

flakes, but have extra modification or resharpening along the utilized edge(s). These modifications were not, however, as extensive as a fully-formed tool that has been flaked on nearly every surface. If utilized and retouched flake categories are grouped together under the title of 'expedient tools', they make up more than half of the tool category at 56.1% (Appendices G6 & G7).

7.1.2 Projectile Points

While conducting the evaluation of 32DI0095 a single Duncan projectile point created from Knife River Flint was located in TU P2-3. This point suggested that the Gabriel Site was from the McKean complex or had a McKean complex component. Another projectile point was also located in TU P2-2. This point was made from fusilinid chert but was missing its tip. Initial analysis identified this point as Pelican Lake or possibly an unfinished Besant. The McKean complex is dated approximately 2500 – 1000 B.C., the Pelican Lake complex has been dated 1500 B.C. to A.D. 400 and the Besant complex has been dated ca. 100 B.C.-A.D. 750 (Gregg 1985). Researchers thought that if the point dated to the Pelican Lake complex, the Gabriel Site might have a second component or could date to the transition from the McKean to the Pelican Lake complex (ca. 1500 B.C.). If, however the point was a Besant, the Gabriel Site would have a separate second component.

Eight projectile points/tools were recovered during the evaluation and data recovery excavations at the Gabriel site, including one Knife River Flint biface/drill, one Knife River Flint projectile point base, one silicified wood projectile point base, one Knife River Flint projectile point, one Knife River Flint projectile point fragment, one fusilinid projectile point, one Hixton Silcified Sandstone point tip, and one chert projectile point (Tables 4 & 5; Appendix G1). These tools are all discussed in detail below.

Table 4:
Projectile Points Subcategories from the Gabriel Site (32DI0095)

subcategory	**Identified**	**Unidentified**	**Total**
n=	**4**	**4**	**8**
% of Lithics	0.2%	0.2%	0.4%
% of Points	50.0%	50.0%	100.0%

Table 5:
Diagnostic Projectile Points from the Gabriel Site (32DI0095)

Location	**Typology**	**Period**	**Dates**	**Material**	**Catalog #**
TU P2-3, L6	Besant	Initial Woodland	700BC-AD700	Fusilinid Chert	1259.1
TU P2-2, L3	Duncan	Middle Plains Archaic	2500-1000BC	Knife River Flint	1265.1-2
TU1, L4	McKean Lanceolate			Knife River Flint	1007.3
TU33, L6	Hanna			Tongue River Silica	1291.1

The first Knife River Flint point base (#1007.3) measures 20.4mm (Length) x 20.9mm (Width) x 3.1mm (Thick), and was recovered from TU 1, level 4 (15-20cmbs). This tool is the basal fragment of a lanceolate projectile point. Stylistically, the point base is comparable to the McKean Lanceolate. The point has a concave base with nearly parallel blade edges that trend slightly convergent towards the distal end. The retouch flakes detached during manufacture extend to the midline. No grinding is observable on either the base of proximal blade edges. The distal end, or tip, of the projectile is missing. The line of the fracture is perpendicular to the blade edges. The surface of the fracture scar is hinged suggesting the item may have been fractured from impact during use.

The silicified wood point base (#1029.1) measures 18.9-x-18.3-x-4.1mm (LxWxT), and was recovered from TU 7, level 2 (5-10cmbs). It is the basal remnant of a projectile point, and is slightly concave with indented side notching. The distal end of the point has been broken from the tool. The surface of the fracture scar is hinged suggesting the item may have been fractured from impact during use. The hinging is accompanied by a series of small spalls, or step-fractures originating from the edge of the fracture. The nature of this damage is indeterminate. The smaller spalls may have originated from the impact that broke the point or may have occurred after the break when the tool may have been used for other activities. One of the edges also exhibits use-wear, possibly the result of scrapping activities.

The third tool is a Knife River Flint point fragment (#1051.3). This tool measures 14.1-x-14.7-x-2.9mm (LxWxT) and was recovered from TU 11, level 5 (20-25cmbs). This point fragment, which includes a section of the lateral edge of the tool with a distal portion of a notch feature, is missing its tip and may have been snapped off during use. A hinge fracture runs along the proximal edge of the tool where the base of the tool has been removed. The edge opposite the remaining retouched edge has likewise been fractured away leaving a single faceted surface. There is no indication as to the nature of this fracture. Remnant flake scar surfaces indicate this point was manufactured from a flake blank.

The forth tool is a bifacially flaked Knife River Flint drill (#1123.2) that was recovered from TU 27, level 3 (10-15cmbs). It measures 41.1-x-17.2-x-4.7mm (LxWxT) and is possible that it was manufactured from a previously formed tool, possibly a projectile point. The proximal end of the tool is a fracture plane. The fracture itself is flat and occurred after the tool was retouched. Several retouch scars are intersected by the fracture. The tool is also widest at the proximal end. The edges of the tool constrict closely beyond the proximal end and taper consistently towards the distal end. Invasive retouch of the working edges of the tool intersect previous removals and appear to have reformed the tool to a thinner, more sharply pointed implement.

The fifth point is a Hixton Silicified Sandstone point tip (#1170.1) exhibits relatively large flake scars on both facets of the tool. It measures 19.8-x-14.7-x-

3.8mm (LxWxT) and was recovered from TU 38, level 3 (10-15cmbs). On one side the flake scars intersect in the midline of the tool. The opposing face of the tools is dominated by a single flake scar along one entire edge with smaller, finer detachments located along the opposing edge. The tool is broken by a snap fracture (flat break) from the base. There does not appear to be any secondary flaking of the lateral edges of the tool which might indicate a reworked edge. Without a base it is not possible to assign this point to a specific typology.

The sixth point is a Fusilinid Chert projectile point (#1259.1) was recovered from TU 2, level 3 (10-15cmbs) is a nearly complete side-notched point. The base is slightly convex and exhibits irregularly shaped side-notches. The morphological characteristics make the point comparably stylistically to both Besant and Pelican lake points. The distal end of the point has been broken from the tool. The surface of the fracture scar is hinged suggesting the item may have been fractured from impact during use. The hinging is accompanied by a series of small spalls, or step-fractures originating from the edge of the fracture. The nature of this damage is indeterminate. The smaller spalls may have originated from an impact that broke the point. The blade edges of the point have been extensively reworked producing a slight concavity to the edges and producing an asymmetry that cants the distal end of the tool laterally.

The seventh point consisted of two pieces of a single Knife River Flint stemmed lanceolate project point with convex lateral edges (#1265.1&2). The point was recovered from TU 3, level 2 (5-10cmbs) and measures 47.1-x-21.1-x-5.9mm (LxWxT). The point is basally notched and lacks side notches. Stylistically the projectile is identified as a Duncan Point and associated with the McKean Complex. The nature of the fracture of the point is indeterminate.

The eighth point was a nearly complete side-notched projectile point (#1291.1) was manufactured from a flake blank and measures 26.0-x-16.5-x-3.1mm (LxWxT). The point was recovered from TU 33, level 6 (25-30cmbs). The base of the point is slightly convex and exhibits irregularly shaped side-notches. Stylistically the projectile is identified as a Hanna point and is also associated with the McKean Complex. The distal end of the point has been broken from the tool. The surface of the fracture scar is hinged suggesting the item may have been fractured from impact during use. The hinging is accompanied by a series of small spalls, or step-fractures originating from the edge of the fracture. The nature of this damage is indeterminate. The smaller spalls may have originated from an impact that broke the point.

7.2 Lithic Raw Material Analysis – by Kent Bakken

Because lithic artifacts are the main kind of evidence recovered from the Gabriel site, much of what we can learn from this site will be learned by understanding the lithic assemblage. This assemblage, however, is initially difficult to untangle or interpret. It varies in character across the site. It was recovered from stratigraphic columns varying in depth from about 20 cm to 60 cm. Some units display unimodal peaks in

artifact distribution, others display bimodal peaks, and there seems to be little consistency in stratigraphic distributions. There are a number of diagnostic lithic artifacts that help us estimate the chronology of the site and what kinds of components are represented, But the diagnostics only go so far in helping us understand site structure and chronology. Beyond that, it might be tempting to say that the site preserves a set of superimposed and intermingled components of uncertain age, components that cannot be analytically untangled or profitably understood.

But the initial examination of the lithic data also provides a few hints that there is some recurrent patterning and, just maybe, some hope to at least partly sort out a complex mix of assemblages of different ages. One of these clues is a tendency, seen in many but not all excavation units, for Swan River Chert to predominate at the bottom of the stratigraphic column and Knife River Flint to predominate at the top. This is reminiscent of the results that might be predicted by a model of raw material use patterns being developed for the region. The model examines changes in raw material use between geographic regions and especially through time (Appendix E).

The following analysis applies this new model to the Gabriel Site assemblage, in an effort to better understand the age and structure of the site. In order for this analysis to make sense, it's first necessary to present a synopsis of the use pattern model. The synopsis necessarily omits much of the supporting evidence and details of the reasoning behind the model. At this time the most detailed examination of the model is a draft manuscript focusing on one region; a complete description will be completed within the year.

Understanding the use pattern model requires also some understanding of a model examining the regional availability of lithic raw materials. The first version of this model (Bakken 1997) has seen some application in regional studies. The current version (cf. Bakken 2006), however, includes some important revisions. Therefore an abbreviated review of the revised model is also presented here. As with the use pattern model, a complete description of the resource region model will be completed within the year.

Further, an interpretation based on the use pattern model only makes sense in the context of the site's geomorphology. Work at the site did not include a geomorphologic study, so we rely on geomorphic models and regional geomorphic syntheses. The relevant geomorphic models and syntheses are also presented in summary.

The Gabriel Site offers an interesting opportunity to work with multiple lines of evidence and multiple models in an effort to understand the human occupation of this part of the landscape. How did this landscape evolve, how long have humans used it, and how can we untangle these matters to learn something about each?

From an archaeological perspective, there is an equation to be solved at this site: what

components are present, and what is their disposition across and into the landscape? This equation has too many variables to solve conclusively -- deposition, erosion, pedoturbation, time, microvariability of landscape use, technological variation, cultural variation, sample size, sampling considerations, random chance, and probably others. At least the equation cannot be solved based on the available information. If more of the variables were controlled, maybe we could solve the problem. But even given this, we can still observe overall, long term trends, and use these observations to guide our questions and procedures in future research. We can propose interpretations that can be tested.

The lithic raw material analysis at this site offers some insights, but does not serve to completely untangle the record from the site. The observed general trends largely conform to what would be expected based on the model of raw material use patterns in the region. Some details, however, do not match the model, and it is not clear why this is so. The final results of this analysis are best considered to be exploratory. They will need to be critiqued in the light of what we find at other sites and, ideally, tested as a part of the excavation of similar sites. Hopefully, however, this sort of analytical approach will prove helpful in better understanding this and other sites around the region.

7.2.1 Supporting Information

The Gabriel Site lithic raw material analysis relies on four basic sets of ideas relating to geomorphology and to regional lithic raw material resources. Each of these is presented in overview in the following pages. The two sets of geomorphic information are more briefly reviewed, since they are well-documented in available published sources. The two regional raw material models are presented at somewhat greater length, since the supporting documentation is not yet generally available. The synopses of the models are still necessarily abbreviated, however, and emphasize conclusions over evidence and the supporting lines of reasoning.[1]

The Burial of Artifacts in Upland Landscape Contexts

The first geomorphic model is reviewed by Van Nest (1993, 1997), who provides a useful exploration of the burial of artifacts in upland landscape contexts. More specifically, she explores biomantle formation as a mechanism for the burial of artifacts on stable uplands in west-central Illinois, building on an idea proposed by Abbott and Tiffany (1986) for Iowa and the Upper Midwest. The biomantle is formed largely by the actions of burrowing animals, which carry finer soil particles to the surface. Larger particles or objects (such as many artifacts) remain in place and are gradually buried by the addition of soil above them; in effect they appear to gradually sink into the soil. The "sinking" begins more rapidly, slows down with increased depth, and ceases at the maximum depth of

[1] The two raw material models are the topic of the author's Ph.D. thesis, which will be completed in 2008.

faunal turbation where clasts (including artifacts) form a stone zone. The biomantle is the upper soil zone of particles that have been carried upward. The size of pieces that will be buried by this process varies with the size of the active fauna; gophers, for example, move larger size pieces than ants or earthworms do. The depth of the stone zone also varies, depending on the faunal agents and the soil. Van Nest (1997:321) credits Abbott and Tiffany with pointing out that the deepest burial will occur in soils with the deepest organic zones, with true prairie soils being at the deep end of the spectrum. It is important to note that in this scenario, older assemblages will be found farther below the surface than younger assemblages, until such time as all pieces of various ages are commingled in the stone zone.

When Van Nest applies this idea to selected sites in west-central Illinois, she concludes that biomantle formation alone was most likely responsible for burial of early archaeological assemblages, with no appreciable addition of aeolian or other sediment to the upland surfaces. She also notes, however, that burial of archaeological assemblages could be accomplished by soil upbuilding. In this scenario, sediment accumulates on the upland surface, but this happens slowly enough that pedogenesis and horizonation keep up with the upbuilding and no paleosols develop.

The joint operation of these processes at a site could conceivably lead to a deeper soil and better separation of assemblages of different age. In such a scenario, it might be possible that assemblages of different ages do not end up mingled in a single stone zone, if the stone zone moves upward with the soil upbuilding.

The Oahe Formation in North Dakota

The second geomorphic model is based on the work of Clayton et al. (1976), as presented in summary and overview by Artz (1995, 2000). Clayton et al. noted that aeolian sediments of Late Wisconsin and Holocene age covered uplands throughout North Dakota. They defined these sediments as the Oahe Formation, and subdivided this formation into the Mallard Island, Aggie Brown, Pick City and Riverdale members. They related these depositional units to major climatic episodes, with dry periods marked by aeolian deposition of sediments removed from eroding slopes, and wet periods marked by landscape stability and soil development. Subsequent work showed that the general outline of their model was sound, but that the complete stratigraphic sequence was rarely preserved at any given location. Instead, periods of erosion had removed parts of the sequence at most places. This results in gaps in both the geological and archaeological record. In addition, the most commonly preserved sediments -- and the attendant archaeology -- belong to the younger members. Artz (1995:75) does note, however, that many of these observations are based on work in western North Dakota, and that "Upland windblown sediments in eastern and northern North Dakota have not been extensively studied."

It is also worth specifically noting that the original model by Clayton et al. posits

increased upland deposition during dry periods, since increased sediment is available from eroding hill slopes and some of this would be deposited on uplands. Artz (1995) also reports on findings that the thickness of the upland loess mantle can vary considerably over local distances, and that it is often thicker on southeastern slopes, in the lee of the prevailing northwest winds. This would be the area where the wind would be more likely to loose energy and drop part of its sediment load.

7.2.2 A Regional Model of Raw Material Resource Availability

The first raw material model examines raw material distribution and availability in Minnesota and neighboring regions. An earlier version of this model is available in published form (Bakken 1997). The version used here is a revision (Bakken 2006) that is still in manuscript form. The model of raw material distribution and availability proposes that there are four raw material resource regions covering Minnesota and nearby parts of neighboring states and provinces (Figure 1). Each region has a different set of lithic raw materials and different conditions of availability. One of these, the South Agassiz Resource Region, includes an area generally covering western to south-central Minnesota and extending into nearby parts of Manitoba, North Dakota, South Dakota and Iowa. The Gabriel site is associated with the South Agassiz region, and may lie at the western limits of the region. The site's marginal position, however, is not certain because the limits of the resource regions have not been explored much beyond the borders of Minnesota.

Figure 1:
Lithic Raw Material Resource Regions and Subregions Compared to Surface Geology

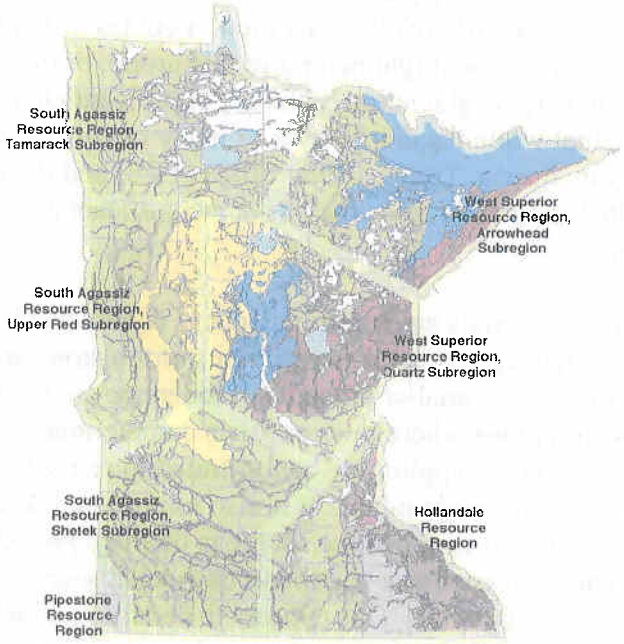


Table 6:
Primary, Secondary and Other Raw Materials
Found in the South Agassiz Resource Region

	Tamarack Subregion	Red River Subregion	Minnesota River Subregion
Primary Raw Materials	• Swan River Chert • Red River Chert	• Swan River Chert • Red River Chert	• Swan River Chert
Secondary Raw Materials	• Lake of the Woods Chert • Lake of the Woods Rhyolite • quartz	• Lake of the Woods Rhyolite • quartz • Tongue River Silica	• quartz • Red River Chert • Tongue River Silica
Minor Raw Materials	• jaspers • cherts • silicified wood • possibly other	• Knife River Flint • jaspers • cherts • silicified wood • possibly other	• Knife River Flint • jaspers • cherts • silicified wood • possibly other

Table 7 makes reference to raw material "groups." A group is a set of raw materials with a common distribution and, usually, common modes of transport (although there is some inconsistency on the latter point). In other words, for this glaciated landscape a group is a set of raw materials that were deposited in the region by the same glacial ice lobes. The Lake of the Woods group, for example, includes Lake of the Woods Rhyolite and Lake of the Woods Chert, both of which apparently originated in the area around and northeast of Lake of the Woods and were deposited in the South Agassiz Resource Region by an ice lobe moving from the north-northeast. A "Western Gravels group" includes pebbles of various cherts, jaspers, agates and other materials derived from sources as far west as the Rocky Mountains, transported into the region by preglacial rivers (e.g., Klassen 1969), and redistributed by glaciation. Pebbles of Knife River Flint (KRF) present in the region might belong in this group, or they may have been redistributed primarily by glaciation without a significant element of fluvial transport. Note that while the distribution of many raw materials is discussed and grouped by region, quartz, Tongue River Silica (TRS) and the Lake of the Woods group are handled separately since they have a significant presence in multiple resource regions.

These various raw materials are commingled and widely distributed throughout the region. Although significant concentrations of toolstone are probably uncommon in the region, smaller amounts of toolstone are likely widespread. This contrast with regions where raw materials come primarily from bedrock sources and raw material supplies are concentrated in restricted areas, but within those areas they tend to be abundant. It is also important to keep in mind that in a glacial landscape, any given toolstone source is likely to provide more than one raw material. This also contrasts with bedrock-related sources of toolstone, which provide only one raw material. This appears to be an important contributing factor in the creation of distinctive raw material use patterns. The presence of

Table 7:
Occurrence Rates of Selected Raw Materials
in the South Agassiz Resource Region and Its Subregions

Raw Material	South Agassiz Resource Region Overall	Tamarack Subregion	Upper Red Subregion	Shetek Subregion
BY RESOURCE REGION				
South Agassiz Matls	63.4	*78.5*	*57.0*	*50.5*
West Superior Matls	1.7	*1.3*	*1.9*	*2.0*
Pipestone Matls	0.1	*0.0*	*0.0*	*0.3*
Hollandale Matls	2.4	*0.1*	*0.7*	*8.8*
Lake of the Woods Group	2.1	*2.5*	*2.2*	*1.0*
LOCAL				
Swan River Chert	45.6	*51.2*	*42.0*	*44.2*
Red River Chert	17.5	*27.1*	*14.5*	*6.2*
Tongue River Silica	5.3	*0.3*	*7.7*	*8.7*
Quartz	5.8	*1.7*	*7.4*	*10.1*
Chalcedony	1.7	*0.5*	*2.5*	*2.3*
NONLOCAL				
Prairie du Chien Chert	1.4	*0.1*	*0.6*	*6.3*
Grand Meadow Chert	0.5	*0.0*	*0.4*	*1.8*
EXOTIC				
Knife River Flint	7.9	*6.7*	*10.5*	*2.9*
Obsidian	0.10	*0.17*	*0.02*	*0.21*

This table lists individual raw materials only if they occur at a frequency of at least 1.0 percent in one subregion; other materials also occur but are not specifically listed.

multiple, distinctive raw materials at any given toolstone source gave flintknappers a choice of raw materials, each with its own distinctive characteristics. The resulting choice of raw materials varied through time, based on factors like the prevailing technologies of the time or the level of demand for raw materials. In contrast, bedrock toolstone sources essentially offered a different choice: take it or leave it. This may have led to somewhat different provisioning strategies and use patterns in areas with bedrock sources for toolstone.

In addition to local raw materials, sites commonly contain exotic or other nonlocal raw materials.[2] The most common exotic raw material in the Upper Red

[2] The term exotic is used to indicate only raw materials that were intensively "quarried" and widely circulated. These should also be better quality, more desirable raw materials.

Subregion is Knife River Flint (Table 7), which can be the single most abundant raw material in some assemblages. Other exotics found at sites in the region include obsidian, Hixton Quartzite and Burlington Chert, although these are much less common. Other nonlocal raw materials found at sites in the region include Hollandale Resource Region materials from the southeast (Prairie du Chien Chert, Grand Meadow Chert, Galena Chert and Cedar Valley Chert); various fusilinid cherts from the south; Bijou Hills Quartzite plus various raw materials originating from the vicinity of the Black Hills to the southwest; Rainey Butte Silicified Wood, grey Tongue River Silica, plate chalcedony and other materials of western origin; and Fort Union Porcellanite of northwestern origin. None of these are particularly common in the Upper Red Subregion.

Table 8 lists the different raw materials found at the Gabriel site, together with information on their origins and distributions.

7.2.3 A Regional Model of Raw Material Use Patterns

The second raw material model examines how raw materials were used in a part of the Upper Midwest centering on Minnesota, and how that use changed through time. The model proposes that raw material use can be understood first in terms of changes in the selection of local raw materials, and second in the interaction between local raw material supplies and the changing availability of nonlocal raw materials. As used in this analysis, the model proposes three basic, underlying patterns in the selection and use of local raw materials -- the Large Biface, Small Biface, and Flake Tool use patterns. These provisional names are used for their mnemonic value rather than as exclusive technological characterizations. Each pattern is described below in moderate detail.

In summary, regional raw materials share a set of basic characteristics that make them suitable for use as toolstone. These raw materials also vary in other characteristics, however, and thus in their utility for various uses. It is the variation that gives rise to the use patterns. The model proposes that we can understand the variation based on two factors: 1) the generally available size of pieces of a given raw material; and 2) the flaking "quality," or how well fracture can generally be controlled in a given raw material. The most desirable raw materials occur in big pieces and have good conchoidal fracture. The least desirable raw materials come in small pieces or have poor conchoidal fracture. The Large Biface Use Pattern focuses on a limited set of the more desirable (i.e., bigger and better) raw materials. The change from Large Biface to Small Biface pattern is marked by a technological reorganization that enables the use of a wider range of local raw materials -- smaller pieces, or lower quality pieces, or both. The change from Small Biface to Flake Tool pattern is similarly marked by a technological reorganization, this time to enable the use of pebbles. The expression of each of these use patterns is also modulated by changing availability of nonlocal raw materials. The details are, as always, more complex than a

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This is a subset of nonlocal raw materials.

summary suggests, but the summary view still proves useful.

Table 8:
Information on the Lithic Raw Materials Found at the Gabriel Site, 32DI0095.

Raw Material	Source Area	Citations
Local		
Lake of the Woods Chert	Should be found through much of the South Agassiz Source Region, but more abundant in the northern reaches of the region. Bedrock source is from Lake of the Woods and generally to the northeast.	No standard references identified at this time.
Red River Chert	Should be found through most of the South Agassiz Resource Regions, but more abundant in the northern reaches of the region. Bedrock source is in the Winnipeg Lowlands.	Bakken 1985, 1997
Silicified Wood	Found in the South Agassiz Resource Region. Abundance within region not well understood, original source unknown.	Bakken 1985, 1997
Swan River Chert	Found throughout the South Agassiz Resource Region. Larger pieces may occur in the northern reaches of the region, and there may also be some higher quality pieces in that range. Bedrock sources have been identified in west-central Manitoba.	Campling 1980; Low 1995, 1996; Grasby et al. 2002; Leonoff 1970
Tongue River Silica (yellow-red)	Found in the Upper Red and Shetek subregions, and more abundant in some areas outside the South Agassiz Resource Region. No bedrock source identified. Should likely be considered a different raw material than grey TRS.	Porter 1962; Anderson 1978; Bakken 1985, 1997
Exotic		
Burlington Chert	Major source near St. Louis, also available in southeast Iowa and western Illinois.	Ives 1975; Meyers 1970; Rick 1978
Knife River Flint	Major source area in west-central North Dakota, secondary sources in a broader part of North Dakota, minor amounts in glacial till in parts of the Dakotas, Minnesota, Iowa.	Clayton et al. 1970; Gregg 1987; Loendorf et al 1987a
Hixton Quartzite	Point source of true Hixton in west-central Wisconsin, related materials found in a broader area of southwestern Wisconsin, possibly southeastern Minnesota.	Porter 1961; Boszhardt 1994; Penman 1981; Behm 1984; Brown 1984

Table 8- Continued

Other Nonlocal		
Fort Union Porcellanite	Parts of northern North Dakota, eastern Montana	Fredlund 1976
Fusilinid Group	Southwestern Iowa into Kansas and Missouri. This is a blanket term for a number of related fossiliferous Pennsylvanian cherts.	Morrow 1984, 1994; Reid 1980, 1981, 1984; Logan 1988
Grand Meadow Chert	Limited area in southeastern Minnesota, possibly into northern Iowa.	Gonsior 1992l Trow 1981
Prairie du Chien Chert	Widespread sources in southeastern Minnesota, especially along river valleys.	Gonsior 1992; Withrow 1983
Rainy Buttes Silicified Wood	Southwestern North Dakota	Loendorf et al. 1984b
Tongue River Silica (grey)	Parts of the central to western North and South Dakota.	Ahler 1977; Porter 1962

Generic Identifications		
Agate	Some may come from preglacial fluvial gravels, glacially redistributed. Some may be brought by human transport from various sources to the west.	
Basaltic Rock	This category includes a variety of dark, grainy materials that are widely available.	
Chalcedony	Some may come from preglacial fluvial gravels, glacially redistributed. Some may be brought by human transport from various sources to the west.	
Chert	This category includes a variety of materials of unknown origin. Some may be local material that is poorly known, some could be nonlocal material that is rarely seen and thus not specifically recognized.	
Granitic Rock	This category includes a variety of coarse-grained materials that are widely available.	
Jasper	Some may come from preglacial fluvial gravels, glacially redistributed. Some may be brought by human transport from various sources to the west.	
Quartz	Mineral quartz comes from many sources and is widely available.	
Quartzite	This category includes varieties of many origins; quartzites are widely available.	

Unidentified	Origin unknown. Some is probably local material that is poorly known, some could be nonlocal material that is rarely seen and thus not specifically recognized.	

Note that there may be a fourth distinctive pattern associated with Village cultures, although definition of the model has not proceeded to analysis of Village-culture assemblages. In addition, there is a still-hypothetical Post-Contact pattern marked first by the addition of industrial-culture materials like bottle glass and kettle brass to the raw material stock, and eventually by the demise of stone toolmaking technology and its replacement by modern industrial technologies. Neither of these potential patterns have been well studied or defined at this point, however, and in the case of the Post-Contact pattern it has been difficult to find relevant lithic assemblages. Because of this and because neither of these patterns seems immediately relevant in this analysis, they are only mentioned here in passing.

The forces driving the changes from one use pattern to another are not clear. In fact, while the model describes the changes, it does not necessarily try to explain them beyond suggesting possible reasons. These might include technological change driven by non-technological factors, raw material stress caused by growing populations or restricted mobility, or many other conceivable factors. Working out the causes for the observed changes is a research agenda in its own right, and one beyond the scope of the present research.

Note that each successive change from Large Biface to Small Biface to Flake Tool patterns results in the use of a wider variety of local raw materials. In effect, each technological reorganization results in an increase in the stock of available toolstone because raw materials that were previously ignored come into use. In practical terms, this shows up as increased diversity in lithic assemblages. Diversity is simply the number of different raw materials present in an assemblage. Although the basic idea is relatively simple, its application of this measure is less straightforward since diversity also varies with sample size (see Kintigh 1989). An extended discussion of the matter is out of place here, so use of the diversity measure will be limited in the following analysis and some explanation will accompany each case of such discussion. Increased diversity is also driven to some extent by later regional-scale circulation of a wide range of raw materials, albeit in small amounts. This circulation is associated most strongly with the Flake Tool use pattern.

Change in preferences for various raw materials also means that the ratios between certain raw materials can change through time. Some of these ratios change in a way that is consistent enough to make the resulting ratios analytically useful. In the South Agassiz Resource Region, for example, the ratio of Swan River Chert (SRC) to Red River Chert (RRC) proves to be useful. This ratio is often in the range of 60:1 to 30:1 in the Large Biface Pattern, 30:1 to 10:1 in the Small Biface Pattern, and 5:1 or less in the Flake Tool Pattern.

In addition to looking at changes in the selection and use of local raw material, the model looks at the interaction between the use of local and nonlocal raw materials. Nonlocal raw materials were present in most times and at most places, but to very different degrees. The presence of minor amounts of nonlocal raw materials was unlikely to affect the way that local raw materials were selected and used. The presence of larger amounts of nonlocal raw materials, in contrast, could have a substantial affect on the selection and use of local raw materials. A good example for the South Agassiz region is seen with the Small Biface Pattern during the Archaic period. The underlying pattern includes the use of several local raw materials that are of average to superior quality and that are available in pieces that range in size from small cobble to boulders. The pattern is most clearly expressed in the earlier parts of the Archaic, when the circulation of nonlocal raw materials appears to be minimal. In the later parts of the Archaic, however, greater and greater amounts of KRF are available in much of the South Agassiz Resource Region. Increasing availability of KRF leads first to discontinued use of the poorer quality local raw materials, and eventually to neglect of all but the most common local raw materials (generally SRC). Thus while the underlying technology and raw material use pattern remain the same, the resulting assemblages look quite different. Such differences can be used to roughly date the associated components.

By using information from selected sites around the region, we can describe the expected characteristics of the three currently-proposed raw material use patterns (Tables 9-12, 17). The list of sites referenced here is not exhaustive. Rather they are chosen to reflect general characteristics and represent something of the expected range of variation within each use pattern.

Large Biface Use Pattern

The Large Biface use pattern is associated with large biface production, and in this area with the Paleoindian tradition. It focuses on better quality raw materials that are dependably available in pieces the size of large cobbles to boulders, or in large pieces from bedrock sources. These are the materials that would support production of large, carefully crafted lanceolate points. Nonlocal raw materials circulate very widely, but generally in very small amounts.

This pattern is distinguished by a very high percentage of a local material that is relatively abundant, of at least average flaking quality, and commonly available in pieces ranging in size from large cobbles to small boulders (or comparably-sized pieces from bedrock sources). In the South Agassiz Resource Region this material is usually Swan River Chert, although it can also be Lake of the Woods Rhyolite. The predominant raw material should constitute around 90 percent of the assemblage, possibly more. Other local raw materials occur only in small amounts, and the total complement of local raw materials typically totals around 95 percent. The remainder of the assemblage includes small amounts of exotic or other nonlocal raw materials, plus pieces identified only to a generic level (e.g.,

chert, jasper) and thus of uncertain origin. Raw material diversity is low, sometimes on the order of only five or six raw materials even in a large assemblage.

Table 9 provides examples of Paleoindian and possibly Paleoindian assemblages in the South Agassiz region. These illustrate the Large Biface Use Pattern. The Branvold (M. Magner, personal comm. 1993) and Greenbush (Peterson 1973) sites are identified as Late Paleoindian sites by the presence of lanceolate points. They are comparable to Late Paleoindian assemblages from other parts of Minnesota, and provide a "classic" picture of the Large Biface Use Pattern. The lower Thorkelson assemblage (Gonsior and Yourd 1990) is not dated, but bears a good resemblance to Branvold and Greenbush and the report suggests that it might be Late Paleoindian to Early Archaic in age based on "limited geomorphological reconstruction" (Gonsior and Yourd 1990:26). The assemblages from 21TR76-77 include a Browns Valley point and flaked stone adze, indicating the presence of a Late Paleoindian component (Forsberg et al. 1999).

Table 9:
Lithic Data from Selected Paleoindian Components or Potential Paleoindian Components in the South Agassiz Resource Region, Illustrating Characteristics of the Large Biface Use Pattern.

Site	Local Selection	Local Intensity	Extralocal Distrib Spheres	Extralocal Distrib Intensity	Diversity SRC:RRC
21RO Branvold		94.4		2.8	5 (n=71) 33:1
Paleo	SRC	91.5	KRF	2.8	
	RRC	2.8			
21RO11 Greenbush		94.6		0.2	10 (n=4,238) 30.0
Paleo	SRC	87.0	KRF	0.2	
	LoW Grp	4.7			
	RRC	2.9			
21RN19 Thorkelson		98.9		0.7	5 (n=279)
Lower Comp	SRC	98.6	Hollandale	0.4	
	Quartz	0.4	W Superior	0.4	
21TR76-77		82.2		11.7	11 (n=180) 7:1
Browns Valley	SRC	69.4	KRF	9.4	
	RRC	10.6	W Superior	2.2	
	TRS	1.7			
	Quartz	0.6			

Branvold (M. Magner, personal comm. 1993), Greenbush (Peterson 1973); Thorkelson (Gonsior and Yourd 1990); 21TR76-77 (Forsberg et al. 1990).

Note that it bears less resemblance to Branvold and Greenbush, and thus to the classic Large Biface Use Pattern. 21TR76-77 may represent an atypical Large Biface Use Pattern profile, but it is tempting to think that a later component (possibly Woodland) has been mixed in with the surficial Paleoindian component.

Small Biface Use Pattern

The Small Biface pattern is associated with production of smaller bifaces, and in this area with the Archaic tradition. It focuses on a wider range of materials both in terms of quality and the size of available stock. These are materials suited to the production of smaller points that are often less carefully made. The circulation of nonlocal raw materials appears to all but collapse at the beginning of this pattern, grows with time, and reaches a significant peak at the end of this pattern.

The underlying pattern is distinguished by a high percentage and wider range of local raw materials, a somewhat wider range of flaking quality in raw materials, and raw materials commonly available in pieces that are at least the size of smaller cobbles. In the South Agassiz Resource Region the most common raw material is often SRC, although TRS, Lake of the Woods Rhyolite or RRC sometimes constitute a substantial percentage of the assemblage. Other local raw materials usually occur only in smaller percentages. Typically, the local raw materials taken together constitute around 80 percent of the assemblage. The importance of exotic and other nonlocal raw materials varies, but between 5 and 10 percent is probably a good representative figure for the general region of the Gabriel site. This variation is both geographic and chronological, in ways that are only partly apparent at this point. There is, for example, a strong west-east gradient for the abundance of KRF, with higher levels of KRF stretching at least to the Red River and possibly to the eastern Agassiz beach ridges. The percentage of KRF also increases through time, a point that is discussed in more detail below. The remainder of the assemblage includes mostly small amounts of raw materials identified only to a generic level (e.g., chert, jasper) and thus of uncertain origin.

The underlying pattern is increasingly obscured through time, however, as the availability of KRF increases. It appears that the increase in KRF may be fairly steady through much of the period represented by this pattern, with a sharp spike in KRF availability near the end of the Late Archaic. As KRF supplies increased, local raw material use was curtailed. The poorer quality local materials were the first to decrease in importance, and finally the use of SRC also began to diminish. This led to an overall decline in raw material diversity through time. In addition, as the use of RRC declined the ratio of SRC to RRC grew; later, as the use of SRC declined, the ratio dropped again.

Tables 10 and 11 provide information on examples of Archaic assemblages in the South Agassiz Resource Region. These illustrate the Small Biface Use Pattern. Table 10 includes initial Archaic assemblages and Table 11 terminal Archaic

assemblages, with each set approximately arranged from oldest to youngest.

Table 10:
Lithic Data from Selected Early to Middle Archaic Components or Potential Early to Middle Archaic Components in the South Agassiz Resource Region, Illustrating Characteristics of the Early Small Biface Use Pattern.

Site	Local Selection	Local Intensity	Extralocal Distrib Spheres	Extralocal Distrib Intensity	Diversity SRC:RRC
32RI0775 Rustad 7180 + 90 7240 + 150 7370 + 150 7490 + 120 7550 + 80 7590 + 90 7675 + 175 *Early Archaic*		c 83.8		c 5.5	12 (n=6,985) 10:1
	SRC	76.3	KRF	5.5	
	RRC	7.3			
	TRS	0.1			
	Quartz	0.0			
21PL0054 Lower 7010 ± 40 7080 ± 40		90.0		10.0	3 (n=10) 2:1
	SRC	60.0	KRF	10.0	
	RRC	30.0			
32RI0785 c 5000 *Early Middle Plains Archaic* *McKean Complex*		81.7		17.8	11 (n=518) 34:1
	SRC	51.0	KRF	16.8	
	TRS	1.9			
	RRC	1.5	Hollandale	1.0	
	Quartz	1.2			
	Sil Wood	0.2			
21BK0111 4500 to 5500 ? *Early to Middle Archaic* *Oxbow Complex*		74.3		7.3	14 (n=331) 13:1
	TRS	31.4	KRF	1.5	
	SRC	20.2			
	LoW Grp	17.2	W Superior	5.4	
	Quartz	3.9	Hollandale	0.3	
	RRC	1.5			
21CE0060 *Archaic*		77.8		0.6	9 (n=334) 23:1
	SRC	70.4	KRF *	0.6	
	TRS	3.3			
	RRC	3.0			
	LoW Grp	1.2			
21SE0016 Van Zomeren *Early Archaic ?*		59.7		30.0	21 (n=749) 6:1
	SRC	43.0	KRF	23.9	
	Quartz	7.2	Hixton	0.1	
	RRC	6.8	W Superior	2.1	
	TRS	2.5	Hollandale	3.9	
	Sil Wood	0.1			
	LoW Grp	0.1			

* The report notes that this may be locally procured KRF (Abel et al. 2001:101). 0.0 percent indicates that a material is present, but at a rate of less than 0.05 percent which rounds off to 0.0.

Rustad (Michlovic and Running 2003), 21PL54 (Florin et al. 2001); 32RI0785 (Dobbs 2000); 21BK111 (Florin 2006); 21CE60 (Abel et al. 2001); 21SE16 (Forsberg et al. 1999).

Table 11:
Lithic Data from Selected Middle to Late Components or Potential Middle to Late Archaic Components in the South Agassiz Resource Region, Illustrating Characteristics of the Late Small Biface Use Pattern.

Site	Local Selection	Local Intensity	Extralocal Distrib Spheres	Extralocal Distrib Intensity	Diversity
21RW53 Jackpot Junction 4580 ± 60 4650 ± 60 4730 ± 100 4800 ± 60 5100 ± 100 *Archaic*		47.7		36.9	16 (n=65) 5:1
	SRC	16.9	KRF	7.7	
	TRS	15.4	Hixton	1.5	
	Quartz	12.3	Hollandale	21.5	
	RRC	3.1	W Superior	6.2	
21NR9 Canning 3340 ± 170 4330 ± 115 *Late Archaic* *McKean*		59.2		30.1	11 (n=1,196) 20:1
	SRC	47.1	KRF	29.8	
	TRS	9.4			
	RRC	2.3	W Superior	0.3	
	Quartz	0.4			
21NR29 Mooney 3420 ± 60 3400 ± 50 *Middle to Late Archaic*		20.8		79.2	3 (n=24) 4:1
	SRC	16.7	KRF	79.2	
	RRC	4.2			
32RI0785 c post 3500 *Late Plains Archaic*		41.8		56.9	12 (n=459) 12:1
	SRC	20.9	KRF	56.0	
	RRC	1.7	Obsidian	0.7	
	Quartz	0.7			
	TRS	0.7	Hollandale	0.2	
	Sil Wood	0.2			
21PL57 Upper 3170 ± 40 3220 ± 40		13.9		84.8	4 (n=433)
	SRC	13.9	KRF	84.8	

0.0 percent indicates that a material is present, but at a rate of less than 0.05 percent which rounds off to 0.0.

21RW53 (Bower et al. 1996); Canning (Michlovic 1986), Mooney (Michlovic 1987), 32RI785 (Dobbs 2000), 21PL57 (Florin et al. 2001).

Rustad (Michlovic and Running 2003) provides an especially good example of the underlying Small Biface Use Pattern as it is seen in the Early Archaic. Since Rustad is located relatively near the Gabriel site, it also provides especially useful comparative information. The same is true for 32RI0785 (Dobbs 2000), which is also valuable for providing three Archaic strata from a single excavation block. Some of the sites in these tables lie outside the Upper Red Subregion, although all are within the South Agassiz Resource Region. The more distant sites are not as directly comparable, since raw material availability varies somewhat between subregions. The sites are still useful, however, to indicate the general characteristics and trends associated with the Small Biface Use Pattern. Note especially the increasing use of KRF, with peaks of 80 percent or more along the Red River in the Tamarack Subregion.

Flake Tool Use Pattern

The Flake Tool pattern may be associated with the expanded use of expedient flake tools, and possibly greater dependence on small projectile points. In this area it probably appears at some point during the Woodland tradition, although the timing is still not clear. This pattern makes use of a wide range of raw materials, especially pebbles that may be generally useful only for the production of flake tools. A wide variety of nonlocal raw materials circulate on a regional scale, although usually in small amounts.

This pattern is distinguished by a moderate to high percentage of local raw materials, a wider range of local raw materials, a wider range of flaking quality in raw materials, and use of raw materials commonly available only as pebbles. In the South Agassiz Resource Region, the most common raw material is usually SRC, although TRS, RRC and even quartz can constitute a substantial percentage of the assemblage. Other local raw materials occur in small percentages, although together they can constitute a noticeable percentage of the assemblage. Typically, identifiably local raw materials contribute 65 percent (plus or minus about 10 percent) to an assemblage. The importance of exotic and other nonlocal raw materials varies; it may be as low as a couple percent, or as high as 20 percent. Many sites exhibiting this pattern, however, include a wider range of nonlocal raw materials originating in different regions, although most of these will be present at very low levels. The remainder of the assemblage includes increased amounts of raw materials identified only to a generic level and thus of uncertain origin. These probably represent, at least partly, increased use of pebble-sized pieces of local raw materials that are not well-studied and thus generally not specifically recognized in a lithic analysis. Tables 12 and 13 provide information on a number of Woodland assemblages in the South Agassiz Resource Region, approximately arranged from oldest to youngest.

The Flake Tool Use Pattern is generally identified with the Woodland period. In some parts of the South Agassiz Resource Region, however, the pattern is essentially obscured in Middle Woodland assemblages by the abundance of KRF

(Table 12). At this point it is still not clear whether "Initial" or "Early" Woodland assemblages would more closely resemble Middle Woodland or Late Woodland assemblages.

Table 12:
Lithic Data from Selected Middle Woodland Components In and Near Minnesota, Focusing on the South Agassiz Resource Region.

Site	Local Selection	Local Intensity	Extralocal Distrib Spheres	Extralocal Distrib Intensity	Diversity
21PL66 Upper 1590 ± 40 1620 ± 40		2.0		91.1	5 (n=101)
	SRC	1.0	KRF	70.3	
	Sil Wood	1.0	Obsidian	20.8	
21PL54 Upper 1680 ± 40		20.4		57.0	5 (n=93) 2:1
	SRC	12.9	KRF	57.0	
	RRC	7.5			
21RO21 Erickson Laurel ?		1.8		98.0	6 (n=561)
	RRC	1.2	KRF	97.9	
	LoW Grp	0.4	Porcellanite	0.0*	
	TRS	0.2			

* = unable to determine from available information. 0.0 percent indicates that a material is present, but at a rate of less than 0.05 percent which rounds off to 0.0.
21PL66 (Florin et al. 2001); 21PL54 (Florin et al. 2001); Erickson (Bakken 1988).

Tables 12 and 13 provide information on a selection of Woodland assemblages in the South Agassiz Resource Region. These illustrate the Flake Tool Use Pattern. Table 12 includes Middle Woodland and Table 13 includes general Woodland assemblages, with each set approximately arranged from oldest to youngest. The assemblages in Table 12 show the potential for high to very high levels of KRF at regional Middle Woodland sites (although such levels are not typical for sites throughout the region). The assemblages in Table 13, in contrast, show the different raw material complements in later Woodland sites, as well as the range of variation between these assemblages.

7.2.4 Sample Size and Sample Aggregation

Sample size has a direct bearing on parts of this analysis, and so merits some discussion. Sample size affects two characteristics that are of particular concern in this analysis. The first is how well the sample (the artifacts recovered) represents the characteristics of the population (all the lithic artifacts at the site). The second is how well the sample represents raw materials that are present in small amounts.

It's obvious that a very small sample cannot provide an adequate characterization of a population. A single flake, for example, cannot adequately characterize a population that contains more than one raw material. On the other hand, a sample of several thousand artifacts is likely to adequately characterize a population containing a couple of dozen different raw materials. The question becomes where, between such extremes, is the threshold of an adequate sample size? For reasons discussed more completely in another source (Bakken 2006), we can

propose a rule of thumb: a minimum adequate sample is about 100 pieces, and a sample of about 300 or more pieces should provide a good characterization in most cases.

Table 13.
Lithic Data from Selected Woodland Components in the South Agassiz Resource Region, Illustrating Characteristics of the Flake Tool Use Pattern.

Site	Local Selection	Local Intensity	Extralocal Distrib Spheres	Extralocal Distrib Intensity	Diversity
21DL2 Lake Carlos SPB I 1880 ± 50 1980 ± 50 *Brainerd*		80.5		9.1	22 (n=514) 4:1
	SRC	46.7	KRF	3.3	
	Quartz	13.0	Hixton	0.8	
	RRC	11.7	Burlington	0.2	
	LoW Grp	5.3	W Superior	2.5	
	TRS	3.9	Hollandale	2.3	
21CY39 Ponderosa III 920 ± 40 *Blackduck*		69.9		13.3	* (n=1,292) 2:1
	SRC	38.5	KRF	13.3	
	RRC	22.8			
	TRS	4.8			
	Quartz	3.8			
21NR3 Natwick *Blackduck?*		77.2		5.1	12 (n=448) 2:1
	SRC	37.9	KRF	5.1	
	RRC	23.4			
	Quartz	10.0			
	TRS	3.3			
	LoW Grp	2.5			
21BK1 Mitchell Dam Late Woodland *Blackduck-Kathio, Sandy Lake*		55.8		19.0	15 (n=285) 3:1
	SRC	27.0	KRF	11.2	
	Quartz	11.2	W Superior	7.4	
	RRC	10.2	Hollandale	0.4	
	TRS	5.6			
	LoW Grp	1.8			
32GF1 Arvilla Late Woodland *Kathio-St. Croix*		76.7		16.7	10 (n=120) 4:1
	SRC	52.5	KRF	16.7	
	RRC	14.2			
	Quartz	5.0			
	TRS	2.5			
	LoW Grp	2.5			

* = unable to determine from available information. 0.0 percent indicates that a material is

present, but at a rate of less than 0.05 percent which rounds off to 0.0.
21DL2 (Gonsior et al. 1999), Ponderosa III (Michlovic 2005); 21NR3 (Thompson 1985); Mitchell Dam (Wilford 1954); Arvilla (Johnson 1973).

One reason for the proposed minimum threshold of 100 is that assemblages are compared as a series of percentages. In sample of fewer than 100 pieces, each piece contributes more than 1 percent to the resulting raw material profile. This rapidly becomes a problem as sample size shrinks. Small (we could say random) variations between assemblages are amplified when counts are converted to percentages, to the point where the resulting profiles bear little resemblance to each other. This also shows up in the kinds of line graphs that are used to present stratigraphic raw material information in this analysis. The graphs begin to display sharper and sharper peaks and valleys reflecting greater (and not at all informative) swings in percentages of the various raw materials. In contrast, larger samples are likely to produce smoother curves on a graph, and any remaining peaks, valleys or sharp changes are more likely to provide useful information about the underlying raw material assemblage.

Sample size also affects the representation of raw materials that are present in very small amounts. Obsidian provides an example. In the regional data set being used to develop the raw material use pattern model, obsidian occurs at an average rate of 0.016 percent, or one piece of obsidian per 6250 artifacts. If for the sake of discussion we consider an excavated sample to be a random sample of the total population of artifacts from a site, at this rate of occurrence the chances of detecting obsidian in a sample of 100 artifacts is about 1 in 63, and in a sample of 1000 the chances have only increased to 1 in 6. This example may be a bit extreme, but it is useful because we are used to thinking about the interpretive value of finding obsidian at a site.

The total sample from the Gabriel site (n=1795) easily exceeds the rule-of-thumb guidelines for minimum sample size. In this analysis, however, we are interested in breaking down this total into smaller samples that represent different components. The sample size rule-of-thumb guidelines also apply to these smaller subsamples. In addition, the analysis sometimes looks at the data from a single excavation block or even a single unit. At such close focus the sample size rarely meets the rule-of-thumb thresholds, a point that is helpful to keep in mind. While we can spot useful clues and maybe something about general trends at this level of focus, the associated stratigraphic raw material profiles will be too noisy to take at face value.

To counter this, we can aggregate data from a number of excavation units or blocks, based on similarity in characteristics like general stratigraphy and landscape position. Hopefully this provides subsamples that are not only analytically defensible but also analytically useful. Note, however, that a few units may be left out of the aggregation if it is difficult to judge how they compare with other units. This can be more of a problem for units with very small samples. Conversely, the omission of units with very small samples does not greatly affect the results.

From this perspective, the site as a whole preserves information on patterns of raw material use. The patterning results from countless episodes of flintknapping, whether related to raw material acquisition, initial reduction, tool finishing, tool maintenance, or some other aspect of the overall lithic technological system. No single flintknapping episode represents the full pattern, but together they can represent the full pattern. At smaller scales of observation -- an individual test unit, for example -- a single flintknapping episode can dominate a lithic sample and obscure the overall pattern of raw material use. As the size and extent of the sample increases, however, the general pattern should emerge more clearly.

7.2.5 Examination of Lithic Raw Material Distributions

The flaked stone assemblage from Phase II and Phase III work at the Gabriel site includes 1798 artifacts. These include flaking debris, expedient tools, formal tools, core fragments and bipolar objects (Appendices D-F). Twenty-two lithic raw materials were identified. These are summarized in Table 15, which also breaks out the raw materials as local, nonlocal, and indeterminate, with information on the source regions for the nonlocal raw materials.

In addition to the flaked stone assemblage, a few other lithic artifacts were recovered from the site. These included two hammerstones, a grooved groundstone maul, and four pieces of fire-cracked rock (Table 14; Appendices D, G4-G5).

Table 14:
Additional Details of the Stratigraphic Correlation Analysis of the Gabriel Site, 32DI95

Strat Unit	Group	Levels	S Ag Matls	Hol Matls	Qrtz	TRS	LoW Matls	Non-local	Oth Local	nID	n=
?	Mid-depth	L1-L3	49.2		1.7	6.8		28.8		13.6	59
?	Deep Central	L1-L4	27.4		1.7	12.3	0.6	49.1	1.7	7.1	351
D			13.8		1.1	8.1	0.3	59.1	1.9	15.7	369
	Shallow	L1	16.7			22.2		61.1			18
	Deep Central	L5-L7	13.9		1.2	7.5	0.3	58.4	2.1	16.6	332
	Deep East	L1-L3	10.5			5.3		68.4		15.8	19
C			29.9	0.3	1.6	14.1		42.9	0.9	10.4	576
	Shallow	L2-L3	26.4	0.5	1.4	14.3		45.3	0.8	11.3	364
	Mid-depth	L4-L5	38.2		2.2	23.6		24.7	2.2	9.0	89
	Deep Central	L8-L12	33.3		3.9	5.9		45.1		11.8	51
	Deep East	L4-L7	34.7			6.9		51.4		6.9	72
B			65.4		1.5	7.4		20.6		5.1	136
	Shallow	L4-L6	68.5		1.1	3.3		22.8		4.3	92

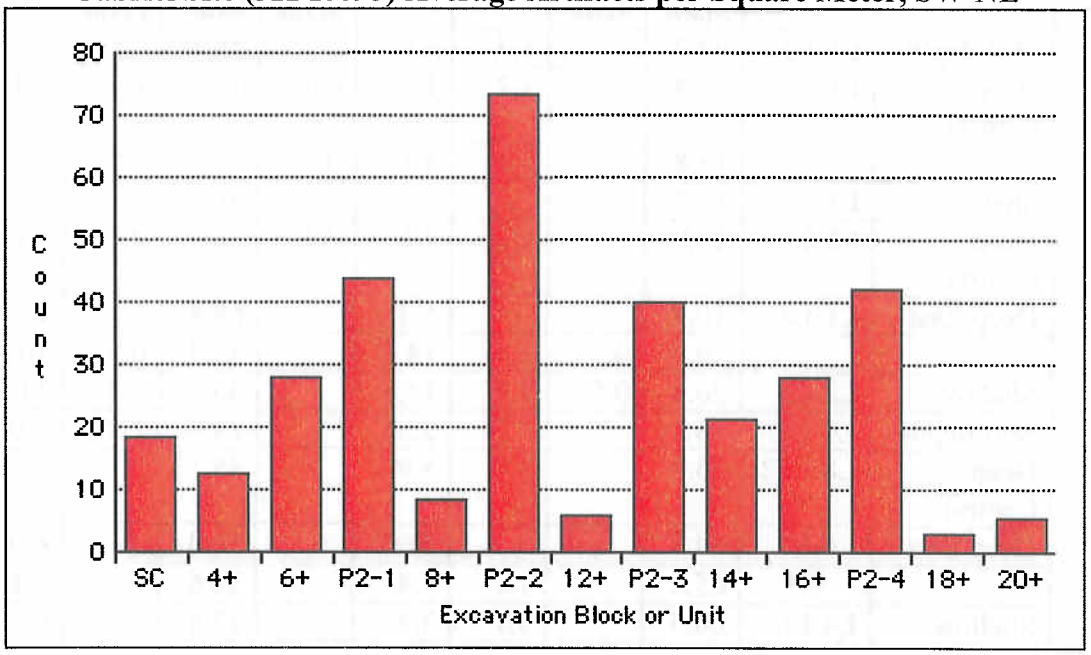
	Mid-depth	L6-L8	59.1		2.3	15.9		15.9		6.8	44
A	Deep East	L8-L12	83.9					14.5		1.6	62

This information was gathered from 53 excavation units, most of which were spread out on a southwest to northeast axis that generally followed the higher topography of the site. Most of the units were part of excavation blocks, which ranged from 2 to 10 units per block. A few were single test units. A few square meters of excavation were also dug away from this axis in the southeastern part of the site. These were dug either as single 1-x-1-meter units or as 1-x-2- m blocks. Some artifacts were also collected from the surface along a two-track dirt road running north-south through the site.

The overall lithic assemblage numbers for the site include artifacts from all of these contexts. The more intensive raw material analysis, however, includes only the information from the excavation units located on the southwest to northeast axis along the higher site topography. These units produced most of the information from the site, and their proximity makes it easier to aggregate information from individual units in a way that supports the analysis. Lithics from Phase I shovel testing are not included, since there is minimal stratigraphic control for these pieces.

Figure 2 shows the average number of artifacts per square meter by excavation block or unit, running from southwest to northeast along the main axis of test units. The figure illustrates some differences in intensity of site use. The 1-x-2 excavation blocks labeled "8+" and "12+" in the graph legend are situated on the west and east rims of a bowl-shaped feature in the landscape near the center of the site (described below).

Figure 2:
Gabriel Site (32DI0095) Average Artifacts per Square Meter, SW-NE



The highest artifact density, for the excavation is in the bottom of the depression or bowl (here labeled P2-2). Beyond this, the higher artifact densities are generally associated with the higher topography, although there is not a precise correlation. The excavation units exhibit variable stratigraphy. In many cases lithic artifacts were first recovered in Level 1 (0-5 cm), and in most other cases in Level 2 (5-10 cm). In a few cases, artifacts were first recovered in Levels 3 or 4 (10-15 or 15-20 cm). In many units, artifacts were confined to the upper four levels, but in other cases, artifacts were found as deep as Level 12 (55-60 cm), with the remaining units in between the extremes. Some units exhibited a unimodal peak in artifact distribution, often in Levels 2 and 3 (5-15 cm) but sometimes deeper. A few units exhibited a bimodal peak in artifact distribution, with no clear trend in the depth of the peaks. Overall, the stratigraphic distribution of the lithic artifacts could be described as variable.

Table 15:
Percentage of Various Raw Materials, Sample Diversity and Sample Size by Level for all Phase II and Phase III Excavation Units at the Gabriel Site, 32DI0095

	South Agassiz	Hollandale	quartz	Tongue River Silica +	Lake of the Woods	nonlocal	Chp*	nID**	Diversity***	n=
Lev 1	38.9			13.3		41.1		6.7	7	90
Lev 2	26.0		1.5	14.3		45.6	1.8	10.8	18	342
Lev 3	30.8	0.5	0.8	9.5	0.3	47.7	0.8	9.5	19	377
Lev 4	40.4		5.1	12.1	0.3	37.0	1.0	4.0	13	297
Lev 5	21.8		0.9	11.6	0.4	46.7	1.8	16.9	15	225
Lev 6	19.2			11.4		55.1	1.8	12.6	10	167
Lev 7	30.3		1.7	5.0		47.9	2.5	12.6	11	119
Lev 8	60.4		4.2	2.1		27.1		6.2	9	48
Lev 9	63.0		3.7			29.6		3.7	5	27
Lev 10	69.0			6.9		24.1			4	29
Lev 11	37.5					25.0		37.5	4	8
Lev 12	33.3					66.7			3	3
Wall Scrp	50.0					40.0		10.0	4	10
Total	31.7	0.1	1.7	10.7	0.2	44.4	1.3	9.9		1742

+ Yellow-red Tongue River Silica only; grey Tongue River Silica is included here in the nonlocal column

*Chp = materials typically used for chopping tools, hammerstones, etc.

** nID = materials identified only to a generic level.

***Diversity = number of different raw materials identified.

Table 15 shows the overall stratigraphic distribution of lithic artifacts from formal excavation units at the Gabriel site, and Figure 4 presents the same information as a graph. For the site as a whole, artifact density rises rapidly to peak in Levels 2 and 3, then gradually trails off through Level 12.

Site Stratigraphy and Geomorphology

What do we make of the artifact distributions summarized above? The answer depends on how we understand the geomorphology of the site, and also on how we look at the mixtures of various raw materials.

Taken at face value the distributions could suggest more intensive use of some parts of the site landscape, and a largely near-surface lithic assemblage. These summary distributions mask a great deal of variation, however, and the variation may be the key to discovering more detailed and informative patterning.

The variation in depths of artifacts and in depths of greatest artifact density is particularly interesting. We could conclude that the stratigraphic disposition was essentially random, the results of gopher burrowing, bison trampling, or other noncultural processes. In that case, we would have little more to learn from the site stratigraphy.

We could also, however, explore the idea that biomantle formation of the type described by Van Nest (1993, 1997) could explain the stratigraphic distributions we see at the Gabriel site. Since the biomantle model she discusses applies to Upper Midwest upland sites and Gabriel is such a site, the idea seems worth exploring.

Imagine a situation where a group uses the Gabriel site at some time in the distant past. They leave a general, thin artifact scatter across the ridge, and a few artifact concentrations. With time, the entire artifact assemblage "sinks" below the surface by the processes of biomantle formation. At a later time, when the first assemblage is already below the surface, another group visits the site. They leave their own general artifact scatter across the ridge, and a few artifact concentrations that do not line up with the earlier artifact concentrations.

More time passes, the first assemblage continues moving lower in the soil profile, and the second assemblage also begins to move down. The two assemblages are still stratigraphically separated in the soil, however, and will remain so until they reach the bottom of the biomantle and collide in the stone zone. Note that this scenario has already produced variable peaks in the depth of greatest artifact density. The artifact concentrations from the first assemblage will produce peak densities at a greater depth than the artifact concentrations from the second assemblage. Because the artifact concentrations do not overlie one another, the overall peaks in stratigraphic distribution will vary from unit to unit.

If this cycle of artifact deposition and sinking was repeated many times, it could

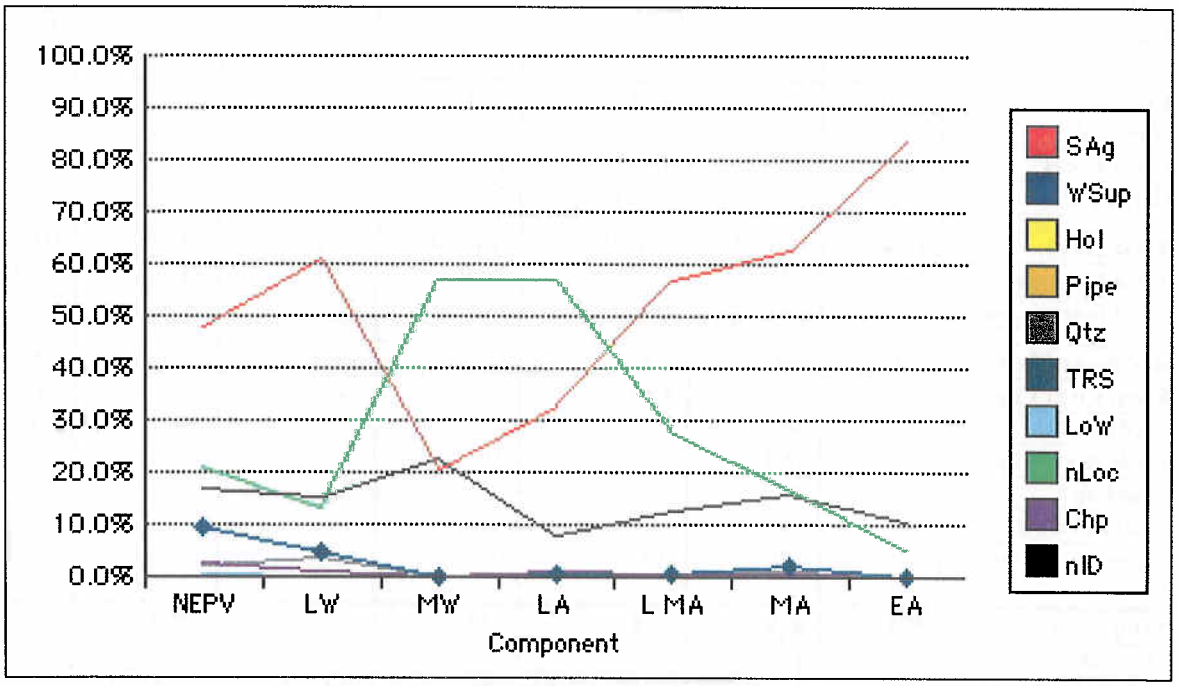
produce a distribution like the one observed at the Gabriel site. If the episodes of site use were infrequent, the assemblages might retain a fair degree of separation in the soil profile. If, however, the site was used more frequently, a large series of small assemblages might essentially stack one on top of the other and partly mingle; the rate of their downward movement would not be enough to preserve complete separation of the assemblages, but it could still preserve some degree of patterning that could be detected using the right analytical tools.

Note that sediment deposition would improve this situation from an archaeological perspective. Even minor -- or very localized -- deposition would contribute to greater separation between assemblages, and possibly forestall or prevent the otherwise inevitable pile-up in the stone zone at the base of the biomantle. The biomantle might deepen or, if it moved upward, strand the earliest assemblages below the biomantle and below the stone zone.

Stratigraphic Distribution of Raw Materials

While this sounds good in theory, we must look for some kind of evidence with at least the potential to prove or disprove the idea. Diagnostic artifacts or radiometrically datable materials would be especially useful in this regard. At the Gabriel site we have a few diagnostic projectile points but no good radiometric dates. The points may help evaluate the biomantle theory, but there are not enough of them to reach strong conclusions.

Figure 3:
Reconstructed General Trends in Lithic Raw Material Use Through Time Based on Data From Selected Sites



We do, however, have one other line of evidence that can potentially help us test the biomantle theory. That evidence is patterning in the use of lithic raw materials. As suggested previously in this report, a new model of raw material use patterns in parts of the Upper Midwest predicts certain patterns that develop and change through time. Therefore we can return to the stratigraphic distribution of artifacts across the site and re-examine it with an eye to raw material composition to see if the results match the predictions of the model.

To recapitulate, for the South Agassiz Resource Region the model predicts 1) that a Paleoindian component should be composed mostly of Swan River Chert; 2) that an initial Archaic component should include a large amount of Swan River Chert, but also a greater diversity of other local raw materials like Red River Chert and Tongue River Silica; 3) that the percentage of Knife River Flint will increase through the Archaic, and by the Late Archaic will be the dominant raw

Table 16:
Summary of Comparative Lithic Raw Material Data
From Selected Sites Near the Gabriel Site,
Representing Raw Material Use Patterns and Raw Material Use Pattern Stages

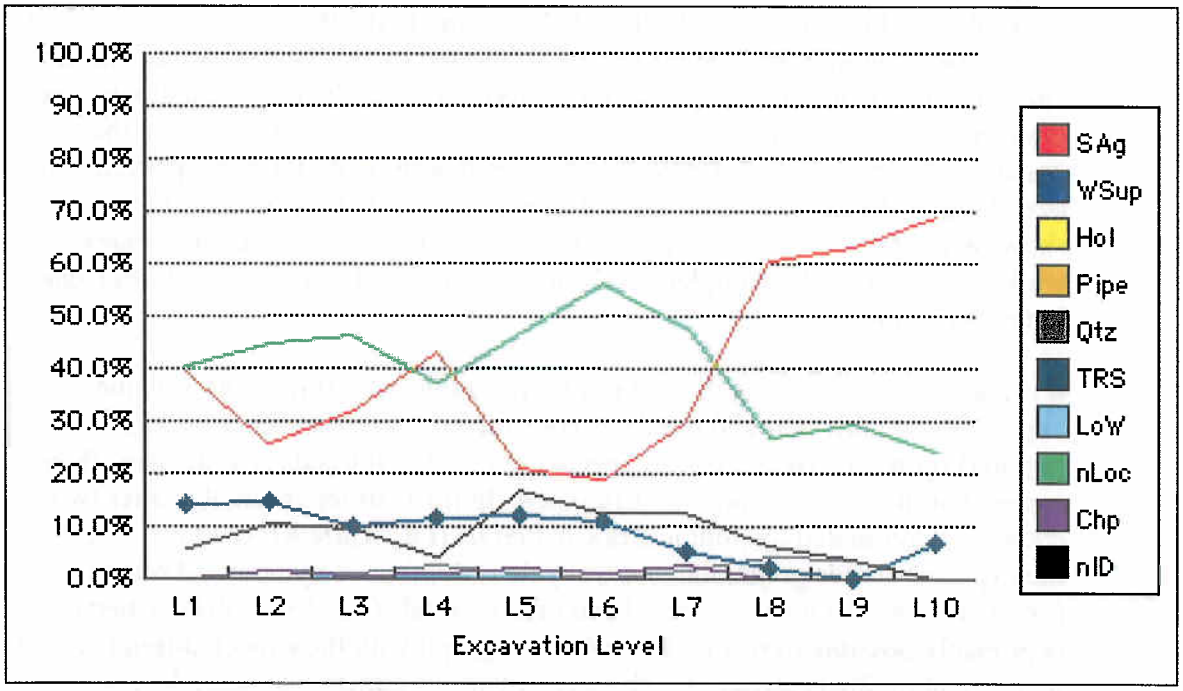
Raw Material or Raw Material Group	32RI775 Early Archaic	32RI785 Middle Archaic	32RI3785 Late-Middle Archaic	32RI785 Late Archaic	21PL54 Middle Woodland	21CY39 Late Woodland	32RM225 NE Plains Village
South Agassiz	83.6	(lo) 52.7	(lo) 46.8	(lo) 22.9	20.5	61.3	48.1
West Superior							
Hollandale		1.0	0.7	0.2			
Pipestone							
Quartz		1.2	0.7	0.7		3.8	2.1
Tongue River Silica	0.1	1.9	0.7	0.7		4.8	9.3
Lake of the Woods Group							0.5
Exotic and Nonlocal	5.5	16.8	27.7	56.6	57.0	13.3	20.9
Other Local		0.6	0.7	1.3		1.3	2.4
Generic IDs	10.7	(hi) 25.9	(hi) 22.7	(hi) 17.6	22.7	15.5	16.7
Total Local	83.8	(lo) 55.8	(lo) 48.2	(lo) 24.2	20.4	69.9	60.0
Total Nonlocal	5.5	17.8	28.4	56.9	57.0	13.3	20.9
Total Indeterminate	10.7	(hi) 26.4	(hi) 23.4	(hi) 18.9	22.7	16.8	19.1
Red River Chert	7.3	1.5	1.8	1.7	7.5	22.8	8.6
Swan River Chert	76.3	51.0	45.0	20.9	12.9	38.5	39.5
SRC:RRC	10:1	34:1	25:1	12:1	2:1	2:1	5:1
Knife River Flint	5.5	16.8	27.7	56.0	57.0	13.3	20.9
Obsidian							
Fusilinid Chert							
Prairie du Chien Chert		1.0	0.7	0.2			
Sample Size	6985	459	278	518	93	1202	580
Diversity	12	11	10	12	5	8	10

32RI0775 (Michlovic and Running 2003); 32RI0785 (Dobbs 2000); 21PL0054 (Florin et al. 2001); 21CY0039 (Michlovic 2005); 32RM0225 (M. Michlovic, personal comm. 2002).

material in the component; 4) and that Woodland-period sites should include a higher total of local materials, a broader range of raw materials (even if many of these occur only in small amounts), that this should include raw materials that are generally available only as pebbles, and that there should be another KRF peak in the Middle Woodland (Table 16, Figure 3).

Table 15 gives site-wide distribution of raw materials by level, and Figure 4 shows the same data. (Note that the lowest and oldest levels are at the right of the graph.) An interesting pattern appears. The two main raw material components at the site are the local South Agassiz group materials (chiefly Swan River Chert) and the nonlocal

Figure 4:
Raw Materials by Level for All Excavation Units



materials (chiefly Knife River Flint). In the three main cycles apparent in the graph, local raw materials dominate the first and nonlocal materials dominate the later two.

This could be a plausible overall raw material pattern for the site. Very high SRC in the lower levels would suggest their association with the initial Plains Archaic. The first KRF peak could coincide with the Late Plains Archaic, especially the end of the Late Plains Archaic, and the second KRF peak with the Middle Plains Woodland. The uppermost part of the stratigraphic column might then correspond to the Late Prehistoric, a period that is not yet well accounted for in the model. Note that there is also a general rise in other raw materials from the

deepest levels, which could fit the model. A continued rise in some of these materials would also be predicted, however, and that does not seem to be present in Figure 4.

In such an interpretation, the shallow-stratigraphy units would represent only the uppermost part of this stratigraphy -- the later part of the time period. Only the deep units would represent the full time span. This could only be the case if earlier use of the site was limited to the areas with deeper artifact stratigraphy and only later use of the site was represented in the areas with shallow artifact stratigraphy. This essentially assumes that the biomantle is the same depth throughout the site, and that there is no significant difference in erosion or deposition between different parts of the site in different landscape positions. A different understanding of the landscape dynamics, however, could lead to a different analysis and interpretation of the raw material stratigraphy.

With this in mind, it is worth noting that there may be a degree of self-similarity embedded in the graph. The third cycle looks much like the second cycle, except with a lower amplitude. One possibility suggested by this pattern is that this is one pattern superimposed over itself at different scales. It could be that what we are seeing is not two cycles but one, and that that cycle is showing up on the graph two times because we have two sets of data showing the same pattern, but stretching or shrinking it to different degrees. Given that the X axis of this graph shows depth below surface, in practical terms the matter of cycles and scales works out to this: The complete cycle appears first in the shallow units and again in the deep units.

It is also worth comparing the Gabriel lithic stratigraphy (Figure 4) with the expected lithic raw material trends as constructed from representative sites in the region (Figure 3). The graph of expected raw material trends also displays three cycles, but there is an important difference. In the Gabriel graph, the latter two cycles are dominated by nonlocal raw materials (i.e., Knife River Flint), while in the expected-trends graph, the middle cycle is dominated by nonlocal materials (i.e., KRF) and the third cycle by local raw materials (i.e., Swan River Chert). It is probably possible to reconcile the Gabriel graph with the expected-trends graph by postulating the presence and absence of various patterns at Gabriel. The difference between the two figures, however, further suggests that it is worth examining whether the Gabriel graph shows the repetition of one pattern at different scales.

We can explore this possibility by going back and attempting to aggregate data from multiple units based on depth of artifact recovery, soil profiles, and general position on the landscape. The first step is to group units by excavation block, adding together the raw material data level by level within each block. The second step is to group blocks by similarity in depth of artifact recovery, soil profiles and landscape position, then add together the data for each block level by level.

7.2.6 Groupings of Excavation Blocks

Using this approach, we end up with five basic groupings of data: shallow units (n=474), mid-depth units (n=192), deep central units (n=734), and deep eastern units (n=153). This grouping focuses on the main southwest-northeast axis of testing, and leaves out four units in the southeast part of the site (n=85), five units along the main axis of excavation that cannot easily be grouped with other units (n=76), and four very low density units at the northeast end of the southwest-northeast axis (n=17). The units included in the four groupings include 90.1 percent of the lithic data from the Phase II and Phase III testing at the site. Table 17 lists the units included in each group, and the raw material stratigraphy for these four groupings is shown in Figures 6, 7, 10 and 5. Note that these figures display the data to the greatest depth of artifact recovery in order to facilitate display of any patterning across scales, rather than against a base of the maximum 12 positive excavation levels.[3]

Figure 5 shows the lithic data from the shallow units. These units occupy some of the higher points on the landscape, although not necessarily the highest points. The units toward the west end of the site are on an almost-level area somewhat to the south of a ridge crest, while the units toward the east end of the site are on a slight north-facing slope to the north of a ridge crest. In general, these units have four artifact-bearing levels (20 cm), beginning with the first or second level; the densest artifact deposits generally occur in Levels 2 and 3.

Figure 10 shows the lithic data from the mid-depth units. These units lie on or near the lip of a somewhat bowl-shaped depression between the two high ridges where the site is located. The field crew reports that the bowl-shaped depression is plainly visible on the ground and is closed enough to hold water after a rain. This feature looks unusual and even out of place on a topographic map of the site, but there is no clear evidence to indicate that it is anything but a natural landscape feature. It is worth noting, however, that the soils profiles are somewhat variable in these units. The units have six to eight artifact-bearing levels (30-40 cm), beginning with the first or second level; the depth of the densest artifact deposits varies, and some units have bimodal artifact distributions.

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[3] Note also, however, that "outlier" levels are omitted from these graphs. These are normally the bottom-most levels -- and less commonly the topmost levels -- which contain very few artifacts. At such very small sample sizes (ca. 1 to 5 pieces), random variations overwhelm any potential patterning and confuse the visual display. This is one reason that assembling data from multiple units is useful; it increases the sample size to a point where random variation is subsumed and general patterning becomes apparent. For this stage of the analysis, sample sizes under 10 artifacts per level can be problematic, and sample sizes under 5 artifacts per level are usually not analytically useful.

Table 17:
Assignment of Excavation Units to Excavation Unit Groupings Discussed in Text, with Notes on the Distribution of Diagnostic Artifacts, Gabriel Site, 32DI95.

Grouping	Units by Block	Notes
Shallow n=474	TUs 1-3, 30, 46 *(west)*	In and around stone circle. Point: III-0104, KRF, MPA, McKean.
	TUs 4, 5 *(west)*	
	TUs 6, 7 *(west)*	Point: III-07-02, silicified wood, type not determined.
	TUs 30, 33-35, 40, 41, 44; Phase II TU 3 *(east)*	Point: II -03-02, KRF, MPA, Duncan (2 pieces). Point: III-33-06, grey TRS, MPA, McKean-Hanna-Duncan.
Mid-Depth n=192	TUs 25, 37, 38; Phase II TU 1	Backed scrapers, maul. Ceramics in one unit-level
	TUs 8, 9	
Deep Central n=734	TUs 10, 11, 26, 27, 42, 43, 45, 47, 49; Phase II TU 2	Point: II -02-03, fusilinid group, EPW, Besant.
Deep East n=153	TUs 16, 17, 29, 39	Ceramics in five unit-levels.
	Phase II TU 4	
Not in Groupings n=178	TUs 12, 13 n=12	Located on the east edge of the "bowl" in the landscape. Not clear which other units these best compare to.
	TUs 14, 15, 28 n=64	Close to block of shallow units that includes P2-3 and with same general landscape context, but the soil profiles look different.
	TUs 18, 19 n=6	
	TUs 20, 21 n=11	
	TUs 22-24, 36, 48 n=85	Southeastern part of site, off of main SWNE axis of testing.

Figure 5:
Raw Materials by Level for Shallow Grouping

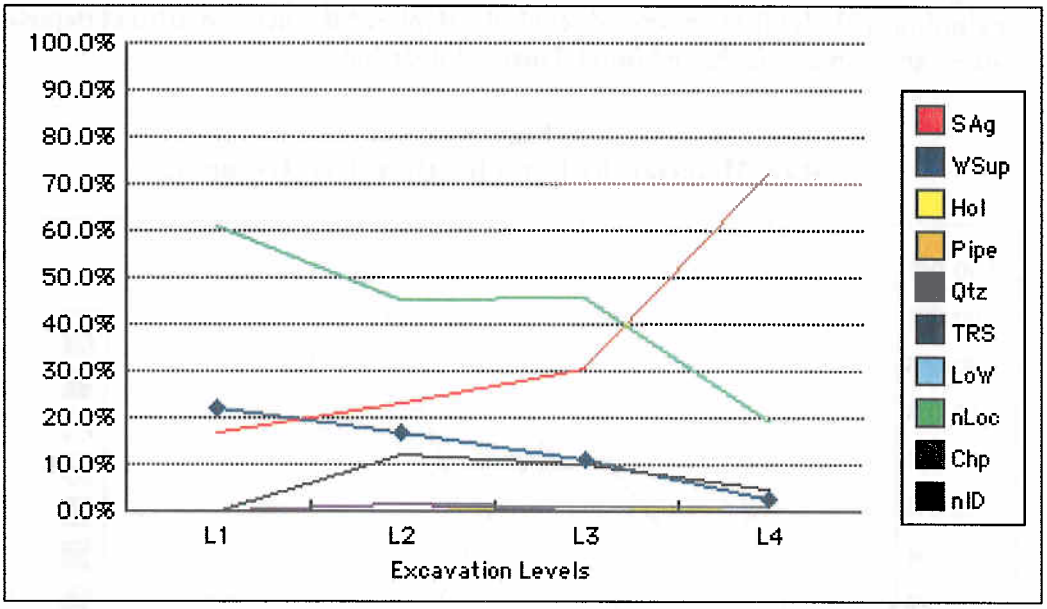


Figure 6 shows the lithic data from the deep units in the central part of the site. These units lie near the bottom of the bowl-shaped depression described above. The soil profiles in these units are somewhat variable. The units have eight to twelve artifact-bearing levels (40-60 cm), beginning at or near the surface; the depth of the densest artifact deposits varies considerably, and some units have bimodal artifact distributions.

Figure 6:
Raw Material by Level for Deep Central Units

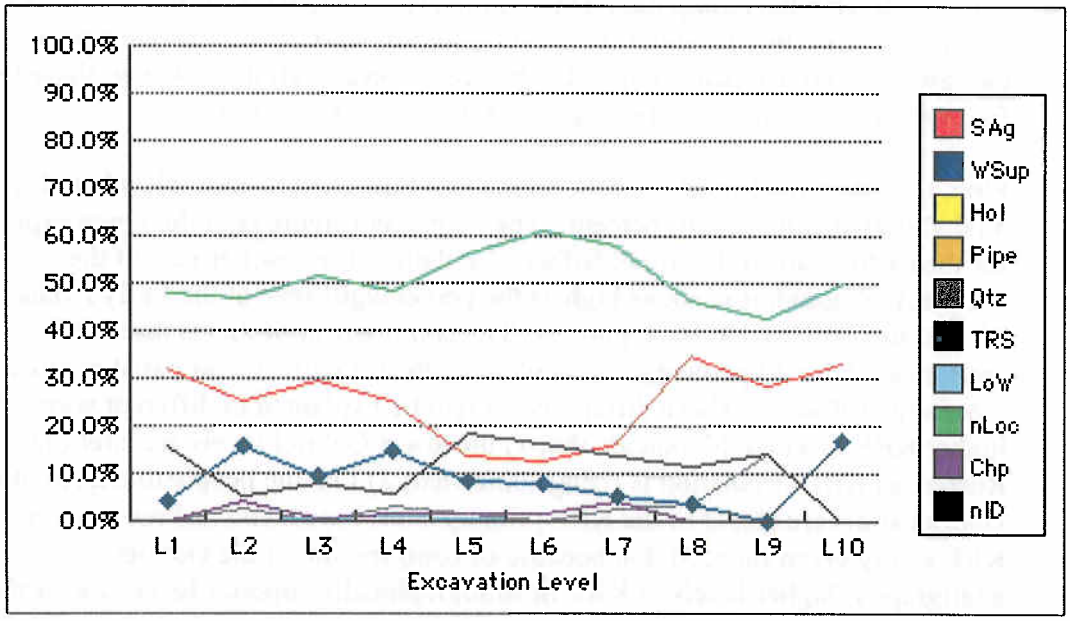
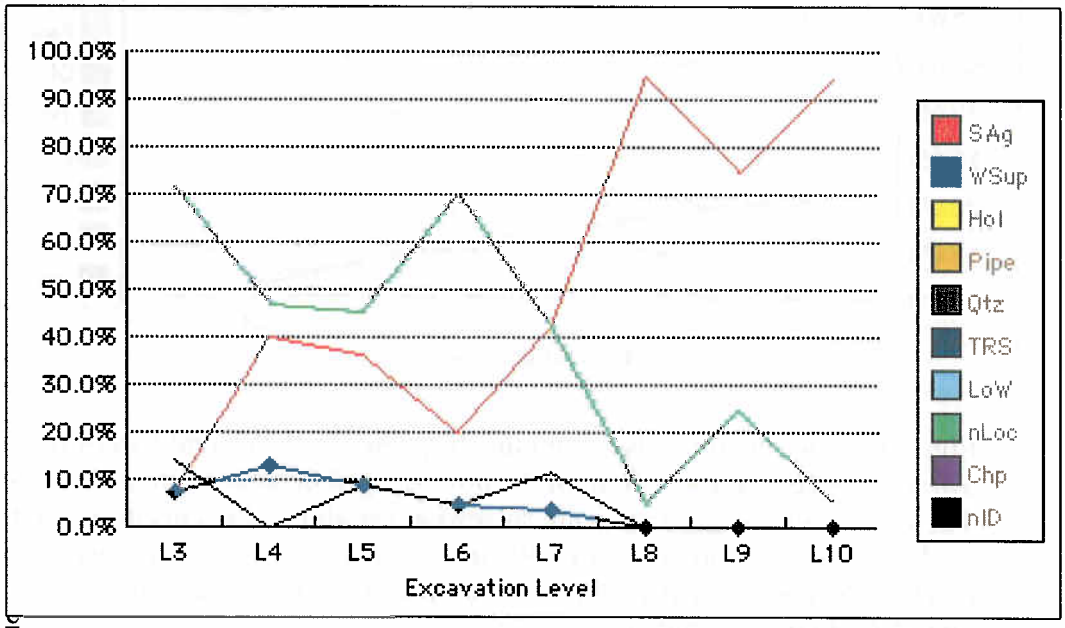


Figure 7 shows the lithic data from the deep units in the eastern part of the site. These units occupy a slight concavity on a slight north-facing slope to the north of a ridge crest. These units have 10 to 12 artifact-bearing levels (50-60 cm), beginning with the first or second level; the depth of the densest artifact deposits varies, and some units have bimodal artifact distributions.

Figure 7:
Raw Materials by Level for Deep East Grouping



Deep Eastern Block Groupings

Figures 5 (shallow) and 7 (deep east) show a pattern of initially high levels of SRC, with KRF becoming the most common raw material, and the use of TRS generally increasing through time. This generally agrees with the predictions of the raw material use pattern model. On closer consideration, however, these two figures may tell a more interesting -- and more detailed -- story.

First, note the initial levels of SRC in the two figures. The initial levels in Figure 5 (shallow) are close to 70 percent. The 70 percent figure is in the range expected for the earlier part of the Small Biface Use Pattern (i.e., earlier part of the Archaic), although it is not as high as the percentages seen at the Early Archaic Rustad site (Tables 10, 16; Figure 3). The complement of this is that KRF appears at about 20 percent in the lowest levels in Figure 5, compared to closer to 5 percent at Rustad. These differences might be explained in different ways. The higher KRF level could indicate that 1) the lower Gabriel levels are later than Rustad, as KRF circulation is rising somewhat; 2) that the people that lived at the Gabriel site were closer to the KRF primary source area, and had more access to KRF at any given time; 3) that because of compression of the Gabriel stratigraphy, higher levels of KRF in stratigraphically superior levels are partly

encroaching on the stratigraphically inferior levels; or 4) that Rustad is not entirely typical of the raw material use pattern of the period. Based on the evidence in hand (regional or site-specific), there is no clear reason at this time to prefer one explanation over the other.

In contrast, the initial levels of SRC in Figure 7 (deep east) are above 90 percent. This number is higher than we would generally expect for the earlier part of the Small Biface Use Pattern, and more in line with what is seen for the Large Biface Use Pattern (i.e., Paleoindian; see Table 9). It would be premature, however, to interpret this as good evidence of a Paleoindian component at Gabriel. This pattern has been seen in at least one Early Archaic site, the Granite Falls Bison Kill. That site is located along the Minnesota River in Yellow Medicine County, Minnesota, and is similar in age to the Rustad site.[4] In addition, most of this very-high SRC signature at Gabriel comes from three excavation units, 16, 17 and 29, and especially TU 29. This could support interpretation of the SRC concentration as a localized flintknapping feature rather than a legitimate overall raw material use pattern. (Note, however, that it could also be argued that a high-SRC flintknapping feature is at least a bit more likely to occur in a Paleoindian stratum than an Early Archaic stratum.) In any case, the model suggests that the high level of SRC should be associated with an earlier rather than a later assemblage, fitting its occurrence in the deepest part of the stratigraphy.

Second, note that in Figure 7 (deep east), TRS is absent from the deepest levels with the 90-plus percent of SRC. This also conforms to the predications of the model for a Large Biface Use Pattern; again, however, this could be seen in some Early Archaic assemblages. In contrast, a small amount of TRS is present in the lowest level in Figure 5 (shallow). Comparison of the two figures suggests that TRS appears at roughly the same point along the SRC line, and (by interpolation) roughly at that point where SRC constitutes 70 or 75 percent of the raw material assemblage.

Third, note that above the point where KRF becomes the predominant raw material, Figure 5 (shallow) shows a more or less steady rise in the importance of KRF, whereas Figure 7 (deep east) shows two peaks in the importance of KRF, and an intermediate stretch where KRF and SRC are close to equal in importance. Two similar peaks are apparent on the right-hand part of the SRC curve. The two KRF peaks could be interpreted as corresponding to the two archaeologically attested peaks in KRF distribution, one in the Late Archaic (Ahler 1986:18) and one in the Middle Woodland (Clarke 1984). The gradual rise in the presence of TRS could speak to the broadening of the lithic raw material economy to use an

[4] These statements are based on review of notes from the Institute for Minnesota Archaeology files at Fort Snelling (Minnesota Historical Society), and on limited examination of the lithic assemblage from the site. A complete raw material inventory is not available for the site.

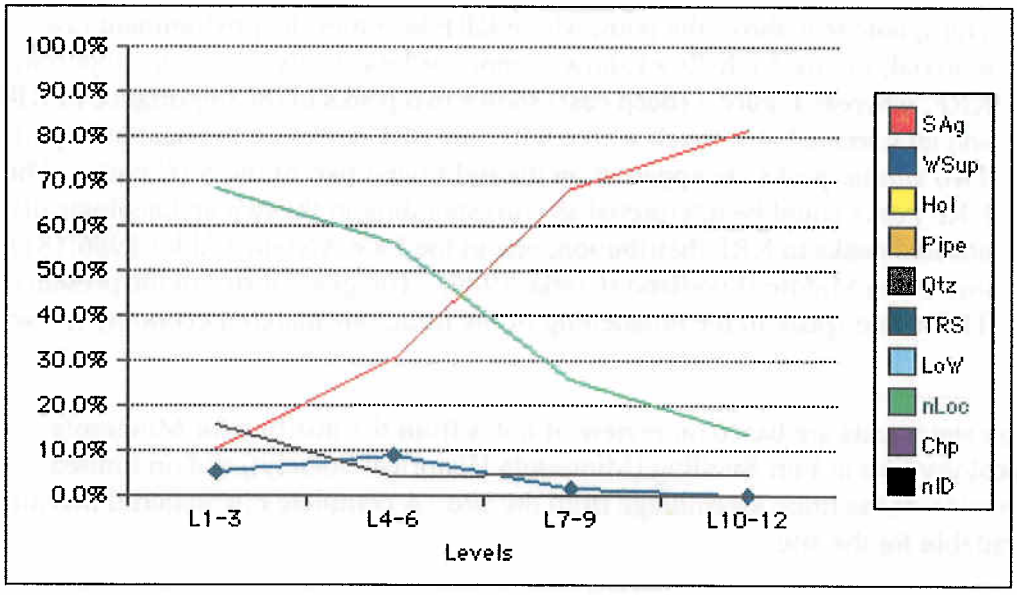
increasing range of local raw materials -- even such marginal quality raw materials as TRS. In this kind of interpretation, however, the significance of the two SRC peaks is not clear.

There is, however, an alternative and probably preferable interpretation. Note the overall "spiky" character of the lines in Figure 7 (deep east). This characteristic usually shows up with small samples: one or another raw material can dominate a level more or less at random, and any overall trends are eventually obscured by the random variation as the sample size decreases. The spiky character of the lines in this graph could be the result of small sample size. In fact the sample size for the grouping is 152 artifacts, around 20 artifacts per level, which is smaller than the sample size per level for the other groupings. The graph still shows general trends, however, unlike most graphs displaying even smaller samples, suggesting that the sample size has not fallen below some critical threshold.

We can attempt to compensate for the relatively small sample size by essentially conflating the stratigraphy of the deep eastern sample, adding together the upper three levels, the next three levels, and so on, to reduce 12 levels to 4. The result is Figure 8. While the curves do not quite match between Figures 5 and 8 note that the general trends agree, suggesting that these different groupings do in fact preserve essentially the same stratigraphy.

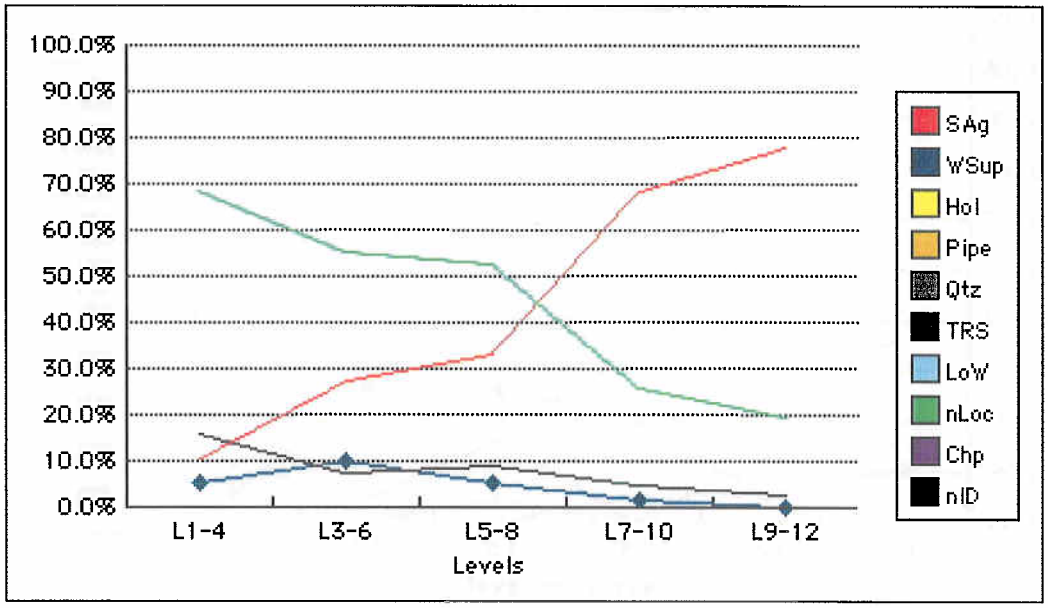
We can also take this exploration one step further. We might posit that the stratigraphy shown in Figure 5 (shallow) is not merely compacted, but that there has also been some mingling of assemblages in the relatively shallow stratigraphy. To simulate such mingling, we again conflate the stratigraphy in the deep eastern grouping. This time, however, we overlap the summing of levels in

Figure 8:
Raw Materials by Level for Deep East Grouping, "Collapsed" Stratigraphy



order to simulate mingling of components: levels 1 to 4 are added together, then levels 2 to 6, and so on. The results are shown in Figure 9, and they are strikingly similar to the shallow-grouping raw material profile shown in Figure 5. While this is not conclusive evidence that the two data sets present the same record -- one compacted and co-mingled in a shallow stratigraphy, the other spread out in a deeper stratigraphy -- it might be persuasive.

Figure 9:
Raw Materials by Level for Deep East Grouping, Sliding "Collapsed" Stratigraphy



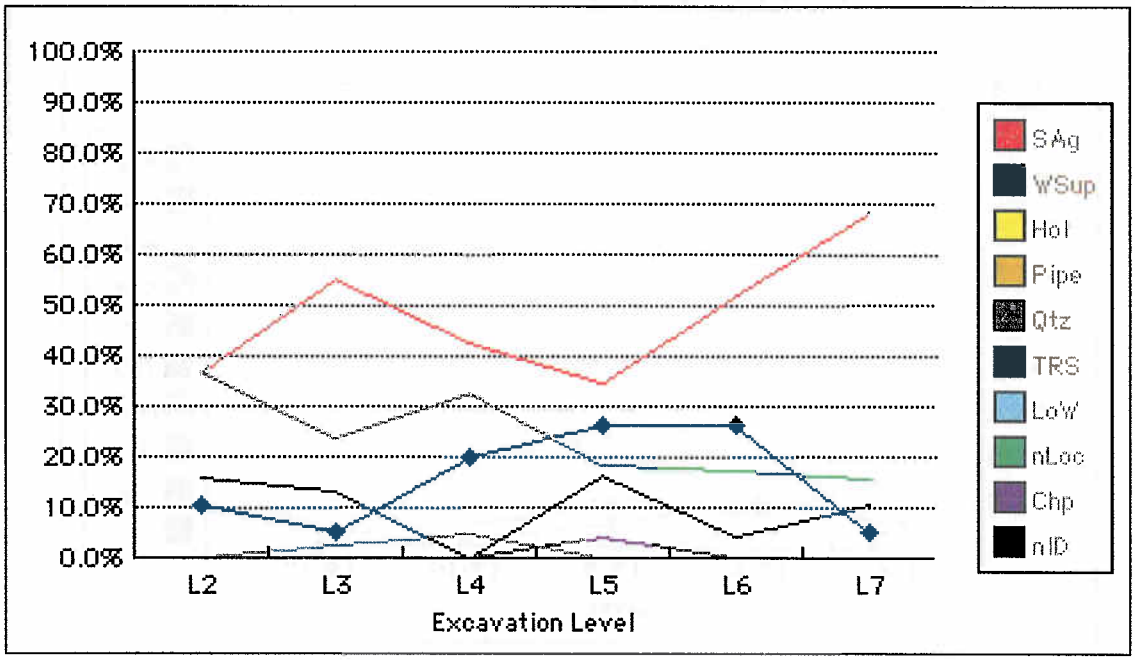
Based on the evidence reviewed so far, we can propose some preliminary conclusions. These two stratigraphic sections represent the same time period, or close to the same time period. Both sections generally agree with the predictions of a raw material use pattern model and the evidence and trends from the two stratigraphies can be correlated, although some details remain unresolved. The shorter section is compressed and components may be co-mingled, while the longer section displays some data that mimic a more detailed record of raw material use patterns. The sections can be interpreted to indicate the presence of components ranging from sometime in the earlier part of the Archaic period to the Late Archaic. They do not necessarily exclude the possibility of later components, and there might be weak evidence for the presence of a pre-Archaic component.

Mid-Depth and Deep Central Block Groupings

If Figures 5 (shallow) and 7 (deep east) show more or less expected patterning, the same cannot necessarily be said of Figures 10 (mid-depth) and 6 (deep central). Figure 10, for example, shows a dominance of South Agassiz raw materials throughout and a rise and fall in the importance of TRS, while Figure 6

shows a dominance of KRF throughout. In general form, the curves in these two graphs is not much like the curves in either the shallow or deep eastern groupings, or the reconstructed curve in Figure 3. In particular, Figures 3, 5 and 7 show a strongly complementary relationship between South Agassiz (SRC) and nonlocal (KRF) materials: when one goes up, the other goes down. This, however, is the case in only parts of Figures 10 and 6.

Figure 10:
Raw Materials by Level for Mid-Depth Grouping



Potentially, there are three basic explanations for the what we see in Figures 10 and 6, and why this differs from what we see in Figures 3, 5 and 7. First, it could be that Figures 10 and 6 represent shorter, expanded segments of the curves seen in the other figures. Second, it could be that Figures 10 and 6 indicate disturbance in these parts of the site, with chaotic mixing of lithic artifacts from different components. Third, it could be that Figures 10 and 6 provide evidence against the validity of the raw material use pattern model. Each of these options is discussed in turn.

The raw material distributions seen in Figures 10 (mid-depth) and 6 (deep central) could represent shorter, expanded segments of the curves seen in the other figures. Figure 6, for example, might align the middle section of Figure 7 (deep east) -- approximately levels 5, 6 and 7. Both show a peak in KRF in level 6, one around 60 percent and the other around 70 percent. There is also the corresponding low point for SRC, both in the range of 10 and 20 percent, and also a rise in the importance of KRF in this part of the graph, which matches the pattern seen in Figure 7 (deep east). In theory, this could represent the same period and stratigraphy as the midsection of Figure 7. It's hard to argue, however, that the

upper and lower sections of the Figure 6 (deep central) stratigraphy match the rest of the curves seen in Figure 7 (deep east) in particular. This could imply that the upper and lower part of the stratigraphy is disturbed, and it could be somewhat awkward to explain how the midsection of the stratigraphy is intact while the upper and lower parts of the stratigraphy are not. In addition, there is an odd symmetry to the distribution shown in Figure 6. The upper half resembles a mirror image of the bottom half, a distribution that is likewise difficult to interpret.

The lower levels of Figure 10 (mid-depth) can be compared to the lower levels of Figure 7 (deep east). In both, SRC appears as the strongly dominant materials, then falls in importance as KRF and TRS rise. This is probably the end of the resemblance, however, as KRF fails to pass SRC in importance, and TRS drops off sharply. In this case, it might be easier to argue that the lower strata remain largely intact while the upper strata are disturbed, but the argument hardly seems compelling.

One other observation pertains to both Figures 10 (mid-depth) and 6 (deep central). In Figures 5 and 7, changes in the importance of SRC and KRF are closely complementary: if one goes up, the other goes down. That is not the case in Figures 10 and 6; the two raw materials are sometimes complementary, sometimes independent. While this sort of pattern might be expected in some cases, it seems unusual here.

The raw material distributions seen in Figures 10 (mid-depth) and 6 (deep central) could indicate disturbance in these parts of the site, with chaotic mixing of lithic artifacts from different components. In some respects this is the most appealing interpretation, but it cannot be based on the lithic evidence alone. Other evidence for disturbance is, however, equivocal. The topography of this upland depression seems odd, especially on the southwest and northeast edges, and somewhat out of character with the surrounding topography. The form and scale of this landscape feature, however, argue against it being a deliberate, prehistoric human modification of the landscape. In addition, soil profiles for excavation units in and around the depression are somewhat variable, but they don't paint a clear picture of a particular mode of disturbance. The soils appear to be well developed and generally consistent in texture with soils in other parts of the site (except for some organic enrichment, maybe associated with periodic ponding of water in the depression).

We could expect that the rim of this upland depression (i.e., the mid-depth grouping) would be more prone to erosion than the bottom (i.e., the deep central block) to deposition. While this could account for the greater depth of the artifact deposits in the deep central block, it does little to explain the mid-depth artifact distribution on or near the rim. (In terms of deposition in the upland depression, however, note the appearance of a dark soil horizon at the bottom of three excavation units.)

Finally, the raw material distributions seen in Figures 10 (mid-depth) and 6 (deep central) could provide evidence against the validity of the raw material use pattern model. Two lines of evidence argue against this interpretation, however. First, the evidence from some parts of the site does conform to the general patterns predicted by the raw material use pattern model. Second, evidence from many other regional sites -- in and beyond the South Agassiz Resource Region -- supports and contributes to the model.

7.2.7 Correlation of Stratigraphic Units

There was also an attempt to produce a more detailed and complete stratigraphic raw material profile for the site by correlating stratigraphic units across excavation block groupings, and creating a composite profile based on the results. This provides a way to examine whether individual "components" might be missing or masked in some parts of the site, but present or more clearly expressed in other parts of the site. This general kind of analysis is used in geology to reconstruct complete stratigraphic sections even known sections contain gaps.

Each of the four groupings of excavation units was examined in terms of raw material distributions. Each was split into a series of "units" based on differences in raw material content. The lowest unit in a grouping, for example, might contain little but SRC; the overlying unit contain about equal amounts of SRC, TRS and KRF; and the topmost unit contain mostly KRF with some SRC. The units are then compared between groupings, with the idea that equivalent raw material content indicates equivalent age and equivalent raw material use pattern -- or effectively the same component. An important caveat is that within any grouping, stratigraphic units must remain in stratigraphic order.

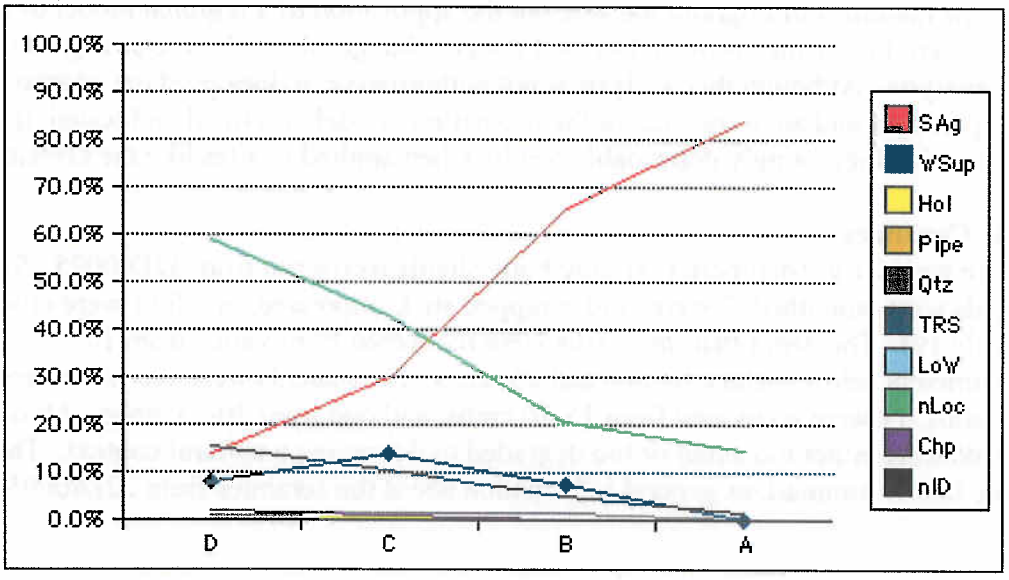
The results are shown in Table 18. The process produced four potential reconstructed components (units A, B, C and D, bottom to top), and initially seemed to be a promising line of analysis. The assignment of projectile points and other potentially diagnostic artifacts shows a plausible distribution (Table 18). The components also show a plausible reconstruction of raw material use trends through the Archaic (Figure 11). This figure, in fact, clearly resembles the other graphs showing plausible stratigraphic patterning in raw material distribution (Figures 7, 5, 8).

Stratigraphic unit A looks like the expected pattern for some time early in the Archaic, with a very high percentage of SRC and low percentage of KRF. Unit D, conversely, looks like the expected pattern for some time fairly late in the Archaic, with a high percentage of KRF and a much diminished percentage of SRC. Units B and C in the middle show a smooth progression from the first condition to the last.

Table 18:
Attempted Stratigraphic Correlations, Gabriel Site (32DI0095).

	Shallow E+W	Mid-depth	Deep Central	Deep East	n=	Notes
?		L1-L3			59	
?			L1-L4		351	• II-2-3 EPW Besant [Fusilinid Group]
D			L5-L7	L1-L3	369	CCCC
C	L1-L3	L4-L5	L8-L12	L4-L7	576	C • III-7-2 Type? [Silicified Wood] • II-3-2 MPA Duncan (2 pcs) [KRF] • III-11-5 Type? [KRF] • Backed scrapers
B	L4-L6	L6-L8			136	C • III-1-4 MPA McKean [KRF] • III-33-6 MPA McKean-Hanna-Duncan [gTR] • Fully grooved maul • Bipolar core
A				L8-L12	62	
n=	474	192	734	153	1533	

Figure 11:
Stratigraphic Correlation and Hypothesized Stratigraphic Units



It is also worth specifically mentioning that this exercise in correlation manages to accommodate the lower levels of the mid-depth and deep-central groupings, both of which have been problematic

In the end this stratigraphic correlation, however, may not be especially productive. It doesn't necessarily provide any new insights on overall trends in raw material stratigraphy. Further, a look at the underlying data shows that it is often difficult to determine where to divide a grouping into different stratigraphic units. It becomes increasingly clear, in fact, that there is considerable mingling of components. There may be two levels with a single clear raw material use pattern, two more levels with a different pattern, and in between them a level with characteristics of both. But in this stratigraphic correlation, the intermediate level has been assigned to one or the other unit.

In addition, although the correlation can accommodate the lower levels of the problematic mid-depth and deep-central groupings, it cannot account for the upper levels. These remain "free floating" above the stratigraphic column. They do not resemble each other, and are not interpreted as representative of any particular component or raw material use patter.

Oddly enough, both of the unaccounted for units look like units that are included in the correlation but lower in the stratigraphy. Clustering these units with the other units they resemble, however, would require putting them out of stratigraphic order. Levels 1 to 4 of the deep-central grouping, for example, would go below levels 5 to 7 of that grouping. This might be taken as evidence of disturbance and redeposition of older deposits in the upland depression containing the deep-central grouping.

The lithic raw material analysis of the Gabriel site suggests a number of useful interpretations regarding site stratigraphy, structure and chronology. This was accomplished in part simply by looking at internal variations in the disposition of raw materials throughout the site, but the application of a regional model of raw material use patterns that addressed pattern changes through time strengthened the analysis. Although this analysis is not authoritative, it does produce interesting questions and answers, and, as the use pattern model is refined and tested, it might provide increasingly dependable results when applied to sites like the Gabriel site.

7.3 Ceramics

There were 27 grit-tempered ceramic body sherds recovered from 32DI0095. Sixteen sherds were smoothed, 7 were cord-wrapped stick impressed, and four were crumbs (Table 19). The depth that the sherds were recovered from varies from 10 centimeters below surface (cmbs) and 25 cmbs. Nine sherds were recovered from 10-15 cmbs, 17 were recovered from 15-20 cmbs, and one from 20-25 cmbs. All of the sherds were either too small or too degraded to determine a cultural context. The table below summarizes general information about the ceramics from 32DI0095.

Table 19:
Summary for Ceramics Recovered from 32DI0095

Test Unit Number	Level	Depth (CMBS)	Decorated	Smoothed	Crumb	Total
TU16	3	10-15	7	4	-	11
TU16	4	15-20	-	7	2	9
TU17	3	10-15	-	1	2	3
TU25	5	20-25	-	1	-	1
TU29	3	10-15	-	2	-	2
TU39	3	10-15	-	1	-	1
		TOTAL	**7**	**16**	**4**	**27**

7.4 Faunal

The Tatanka faunal assemblage consists of twenty bone fragments (Table 20). According to University of Minnesota's Managing Director of the Evolution Anthropology Laboratory, John Soderberg, most of the fragments were undiagnostic and show moderate battering and weathering.

Table 20:
Faunal Remains from the Gabriel Site (32DI0095)

Test Unit	Level	cmbs	n=	Description	Max. Length (mm)	Weight (g)
25	6	25-30	1	One fragment of tooth enamel of a large ungulate, possibly bison.	32.6	1.2
26	1	0-5	4		73.0	12.2
					32.8	4.6
					17.6	0.9
					9.8	0.3
42	2	5-10	10	Five pieces refit to form two larger fragments. Remaining five pieces are undiagnostic.	54.2 (3 refit)	9.5
					30.6 (2 refit)	1.8
					30.6	1.4
					29.7	0.5
					23.0	0.4
					20.6	0.8
					9.1	0.1
43	2	5-10	1	AMS dating specimen (Beta 239659).	84.0	12.0
47	1	0-5	1	One undiagnostic fragment.	38.1	3.6
	2	5-10	3	Largest fragment used for AMS dating (Beta 239658).	49.5	9.0
					16.8	
					13.2	
Construction Monitoring		15-20	1	Possible ungulate vertebra or radial carpal.	35.2	13.0

Two of the faunal fragments, one from TU43 and the largest from level two of TU47 were sent to Beta Analytic for AMS dating. Both fragments went through an alkali pretreatment, and both contained enough carbon for dating. Unfortunately it appears that these faunal fragments were most likely modern. The fragment from TU 47, Beta – 239658, was dated to 30 +/- 40 RCYBP. It was calibrated with a 95% certainty to AD 1950 to present, AD 1880 to 1920, AD 1820 to 1840, or AD 1700 to 1720. With the use of Calib, it was determined the greatest likelihood is a date from AD 1880 through 1919. The fragment from TU 43, Beta – 239659, was dated to 0 +/- 40 RCYBP. The radiocarbon date was too modern and therefore outside the range of calibration

7.5 Stone Features

Investigations at the Gabriel Site resulted in the identification of thirteen stone features consisting of four complete stone circles (C1, C2, C3, and C4), three incomplete stone circles (I1, I2, and I3), two cairns (Cairn 1 and Cairn 2), two rock lined depressions (D1 and D2), one rock line (RL), and one petroform (PF) (Table 21; Exhibit 4). All features were located by pedestrian survey in mixed grass pasture with poor visibility and are located on a terrace in upland plain. The features are located near a permanent lake known as a prairie pothole, and made of locally available stone. Some of these features are somewhat disturbed by cattle and erosion, and none of the features appear to have associated features, such as fire hearths. Only stone circle C4 and the Petroform (PF) were located within the APE.

Table 21:
General Information for Individual Stone Features at site 32DI0095

Feature Name	Shape	Area of Site (m)	Distance to Water/Direction	Condition
C1	Circular	4-x-4	100 m/North	Complete
C2	Circular	4-x-4	150 m/North	Complete
C3	Circular	4-x-4	100 m/North	Complete
C4	Circular	4.5-x-4.5	200 m/North	Complete
I1	Circular	4-x-2	100 m/North	Incomplete
I2	Circular	3.5-x-3.5	150 m/North	Incomplete
I3	Circular	4-x-4	100 m/North	Incomplete
RL	Linear	5.5-x-1	150 m/Northeast	Unknown
PF	Linear	5-x-4	170 m/North	Unknown
Cairn 1	Round	6-x-5	170 m/Northwest	Complete
Cairn 2	Round	6-x-5	230 m/Northwest	Complete
D1	Round	2-x-2	140 m/Northwest	Complete
D2	Round	2-x-2	140 m/Northwest	Complete

7.5.1 Stone Circles

There were four complete stone circles and three incomplete stone circles. These features were identified by pedestrian survey during the Class III Investigation. The circles were located on flat surface overlooking a prairie pothole lake, in grass and various scrub on the west half of the site. Only one stone circle (C4) was located within the proposed project APE.

Incomplete Stone Circles

Three of the circles located at the Gabriel Site were incomplete, meaning that either a complete, closed circle was not constructed at this location, or that some of the stones have been moved or removed, leaving partial circles. Stone circle I1 consisted of approximately 13 stones, measured 4-x-2-meters across, and was located adjacent to stone circle C3, approximately 100 meters south of the prairie pothole. Stone circle I2 consisted of approximately 20 stones, measured 3.5-x-3.5-meters across, and was located approximately 150 meters south of the prairie pothole. Stone circle I3 consisted of 19 stones, measured 4-x-4-meters across, and was located approximately 100 meters south of the prairie pothole.

Complete Stone Circles

Four of the stone circles recorded at the Gabriel site were complete. Stone circle C1 consisted of approximately 40 stones and measured 4-x-4-meters. C1 was located approximately 100 meters south of the prairie pothole. Stone circle C2 consisted of approximately 37 stones, measured 4-x-4-meters, and was located approximately 150 meters south of the prairie pothole. Stone circle C3 consisted of approximately 26 stones, measured 4-x-4-meters, and was located 100 meters south of the prairie pothole. Stone circle C4 consisted of over 70 stones and measured 4.5-x-4.5-meters. C4 was located approximately 200 meters south of the prairie pothole and was the only stone circle located in the proposed project APE. To mitigate the inevitable destruction of this feature, much of C4 was excavated during the data recovery.

Excavation of Stone Circle C4

Stone Circle C4, located on the far western boundary of the Gabriel Site mitigation area, was chosen for excavation because it was relatively complete and was going to be adversely affected by road construction. The ground on which the stone circle was located was very flat and covered with grass and short scrubby foliage. This circle measured roughly 6.5-x-8-meters across, from the outer edge of the stones, with a slightly less complete section in the northwest quadrant and a phalange of stones at a southeast angle off the southeast quadrant which might be associated with the circle structure (Figure 12). Over 70 stones were recorded as part of the circle structure. Very few stones within the bounds of the circle were visible on the surface. In addition to the feature, the surrounding stones were also mapped to illustrate the general distribution in the area.

Six 1-x-1-meter test units were excavated as part of the stone circle investigation. Test unit 1 was placed in the north-east quadrant of the stone circle, while TUs 2, 3, 31, 32 were located inside the stone circle. Test unit 46 was placed outside the stone circle to serve as a "control" unit. This was performed to uncover if there was a difference in number or type of artifacts between inside and outside of the stone circle. All units were excavated in 5 centimeter levels, soil was screened through 1/4-inch hardware cloth, and the stones were sketched by level.

Test unit 1 was excavated to better define the stone circle, give insight into its construction, and possibly locate a living surface. Units 2, 3, 31 and 32 were placed in a contiguous block inside the circle to further investigate the circle's construction, and possibly locate subsurface features, living surfaces, and cultural remains.

As levels one and two of TU 1 were excavated, more rocks were revealed, however, by level three no new stones were emerging. A Knife River Flint (KRF) projectile point base was recovered from TU 1, level 4 (15-20cmbs), underneath the stones that made up the circle (Appendix G1). This point has been typed as a McKean Lanceolate which roughly indicates dates from 2500 BC to 1000 BC.

Excavation of TUs 2 and 3 revealed a moderate number of small stones, probably related to the glacial till. Rocks increased in frequency and size in TU 2 between levels four and seven until they completely covered the bottom of the excavation unit.

Test unit 31 revealed no cultural material whatsoever and only a very few sizable stones located between levels four and six. Test unit 32 had a few stones on the surface and only a handful of KRF and Swan River Chert flakes were recovered from the unit. The pattern of vertical material dispersion in this unit follows Bakken's model, outlined in the analysis section of this report, where KRF is present in the upper levels and SRC in the lower levels. No diagnostic artifacts were recovered from TUs 2, 3, 31, or 32, and no subsurface features of any kind were located in the excavation units associated with C4.

7.5.2 Petroform and Rock Line

The petroform lies at the south west end of the Gabriel Site. This feature measures approximately 5-x-4-meters and consists of a line of stones that branches off on the southernmost end of the line, for a total of 56 stones (Figure 13). Although no definite shape has been determined, it appears as though it might be a dragonfly or thunderbird. The petroform was avoided during construction. The rock line lies outside of the APE at the west end of the Gabriel Site. This linear feature measured 5.5-x-1-meter and consisted of approximately 32 stones. The features were identified during the Phase II investigations but only the petroform investigated further during the data recovery.

Figure 12:
Stone Circle C4 Sketch

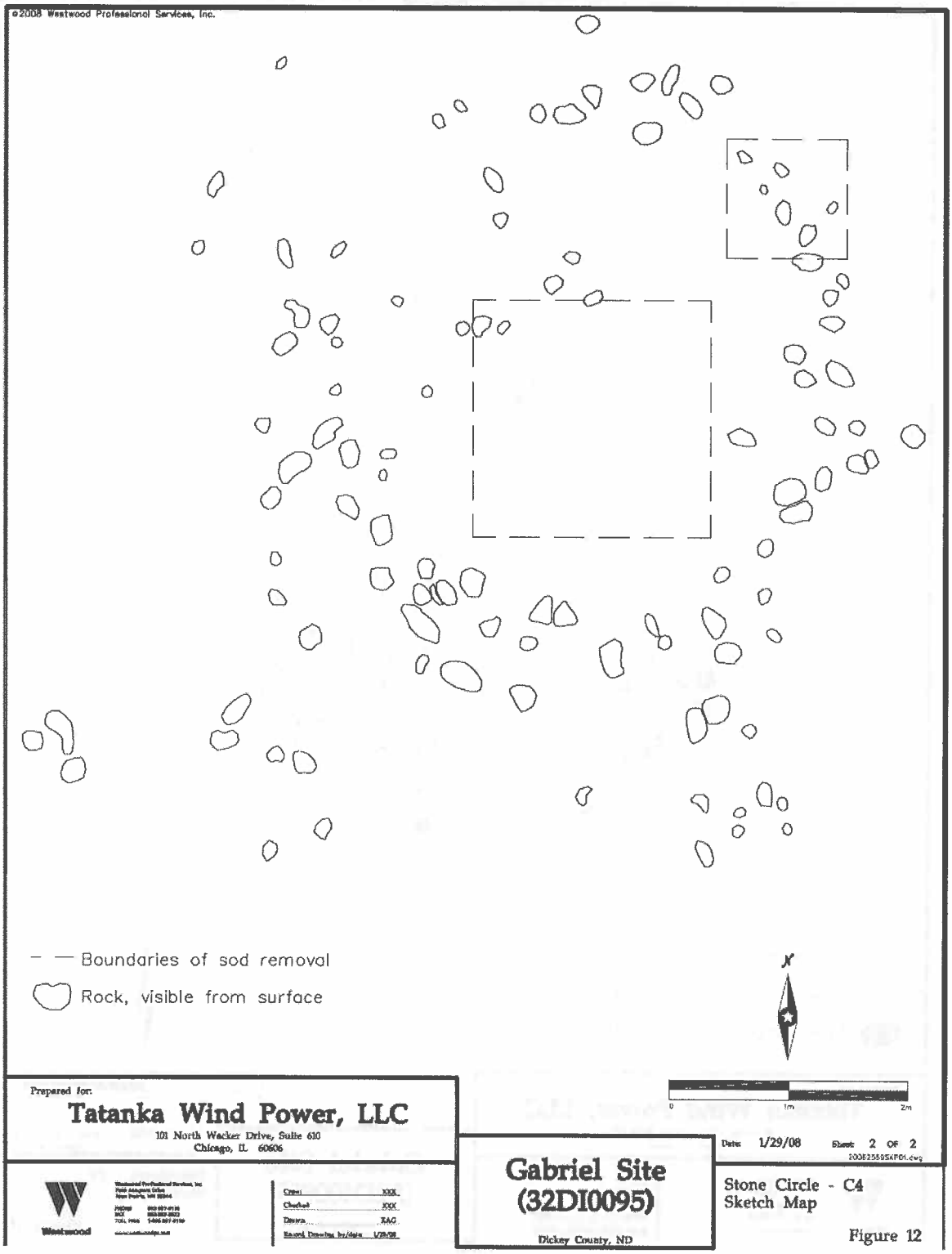
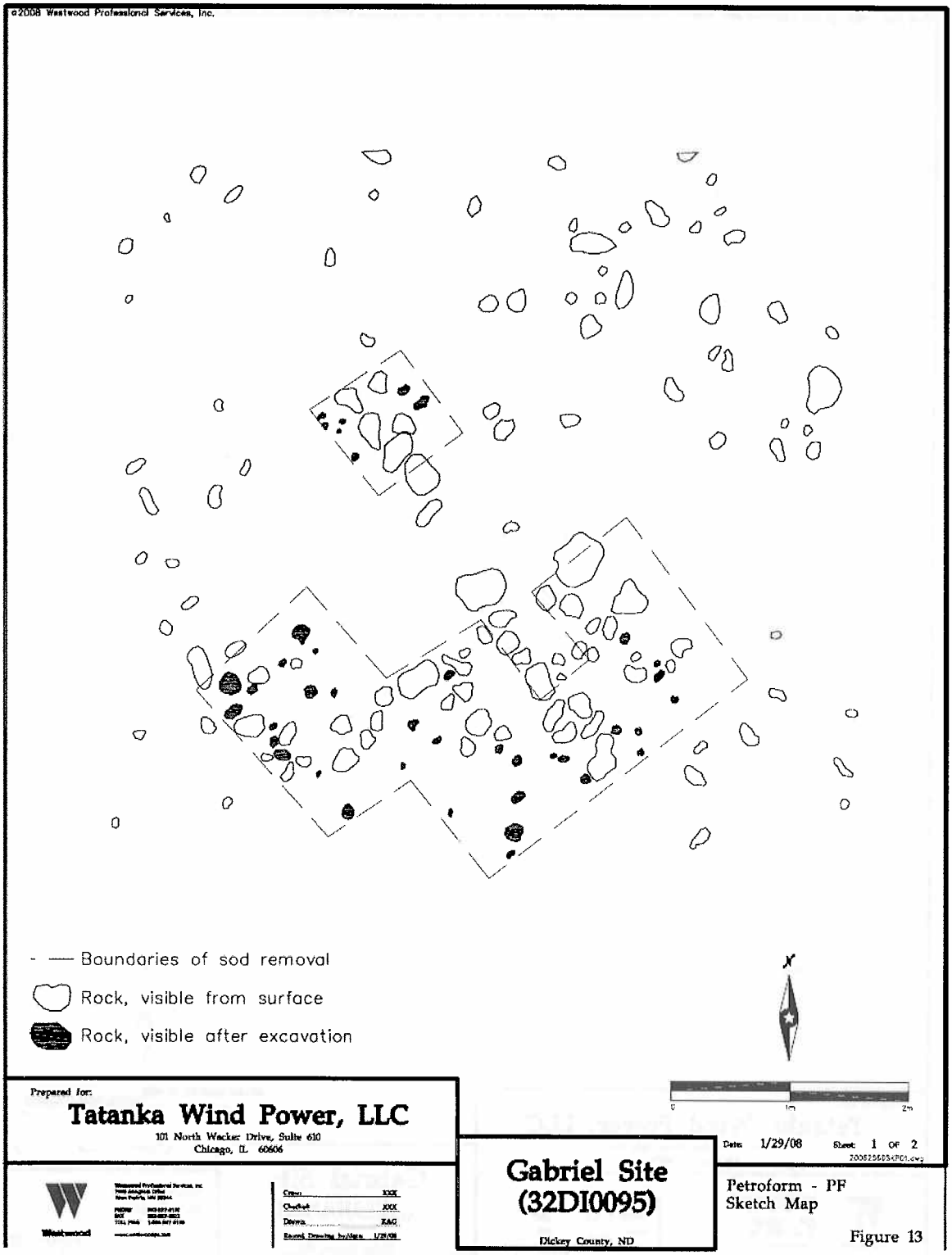


Figure 13:
Petroform Sketch



During laboratory analysis of the Gabriel Site, researchers realized that the line of rocks in the petroform aligned exactly on a northwest to southeast angle with the rock line, approximately 65 m to the northwest (Exhibit 2). This linear relationship is similar to that of the cairn alignments at the Big Horn Mountain Medicine Wheel in Wyoming and the Moose Mountain Medicine Wheel in Saskatchewan, Canada, where the alignments appear to predict the helical rising of the star Fomalhaut.

7.5.3 Cairns

The cairns were discovered during the Class III investigation. They lie in the east half of the Gabriel site, on the highest landform within the site boundary, overlooking the James River Valley (Exhibit 4). Both cairns are described as large piles of rocks adjacent to depressions. Cairn 1 is located on the highest point of the site and measures 6-x-5-meters. Cairn 2 is located near the easternmost boundary of the Gabriel Site and measures 6-x-5-meters. From various gulches of the James River Valley, one can clearly see both cairns atop the landform.

Closer examination of the two cairns at the Gabriel Site revealed that their alignment is the same as the cairns at the Moose Mountain Medicine Wheel which appear to predict the helical rising of the star Sirius.

8.0 Conclusions and Research Question Discussion

Data recovery excavations at the Gabriel site were conducted in an attempt to mitigate the adverse effects of a wind farm proposed within bounds of this National Register eligible site. Investigations focused on four specific questions. Conclusions regarding the data recovery excavations and research questions is discussed below.

8.1 Gabriel Site Complexes and Components (Research Question #1)

- Is the Gabriel Site part of the McKean Complex? Are other components present? What are more precise dates for the McKean and/or other complexes at 32DI0095?

Several modes of investigation were used to try to determine when the Gabriel site was occupied, and by whom. First, the diagnostic tools were examined. This analysis revealed that at least two components are represented by the projectile points recovered from the site. One of these components relates to the McKean complex of the Middle Plains Archaic (2500 – 1000 B.C.). The McKean complex is the dominant culture of the Middle Plains Archaic. In North Dakota the McKean complex dates from 2500 – 1000 B.C. (SHSND 1990) Three point types make up the named point typology of the McKean complex; the McKean Lanceolate, Duncan and Hanna.

Points found at the Gabriel site relating to the McKean complex include the base of a McKean Lanceolate point, a complete but broken Duncan point, and a broken side-notched point with a slightly concave base that can be typed as a Hanna point. The second component identified by the projectile points at the Gabriel site is the Besant culture of the Initial Plains Woodland dating from approximately 700 B.C – A.D. 700.

The second mode of investigation involved running an analysis of the lithic raw materials recovered from the site. The lithic raw material analysis indicates that the Gabriel site was occupied at a minimum during the Plains Archaic period. The analysis also suggests a Woodland occupation and the slight possibility of a Paleoindian component. The results and conclusions about the lithic raw material analysis will be discussed in more detail below, in conjunction with Research Question #3,

In addition to the lithic raw material analysis and point typology suggesting that a Woodland component is present at the Gabriel site, the presence of ceramics at the site also indicated that the site was occupied during the Woodland period, although the ceramics were too small and degraded to determine decorative motifs of other possibly diagnostic characteristics.

Thus, at a minimum, the Gabriel site appears to have a Plains Archaic (McKean) component, and a Plains Woodland component. Lithic raw material analysis also suggests the possibility of a Paleoindian component.

8.2 Stone Circles and Features (Research Question #2)

- Are the stone circles located at 32DI0095 associated with the McKean complex? Are the stone circles the only remaining portions of habitation structures (tipi rings) or did the stone circles serve some other purpose? What additional surface features are associated with this site?

Of the seven stone circles identified at 32DI0095, 4 were complete, and 3 were partial. Excavations at the Gabriel site did not shed much light on the dates or use of the stone circles. The excavation of the one stone circle slated for destruction in the project plans, C4, gave little information in regards to subsistence or settlement patterns of the site. No subsurface features were located within or near this stone circle, and although the base of a McKean point was recovered from below the rocks that made up the circle, it is impossible to know if the point was related to the stone circle or if the point represented an earlier component and the circle a later component.

It is also impossible to assign this stone circle to a specific cultural context. While stone circles have been identified in relation to the earlier Oxbow culture and Gregg (1985) suggests tipi ring camps as a possible settlement type of the McKean, very few stone circles have been definitively associated with the McKean peoples (Webster 2004).

Although there is some debate on the function of stone circles on the Plains, Kehoe (1958) and Malouf (1961) both gave strong evidence to their use as "tipi rings" or stones used to weigh down lodge covers. Quigg and Bruley (1984) list Finnigan's five criteria for a stone circle being a tipi ring. They are:

1. The shape does not deviate significantly from a circle;
2. There are no interior stone features that would render the interior of the tipi ring uninhabitable unless they are clearly a post-use modification;
3. The inside diameter falls between 2.5m and 9m;
4. The slope of the ground is less then or equal to five degrees;
5. The ground surface is dry and stable.

All stone circles at 32DI0095 meet Finnigan's criteria for use as tipi rings.

Other features recorded at the Gabriel site include two cairns, two rock-lined pits, a petroform, and a rock line. These features might indicate that this site played a larger role than that of simply a habitation. These thoughts are very preliminary but should be mentioned so that future researchers at the Gabriel site and in the area can be aware of these possibilities.

During analysis, researchers observed that the line of rocks in the petroform aligned exactly on a northwest to southeast angle with the rock line, approximately 65 m to the northwest. This linear relationship is similar to that of the cairn alignments at the Big Horn Mountain Medicine Wheel in Wyoming and the Moose Mountain Medicine

Wheel in Saskatchewan, Canada, where the alignments appear to predict the helical rising of the star Fomalhaut. Closer examination of the two cairns at the Gabriel Site revealed that their alignment is the same as the cairns at the Moose Mountain Medicine Wheel which appear to predict the helical rising of the star Sirius. Although these similarities between petroform and rock line at the Gabriel Site and alignments at the Medicine Wheels exist, more research is required to determine if, in fact, the sites are connected either directly or indirectly.

8.3 Lithic Raw Materials and Site Components (Research Question #3)

- What can the raw material profiles at 32DI0095 tell us about the site? Can they help ascertain whether the site is single component or multicomponent, or whether any stratigraphic trends occur? What do they suggest about the age of any components that are present? What do the nonlocal and exotic raw materials indicate about contact with other regions?

The raw material analysis of the Gabriel site suggests three primary conclusions:

1. Parts of the site preserve essentially the same record even though the depths vary significantly;
2. Other parts of the site may have incurred disturbance that mixed the raw materials and affected patterning;
3. The Gabriel site was probably used through most of the Plains Archaic and possibly in the Middle Plains Woodland and Paleo periods.

First, parts of the site preserve essentially the same record covering the same time about 12 levels (60 cm). Specifically these are the shallower excavation units and blocks located towards the western and eastern ranges of testing, when compared to another area of deeper excavation just east of center. In the shallow units , biomantle formation has condensed many assemblages into a relatively shallow stratigraphy. This results in partly co-mingled assemblages, while preserving the general trends in changing raw material use patterns over a period of some thousands of years.

Unfortunately it is not possible to cleanly separate the co-mingled components in the shallower units. In the deeper excavations, however, minor sediment deposition may have contributed to soil upbuilding and separated the components. Although low artifact density in this area hampers interpretation, higher levels of Swan River Chert were recovered from the deepest levels. This suggests an earlier occupation at the site than is suggested by the shallower excavation units, specifically Early Archaic or possibly Late Paleoindian.

Second, some areas of the Gabriel site might have incurred some kind of disturbance that muddled raw material patterning in those areas. The evidence for this comes from the excavations around the rim and in the bottom of an upland depression near the center of the site. Although the raw material analysis and use pattern model can account for parts of the raw material distributions in these excavation units, other parts defy interpretation.

One explanation for this disturbance is that the depression was originally a very small, shallow pothole lake or wetland. As time wore on, the higher ground surrounding the lake eroded down, eventually filling the depression with sediments. If, during and after this time, the area around this small lake was occupied by people that left scatters of artifacts, it would also be reasonable to think that some of the artifacts also eroded from the higher areas above the lake, into the slowly filling depression. Once the depression was filled, people began to occupy not only the area around the depression, but the actual depression. Thus, the lithic raw material and use pattern analysis would yield results that partly followed typical patterns and party mirrored or were completely dissimilar to typical raw material and use patterns.

The raw material analysis alone is not a basis for concluding that these parts of the site have in fact been disturbed. It would be better to say that the analysis provides questions that should be addressed with other lines of inquiry, such as geomorphic investigation. Since it does not seem likely that additional investigations will occur at the Gabriel site in the near future, this question might be considered in the investigation of other sites located in similar landscape situations.

Third, the raw material analysis suggests that the Gabriel site was used through most of the Plains Archaic period. The proportion of various raw materials, and in particular the proportions of Swan River Chert and Knife River Flint, can be compared to the raw material use pattern model and calibrated by comparison to nearby dated assemblages like those from the Early Plains Archaic component at the Rustad site. According to the calibrated model, the Gabriel site use extends from the Early Plains Archaic (and possibly earlier) through the end of the Plains Archaic with its attendant peak in the use of Knife River Flint. It is interesting to contrast this with the line of evidence provided by projectile points, which indicate use of the site from the Middle Plains Archaic into perhaps the Initial Plains Woodland. The recovery of ceramic sherds also confirms use of the site during the Plains Woodland, while the recovery of a fully grooved groundstone maul might indicate a somewhat earlier Plains Archaic component. The overlap of the projectile point and raw material evidence in the Middle to Late Plains Archaic lends greater credence to the conclusion that people used the Gabriel site for quite an extended period of time.

8.4 Subsistence, Function and Seasonality (Research Question #4)

- What were the subsistence practices at 32DI0095? What was the site's function? Through subsistence practices and settlement behavior can the sites seasonality be inferred?

Unfortunately, the excavations at the Gabriel site yielded little information directly pertaining to the subsistence practices, settlement behavior, and seasonality of the people that occupied the site other than that the Gabriel site appears to be a habitation site. Only a handful of faunal remains were recovered from the site, and of those, few were diagnostic, and based on the results of the AMS dating by Beta Analytic, relatively modern.

Little to no direct information relating to the seasonality and site use was recovered during the excavations at the Gabriel site. However, we might be able to form some basis for use and seasonality if we proceed with the speculation that the petroform, rock line, and rock cairns were purposefully aligned with the heliacal rising of Fomalhaut (five months after summer solstice -- 28 days before winter solstice) and Sirius (three months after summer solstice) (Eddy 2008). If in fact, the cairns, petroform, and rock line do predict the heliacal rising of these stars, then it seems a logical step to assert that the site might have served a ceremonial or at the very least calendrical purpose.

9.0 Recommendations

Although construction of the Tatanka Wind Farm significantly disturbed the Gabriel site (32DI0095), all but one of the surface features was preserved, and over 80% of the site is estimated to remain intact. Additionally, it is not only possible, but likely that this site is larger than previously thought. This is because 1) the site boundaries were defined within and relating to the proposed project's APE, and 2) a previously unrecorded stone circle was observed a short distance to the west of the current site boundary after the mitigation was completed.

Thus, there remains *significant* research potential involving both excavation and mapping of the surface features and their relationships to one another. The Gabriel site could yield additional important information on the Middle Archaic, Plains Woodland, and possibly Paleo periods in North Dakota. Also, the possibility of stellar alignments similar to those seen at the medicine wheels at Bighorn Mountain and Moose Mountain should be researched further.

Because over 80% of the site remains intact, and significant potential exists for locating undisturbed subsurface features, and studying intact cultural deposits, the Gabriel site retains substantial research potential. Westwood and 10,000 Lakes recommend that the Gabriel site (32DI0095) remains eligible for listing on the National Register of Historic Places under Criteria D, "may be likely to yield, information important in prehistory."

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APPENDIX A: NORTH DAKOTA SITE FORM

N 3633

update

NDCRS SITE FORM
ARCHEOLOGICAL SITES

I. SITE I.D.

SITS # 32 DI 0095
State County Site Number

Field Code I1 Site Name GABRIEL SITE
Field Code _____ Site Name _____

Map Quad FORBES NW
Map Quad _____

LTL _	Twp 129	R 66	Sec 23	QQQ 6	QQ 6	Q 6
LTL _	Twp 129	R 66	Sec 24	QQQ _	QQ 7	Q 7
LTL _	Twp _	R _	Sec _	QQQ _	QQ _	Q _
LTL _	Twp _	R _	Sec _	QQQ _	QQ _	Q _
LTL _	Twp _	R _	Sec _	QQQ _	QQ _	Q _
LTL _	Twp _	R _	Sec _	QQQ _	QQ _	Q _

1. N½
2. E½
3. S½
4. W½
5. NE¼
6. SE¼
7. SW¼
8. NW¼
9. C

II. SITE DESCRIPTION

FEATURE TYPE	CULTURAL MATERIAL
_ Conical Timber Lodge	_ Bone, worked
1 CM Scatter	1 Ceramics
_ Earthlodge Village	_ Charcoal
_ Earthworks	_ Copper
_ Fortification	1 Faunal Remains
_ Grave	1 Fire Cracked Rock
_ Hearth	_ Floral Remains
_ Jump	_ Fossil
_ Mound	_ Hide, Hair, Fur
1 Other Rock Features	_ Human Remains
1 Pit	1 Projectile Point
_ Quarry/Mine	_ Shell, worked
_ Rock Art	1 Stone, Chipped
_ Rock Shelter	1 Stone, Ground
1 Stone Circle	_ Trade Good
_ Trail	_ Wood, worked
_ Miscellaneous	_ Other
_ Isolated Find	1 CM Density

9820 m. x m. Site Area
55 Cultural Depth cm.
3 Depth Indicator

CULTURAL/TEMPORAL AFFILIATION
==========
_ Paleo
3 Archaic
_ Late Prehistoric
_ Historic
_ Period Unknown

3 Basis for Dating

III. ENVIRONMENT

8 Landform 1	9 Landform 2	10 Slope/Exposure		7 Ecosystem
_ Landform 1	_ Landform 2	_ Slope/Exposure		_ Ecosystem

Elevation 655 m. Drainage System JAMES RIVER

View, Degree 2

View, Distance 1

Dist Perm Water	Perm Water Type	Dist Seas Water	Seas Water Type
1 m.	5	4000 m.	2

IV. C.R.M.

3 Ownership — _ Ownership

10/5/02/07 Fieldwork Date — 07/1/10/7 Fieldwork Date

6 Site Condition — 4 Collection — 1 Test/Probe — 1 Excavation

Additional Information

5 Management Recommendation

SHSND USE

_ Soil Association _ Ecozone _ Area Signf _ MS Number

_ Soil Association _ Ecozone _ Area Signf _ MS Number

_ CR Type _ Verified Site _ Non-Site _ E C F _ T F

_ State Registry _ National Register

Coder Ryan Paul Grohnke

Date Coded 5/29/07

FIELD MANUAL
NDCRS ARCHEOLOGICAL SITE FORM

II. SITE DESCRIPTION

FEATURE TYPE
0. or blank Absent
1. Present
2. Probable

CULTURAL MATERIAL
0 or blank. Absent
1. Present
2. Probable

DEPTH INDICATOR
0. Not applicable
1. Auger
2. Cutbank or erosional feature
3. Excavation
4. Guess
5. Shovel
6. Soil Probe
7. Other

PALEO
0. No
1. Yes-unspecified
2. Pre-Clovis
3. Clovis
4. Folsum 5. Plano
6. Post-Plano 7. Goshen

ARCHAIC
0. No
1. Yes-unspecified
2. Early Large Side-Notched
3. McKean/Duncan/Hanna
4. Oxbow
5. Pelican Lake
6. Besant
7. Pre-ceramic
8. Early Woodland
9. Middle Woodland

LATE PREHISTORIC
0. No
1. Yes-unspecified
2. Avonlea
3. Late Woodland
4. Arvilla
5. Blackduck
6. Devilslake/ Sourisford
7. Plains Village
8. Plains Nomadic
9. Sandy Lake

HISTORIC
0. No
1. Yes-unspecified
2. Arapaho
3. Arikara
4. Assiniboine
5. Blackfoot
6. Cheyenne
7. Chippewa
8. Cree
9. Crow
10. Euro-American
11. Hidatsa
12. Mandan
13. Pawnee
14. Sioux
15. Other

CM DENSITY
0. No cultural material
1. Sparse distribution
2. Medium distribution
3. Dense distribution
4.
5. Medium-dense concentration within a sparse scatter
6. Dense concentration(s) within a medium scatter
7. Denser concentration(s) within a dense scatter
8. Isolate

BASIS FOR DATING
1. Date Unknown
2. Radiocarbon
3. Typology
4. Dendrochronology
5. Thermoluminescence
6. Geology
7. Patination
8. Professional Judgement
9. Both Absolute & Relative

III. ENVIRONMENT

LANDFORM 1
1. Top of
2. Bottom of
3. Side of
4.
5. Top and Bottom of
6. Top and Side of
7. Bottom and Side of
8. Top, Bottom, & Side

LANDFORM 2
1. Beachline (glacial)
2. Beach or riverbank
3. Canyon
4. Island
5. Delta
6. Draw
7. Upland plain
8. Floodplain
9. Hill-Knoll-Bluff
10. Ridge
11. Saddle
12. Sandbar
13. Spur
14. Swale
15. Terrace
16. A. Fan
17. Butte
18. F. Slope
19. Other
20. Dune
21. Lacustrian Plain
22. Levee

SLOPE/EXPOSURE
1. North
2. Northeast
3. East
4. Southeast
5. South
6. Southwest
7. West
8. Northwest
9. Closed
10. Open

VIEW, DEGREE
1. 90°
2. 180°
3. 270°
4. 360°
5. No View

VIEW, DISTANCE
1. Excellent (5-7miles)
2. Good (2-5 miles)
3. Fair (1-2 miles)
4. Poor (less than 1 mile)
5. No View

PERM & SEAS WATER TYPE
1. Lake
2. Spring
3. Moving Water (Stream)
4. Intermittent Stream
5. Intermittent Pond
6. Marsh

ECOSYSTEM
0. Unknown
1. Bottomland
2. Terraces
3. Toe Slope
4. Scoria
5. Badlands
6. Upland Grassland
7. Rolling Grassland
8. Hardwood Draw
9. Marsh
10. Ponderosa Pine
11. Hilly Scoria
12. Upland Breaks
13. River Breaks
14. Rockland
15. Choppy Sandhills
16. Savanna
17. Mixed Grass Prairie-Dry
18. Mixed Grass Prairie-Wet
19. River Terrace and Bottom Lands

IV. C.R.M.

OWNERSHIP
1. State
2. Federal
3. Private
4. Local Government
5. Reservation

SITE CONDITION
1. Destroyed
2. Inundated
3. Very Poor
4. Poor
5. Fair
6. Good
7. Excellent

COLLECTION
0. No Cultural Material
1. CM but No Collection
2. Systematic Collection
3. Non-Systematic
4. Completely Collected

TEST & EXCAVATION
0. No
1. Yes, Results Positive
2. Yes, Results Negative

MANAGEMENT RECOMM.
1. No Further Work
2. Further Work
3. Impact Analysis
4. Both 2 & 3
5. Avoidance-Mitigation
6. Exclusion-Preservation

OFFICE

AREA SIGNF.
1. Archeological
2. Architectural
3. Historical
4. Paleontological

CR TYPE
0. Unknown
1. Site
2. Building
3. Structure
4. Object
5. District

NATIONAL & STATE REGISTER
0. Undetermined
1. Listed
2. Nominated
3. Eligible
4. Not Eligible
5. Determined Eligible
6. Eligible as Part of a District

E C F AND T F
1. Exclusion Area
2. Avoidance Area
3. Area of Concern

Field Code WPS-I1 SITS Number 32DI95

1. Access From the intersection of Hwy. 11 and County Road 9a, go south on CR 9a for 5 miles. Turn left and go east for 1 mile. Turn left and go north for 1 mile. Turn right and go east for 4 miles. Go through a gate on the north side of the road.

2. Description of Site The site is in rolling hills near the east edge of the Missouri Coteau. It is pastureland covered in grass. Hart's Gulch is to the northeast of the site.

3. Description of Cultural Materials (Quantify and identify) The site consists of 12 surface features and significant lithic deposits.
+ **Two large possible cairns next to depressions** on the two highest points of the hills. One measures 6x5 m, on a ENE-WSW line with the depression, which is encircled by rocks, ESE of the cairn. The second is an oblong, rock-covered mound, 6 m long, with a depression incorporated into the N 1/3.
+ **Two rock-encircled depressions** located on hills. Depressions are adjacent. Each of these is approximately 2 m in diameter, and 2 m apart, east to west. The rocks around the depressions are slightly built up above ground level.
+ **One rock alignment** which is a fragmented 5.5 m line on a NNW line.
+ **Seven stone circles**. Four stone circles are complete. Three are only partially complete. The stone circles are between 4 and 5 meters in diameter.
+**One petroform** possibly zoomorphic in nature. It is approximately 5 x 4 meters. The longest straight line of the petroform aligns with the rock alignment.
+ **Surface and subsurface cultural material** yielding 1885 artifacts. 1708 artifacts were chipped stone debitage including flakes of all stages of reduction, but primarily tertiary flakes. Eighty-two chipped stone tools were observed. Eight projectile points were observed including a KRF McKean Point (broken but both pieces recovered), a fusilinid chert Besant Point (tip broken and not recovered), a KRF McKean Lanceolate base, and a Red River Chert Hanna base. A single fully grooved groundstone maul was recovered.
13 surface features and 1845 artifacts # of items of cultural material observed 1845 artifacts # Collected

4. Artifact Repository
It is anticipated landowner will retain the collection.
5. Description of Subsurface Testing: A total of 43 shovel tests were placed at 32DI0095 within the APE, of which 13 were positive for cultural materials. 53 test excavation units were also placed; all but one positive with intact subsurface deposits. Four test units placed during evaluation, 49 during data recovery.

Recorded by Ryan Paul Grohnke Date 02-03-08

Field Code WPS-I1 SITS Number 32DI95

6. Field Conditions
   Wet ☐ Dry ☒ Windy ☒ Raining ☐ Snowing ☐ Overcast ☐
   Bright Sun ☒ Twilight ☐

7. Techniques(s) Used to Estimate Site Area
   Transit ☐ Tape Measure ☐ Paced ☐ Visual Estimate ☐
   Other ☒ (Explain) GIS

8. Rationale for Site Boundary Determination
   Surface Cultural Materials ☐ Features ☒ Topography ☒
   Continuous Stratigraphic Exposure ☐ Systematic Subsurface Probing ☐
   Subsurface Testing ☒ Other ☐ (Explain) _____

9. Current Use of Site Pasture

10. Owner's Name/Address
    Arlena Heinrich, P.O. Box 305, Ellendale, ND 58436

11. Vegetation Short grass

12. Vegetation Cover (% of visual ground) 0

13. Snow Cover (% visible) N/A

14. Man-hours Spent on Site apx. 1000

15. Project Title Tatanka Wind Power Project P.I. Amanda Gronhovd, 10,0000 Lakes Archaeology, LLC

16. Report Title Archaeological Data Recovery Excavations of 32DI0095, The Gabriel Site, Albertha Township, Dickey County, North Dakota Author Ryan Grohnke, Anne Anderson, Kevin Mieras, Dean Sather, Amanda Gronhovd, Kent Bakken,

17. Other Published References -Class III/Level III Cultural Resource Report for the Proposed Tatanka Wind Farm Project – Grohnke, Blondo, Anderson, Gronhovd
    - An Archaeological Evaluation of 32DI0095 – The Gabriel Site, Albertha Township, Dickey County, North Dakota – Grohnke, Gronhovd

18. Description of Collections Observed N/A
19. Owner-Address of Collections Observed N/A

Field Code WPS-I1 SITS Number 32DI95

20. Statement of Integrity Most of the features appear to have excellent integrity with little disturbance by human activity or erosion; however, one stone circle was destroyed by construction of wind farm Subsurface deposits are intact with excellent integrity. The site also currently retains integrity of location, materials, and association. Approximately 19 percent of the site was disturbed by construction of the wind farm.

21. Statement of Significance This site appears to be very significant with multiple intact surface features and significant intact subsurface deposits. The probability of finding intact subsurface features is high. This site appears to meet Criteria D of the NRHP, "...may be likely to yield information important in prehistory". It was recommended as eligible for the NRHP following an evaluation of the site. ND SHPO concurred. Despite the disturbances by development, it is recommended by Westwood Professional Services and 10,000 Lakes Archaeology that the site is still eligible for the NRHP as significant information potential remains.

22. Comments/References _____

Recorded by Ryan Paul Grohnke Date 02-03-08

APPENDIX B: RÉSUMÉS

AMANDA M. GRONHOVD

10,000 Lakes Archaeology, LLC
220 9th Ave South South St. Paul, MN 55075
612-670-6431 Gronhovd@10000LakesArchaeology.com

EDUCATION

M.S. - Industrial Archaeology, 2001, Michigan Technological University, Houghton
B.A. – Anthropology, August 1991, Minnesota State University, Moorhead

CONTINUING EDUCATION, SPECIALIZED TRAINING, AND VOLUNTEERING

Historic Bridge Workshop:
Taught by Patrick Harshbarger and Mary McCahon, Society for Industrial Archeology, Milwaukee, Wisconsin, 2005

Sacred Places Workshop:
Jeffers, Minnesota

Archaeology Department Volunteer:
Minnesota Historical Society, St. Paul, 2004-present

GIS Certification:
St. Cloud State University, Minnesota

Historic Ceramics Workshop
Taught by George Miller, Historic Archaeology Conference of the Upper Midwest, Red Wing, Minnesota

American Indian Studies:
Contemporary American Indian Movements (University of Minnesota, Minneapolis), 1995
NAGPRA: Implications and Practical Applications (University of Nevada, Reno), 1996

EXPERIENCE

Chief Manager/Principal Investigator
10,000 Lakes Archaeology, South St. Paul, MN, 1998-present

- Serve as Principal Investigator on archaeological and architectural history projects
- Perform and/or supervise all aspects of the business and cultural resources projects, including marketing, invoicing, proposal preparation, client contact, research, fieldwork, and report preparation
- Conduct and direct artifact processing and analysis, and archival research, historic and prehistoric archaeological surveys, and testing

Project-Specific Experience

- Principal Investigator for a data recovery on a McKean complex archaeological site in south-central North Dakota
- Principal Investigator for Cultural Resources survey for proposed wind farms in Minnesota, North Dakota, and South Dakota

- Principal Investigator for the public archeology program at Mill Ruins Park in Minneapolis, Minnesota
- Principal Investigator at the proposed Harness Track site data recovery excavations near Forest Lake, Minnesota
- Principal Investigator for a 1,400-acre proposed development on Lake Vermilion in northeastern Minnesota
- Principal Investigator for cultural resources on a proposed pipeline project involving numerous pipeline segments throughout Minnesota
- Cultural Resources survey at Camp Ripley, Morrison County, Minnesota
- Lincoln Mounds excavation, burial recovery, and historic artifact analysis, Bloomington, Minnesota
- Construction monitoring in the vicinity of a potential historic Ojibwe cemetery, Vermilion, Minnesota and consultation regarding an early historic cemetery in Northeast Minneapolis
- Documented and researched the historic Croft Mine, including assessing and cataloging the Mine's artifact and document collections, and making recommendations about the collection's storage, security, and overall collection policy

Archaeologist II
Minnesota Historical Society, St. Paul, MN, 2004

- Served as an archaeologist/researcher for the Minnesota Historical Society's Archaeology Department

Project-Specific Experience

- Assisted the MnDNR's Trails and Waterways Archaeologist (through the Minnesota Historical Society) conducted field surveys, edited, formatted, and produced technical reports, and created a database of current projects
- Conducted research and created a database of information pertaining to over three decades of excavations at Fort Snelling

Principal Investigator
Summit Envirosolutions, Inc., St. Paul, MN, 2002-2004

- Served as Principal Investigator on archaeological and architectural history projects
- Performed and/or supervised all aspects of cultural resources projects, including proposal preparation, client contact, research, fieldwork, and report preparation

Project-Specific Experience

- Developed a public archaeology program for the Minneapolis Park and Recreation Board in the Mill Ruins Historic District at St. Anthony Falls, Minneapolis, Minnesota
- Assessed the potential significance of the standing structures within the Area of Potential Effect of a proposed highway project in North St. Paul, Minnesota
- Conducted an architectural history survey of a school in Duluth, Minnesota, which resulted in the building being deemed potentially eligible for the National Register
- Assessed the standing structures and conducted archaeological testing within the Area of Potential Effect of a proposed road project in central Minnesota

Principal Investigator
Loucks Associates, Maple Grove, MN, 2001-2002

- Served as Principal Investigator on archaeological and architectural history projects
- Performed all aspects of cultural resources projects, including proposal preparation, client contact, research, fieldwork, and report preparation

Project-Specific Experience

- Inventoried and assessed the historical and architectural significance of a neighborhood for St. Cloud, Minnesota's Historic Preservation Commission
- Inventoried the standing structures within 1½-mile radius of numerous proposed cell tower sites throughout Iowa
- Wrote the research design and excavation plan for the mitigation of two National Register sites (a historic hotel and a store) in Grand Forks, North Dakota
- Excavated and assessed the National Register Significance of a prehistoric archaeological site along the Mississippi River in Central Minnesota

Archaeology Crew Chief/Quality Assurance Officer
Statistical Research, Inc., Tucson, AZ, 1999-2001

- Developed and standardized Quality Assurance procedures for large excavations, and co-authored a comprehensive excavation manual
- Supervised the recordation of large-scale excavations, managed the excavation documentation to ensure complete and accurate data, and maintained a database of this information
- Conducted archival research
- Served as crew chief on archaeological projects

Project-Specific Experience

- Researched, surveyed, and re-assessed the boundaries of a historic nineteenth century canal system listed on the National Register (the Carlsbad Canals in New Mexico)
- Analyzed the artifacts from excavations at the historic Brookside-Vache winery in California
- Mapped and assessed presumed pre-European contact American Indian trails in northwestern Arizona
- Excavated and served as quality assurance officer during the mitigation of the prehistoric (Hohokam) Badger Hole Site in Tucson, Arizona
- Excavated and served as quality assurance officer during the mitigation of the prehistoric Marsh Station Site south of Tucson, Arizona
- Excavated and served as quality assurance officer during the mitigation of 9 prehistoric sites for the Arizona Department of Transportation. The project involved excavating several hundred square meters on 9 prehistoric sites. These excavations also rescued up to 50 Native American burials per site.
- Assessed the potential National Register eligibility of a prehistoric (Hohokam) archaeological site in Tucson, Arizona

Archaeologist
Loucks & Associates, Inc., Maple Grove, MN, 1998-1999

- Supervised the archaeology laboratory, lab workers, and interns
- Developed an artifact cataloging system and prepared collections for curation
- Conducted all phases of archaeological fieldwork, including burial mitigations and repatriations
- Conducted National Environmental Protection Act compliance surveys

Project-Specific Experience

- Excavated and analyzed artifacts from the southern portion of the Lincoln Mounds Site in Bloomington, Minnesota, including the mitigation and repatriation of Native American burials
- Excavated and analyzed artifacts from a prehistoric Dakota site near Mille Lacs, Minnesota

Teaching and Research Assistant
Michigan Technological University, Houghton, 1996-1998

- Co-authored and edited archaeological reports
- Conducted lectures, discussions, and help sessions for archaeology and history students
- Tutored students, and graded exams, quizzes, and assignments
- Cataloged and entered collections into the University's curation facility

Project-Specific Experience

- Documented the physical features of the Soudan Mine, and researched its history. This project included significant archival research pertaining to the communities of Tower and Soudan and the iron industry. This research resulted in a discussion on how economics and politics affected the development of the community and the Soudan Mine in northeastern Minnesota
- Researched the historic Quincy Smelter in Hancock, Michigan
- Documented the structural remains and excavated a 17th-18th century sugar processing site
- Analyzed artifacts recovered from a mid-1800s historic copper mining site (Ohio Trap Rock Mine) in the Upper Peninsula of Michigan
- Excavated a 19th century iron processing site (Carp River Forge) in the Upper Peninsula of Michigan

Intern
Minnesota Department of Natural Resources, Soudan Underground Mine State Park, 1997

- Cataloged collections
- Set up the Park's archives, and established treatment policies

Project-Specific Experience

- Cataloged, computerized, and stabilized the mine's historic document collection
- Authored technical guides to the mine's document collection
- Recommended archival strategies for managing the site's collection

Archaeologist and Historian
BRW, Inc., Minneapolis, MN, 1995-1996

- Supervised historic and pre-historic archaeological surveys
- Performed historic structure and historic district reviews
- Authored and edited archaeological and historical site reports
- Conducted archival and records research on archaeological and historical sites
- Developed and authored guides to cataloging, tracking, and curating artifacts.

Project-Specific Experience

- Excavated, conducted archival research, and assessed the National Register significance of a prehistoric (Woodland) site for a proposed trail in near Sauk Rapids, Minnesota
- Conducted archival research of the Area of Potential Effect and tested historical archaeology sites along TH 14 and its proposed alternate routes near Waseca, Minnesota
- Re-assessed the structures within a Hastings, Minnesota National Register of Historic Places District to determine whether the district boundaries should be expanded or remain unchanged

Archaeologist
Minnesota Historical Society, Trunk Highway Archaeology Program, St. Paul, MN, 1991-1995

- Co-authored and edited archaeological and historical site reports
- Took part in all Phases of archaeological field work on dozens of projects
- Conducted archival research on cultural resources threatened by highway construction
- Cataloged and analyzed artifacts recovered from prehistoric and historic archaeological sites
- Performed historic structure reviews to determine eligibility to the National Register
- Analyzed field and archival data from archaeological and historic structure reviews

PROFESSIONAL ORGANIZATIONS and ACTIVITIES

- Society for Historical Archaeology
- Council for Minnesota Archaeology
  - Secretary/Treasurer
- Register of Professional Archaeologists
- Society for Industrial Archeology
- Cooperative Stewardship Committee

PUBLICATION

Gronhovd, Amanda

2003 "Industrial Archaeology and the Soudan Mine's No. 8 Engine House," In *The Minnesota Archaeologist* 62:49-60.

SESSION ORGANIZED

"The Society for Industrial Archeology at Thirty Years." Session presented at the 30th Annual Conference of the Society for Industrial Archeology, Washington D.C. May 10-13, 2001.

SESSION CO-CHAIRED

"The Archaeology of Mining." Session presented at the 2005 Conference on Historical and Underwater Archaeology, York, England. January 5-10, 2005.

PROFESSIONAL PRESENTATIONS

Gronhovd, Amanda

2006 The Lincoln Mounds Site Farmstead: Studying a Farmstead Built on An American Indian Sacred Site. Paper presented at the Annual Meeting of The Society for Historical Archaeology Conference on Historical and Underwater Archaeology, Sacramento, California. January 11-15, 2006.

Gronhovd, Amanda and Timothy A. Tumberg

2004 Iron Mining In Minnesota. Paper presented at the Annual Meeting of The Society for Historical Archaeology Conference on Historical and Underwater Archaeology, St. Louis, Missouri. January 7-11, 2004.

Taking Control of Your Future. Panel Discussion at the 36th Annual Conference on Historical and Underwater Archaeology, Providence, Rhode Island. January 14-19, 2003.

Gronhovd, Amanda

2001 The Soudan Mine and Its No. 8 Engine House. Paper presented at the 30th Annual Conference of the Society for Industrial Archeology, Washington D.C. May 10-13, 2001

Tumberg, Timothy A. and Amanda T. Gronhovd

2000 Bridging the Gap Between Industrial and Historical Archaeology. Paper presented at the Annual Meeting of The Society for Historical Archaeology Conference on Historical and Underwater Archaeology, Quebec City, Canada.

Gronhovd, Amanda and Douglas George

1997 Beaulieu House Site (21CW15); The History and Mitigation Excavation at Crow Wing State Park by the Minnesota Department of Resources (DNR). Paper presented at the Annual Historical Archaeology Conference of the Upper Midwest, Red Wing, Minnesota.

Book Review

Gronhovd, Amanda

1997 "Review of Equity Issues for Women in Archaeology," edited by Margaret Nelson, Sarah Nelson, and Alison Wylie. In *Historical Archaeology* 31(4):110-2.

REPORTS

Grohnke, Ryan and Amanda Gronhovd

2007 *Phase I Archaeological Reconnaissance Survey for the Proposed Ridgewind Wind Farm in Pipestone and Murray Counties, MN.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota and Westwood Professional Services, Eden Prairie, Minnesota. Submitted to Project Resources Corporation, Minneapolis, Minnesota.

Gronhovd, Amanda

2007 *Phase I Archaeology Survey for the Proposed Agralite Electric Cooperative Minnesota-79-Big Stone Project BE-3 in Swift County, Minnesota.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota. Submitted to Agralite Electric Cooperative, Benson, Minnesota.

Gronhovd, Amanda

2007 *Cultural Resources Investigations for the Proposed Agralite Electric Cooperative Minnesota-79-Big Stone Projects in Swift and Stevens Counties, Minnesota.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota. Submitted to Agralite Electric Cooperative, Benson, Minnesota.

Gronhovd, Amanda, Grant Goltz, Christy Hohman-Caine

2007 *Background Research and Phase I Cultural Resource Survey for the Minnesota Steel Industries Taconite Mine, Concentrator, Pellet Plant, Direct Reduction Iron Plant, and Steel Mill near Nashwauk, Itasca County, Minnesota.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota and Soils Consulting, Hackensack, Minnesota. Submitted to Brad Johnson, U.S. Army Corps of Engineers, St. Paul, Minnesota

Grohnke, Ryan, Amanda Gronhovd, and Kent Bakken

2007 *Draft Research Design and Data Recovery Plan for 32DI95.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota and Westwood Professional Services, Eden Prairie, Minnesota. Submitted to the North Dakota State Historic Preservation Office.

Grohnke, Ryan and Amanda Gronhovd

2007 *An Archaeological Evaluation of 32DI95, The Gabriel Site, Albertha Township, Dickey County, North Dakota.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota and Westwood Professional Services, Eden Prairie, Minnesota. Submitted to the North Dakota State Historic Preservation Office and U.S. Fish and Wildlife Service.

Grohnke, Ryan and Amanda Gronhovd

2007 *Phase Ia Cultural Resource Assessment for Osakis Telephone Company Proposed Construction Routes; Douglas, Todd, and Pope Counties, Minnesota.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota and Westwood Professional Services, Eden Prairie, Minnesota. Submitted to CC & I Engineering.

Grohnke, Ryan and Amanda Gronhovd

2007 *Phase Ia Cultural Resource Background Literature Search and Predictive Modeling for Ryland Homes Project, Anoka, Anoka County, Minnesota.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota and Westwood Professional Services, Eden Prairie, Minnesota. Submitted to Ryland Homes.

Grohnke, Ryan and Amanda Gronhovd

2007 *Phase I Cultural Resource Survey for Azure Properties Proposed Development, City of Lino Lakes, Anoka County, MN.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota and Westwood Professional Services, Eden Prairie, Minnesota. Submitted to Azure Properties.

Gronhovd, Amanda, Steven Blondo, Ryan Grohnke, and Anne Anderson

2007 *Cultural Resources Identification and Assessment Report, Fenton Wind Farm Project, Nobles and Murray Counties, Minnesota.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota and Westwood Professional Services, Eden Prairie, Minnesota. Submitted to enXco.

Grohnke, Ryan, Amanda M. Gronhovd, Steven J. Blondo, and Anne Anderson
2007 *Class III/Level III Cultural Resource Report for the Proposed Tatanka Wind Farm Project.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota and Westwood Professional Services, Eden Prairie, Minnesota. Submitted to the U.S. Fish and Wildlife Service.

Gronhovd, Amanda
2007 *Phase I Cultural Resources Survey of the Proposed 3 Bays of Vermilion Development, St. Louis County, Minnesota.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota and Westwood Professional Services, Eden Prairie, Minnesota. Prepared for US Steel Real Estate, Mountain Iron, Minnesota

Gronhovd, Amanda
2007 *Phase I Cultural Resource Survey of Proposed Variances to the Northern Natural Gas Northern Lights Project, Minnesota.* Prepared by 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota. Submitted to ENSR Corporation, Warrenville, Illinois.

Gronhovd, Amanda
2007 *Phase I Cultural Resources Survey of the Wendy and Scott Larsen Property Near Granite Falls, Minnesota.* Prepared by 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota. Submitted to Indian Health Services, Bemidji, Minnesota.

Gronhovd, Amanda
2007 *Phase I Cultural Resources Survey of the New Cedar-High Bridge/Black Dog/St. Paul 1A TBS for the Northern Natural Gas Northern Lights Pipeline Project, Dakota County, Minnesota.* Prepared by 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota. Submitted to ENSR Corporation, Warrenville, Illinois.

Gronhovd, Amanda
2007 *Phase I Cultural Resources Survey of the Faribault Farmington E-Line Organic Farm Re-Route for the Northern Natural Gas Northern Lights Pipeline Project, West of Northfield, Minnesota.* Prepared by 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota. Submitted to ENSR Corporation, Warrenville, Illinois.

Gronhovd, Amanda
2006 *Phase I Cultural Resources Survey of Previously Recorded Sites and Areas with High Potential for Archaeological Sites for the Northern Natural Gas Northern Lights Pipeline Project, Minnesota.* Prepared by 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota. Submitted to ENSR Corporation, Warrenville, Illinois.

Gronhovd, Amanda, Grant Day, Susan Andrews, Duane Simpson
2006 *The 1996 and 1998 Archaeological Excavations at the Sibley House.* Prepared by 10,000 Lakes Archaeology, LLC, South St. Paul, and AMEC Earth & Environmental for the Minnesota Historical Society Archaeology Department, St. Paul.

O'Brien, Mollie, Amanda Gronhovd, et. al
2006 *Mitakuye Owasiâ, All My Relatives: Authentication, Recovery and Reburial at the Lincoln Mounds.* Prepared by Summit Envirosolutions, Inc.; St. Paul, Minnesota, 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota; Minnesota Indian Affairs Council; Mather Heritage Group, LLC, Onamia, Minnesota; Upper Sioux Community; and Sisseton-Wahpeton Sioux Tribe. Submitted to McGough Companies, St. Paul, Minnesota.

Gronhovd, Amanda
2006 *Phase Ia Cultural Resource Assessment of Proposed Pipeline, Town Border Station, and Contractor Pipe Yard Locations for the Northern Natural Gas Northern Lights Pipeline Project, Minnesota.* Prepared by 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota. Submitted to ENSR Corporation, Warrenville, Illinois.

Gronhovd, Amanda, Timothy A. Tumberg
2006 *Phase I Cultural Resource Surveys of Three River Crossings (the Mississippi, Vermillion, and Cannon Rivers) for the Proposed Northern Natural Gas Northern Lights Pipeline Project, Minnesota.* Prepared by 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota. Submitted to ENSR Corporation, Warrenville, Illinois.

Gronhovd, Amanda
2006 *Archaeological Investigations at the Folsom House In Taylors Falls, Chisago County, Minnesota.* 10,000 Lakes Archaeology, LLC, South St. Paul, Minnesota. Submitted to the Minnesota Historical Society Archaeology Department, St. Paul.

Gronhovd, Amanda and Grant Day
2005 *Phase I Cultural Resources Survey of the Proposed Combined Arms Collective Training Facility, Morrison County, Minnesota.* 10,000 Lakes Archaeology, South St. Paul, Minnesota. Submitted to the U.S. Arm Corps of Engineers, St. Paul District, Minnesota.

Gronhovd, Amanda
2004 *Mill Ruins Park Public Archaeology Program, Minneapolis, Minnesota.* Summit Envirosolutions, St. Paul, Minnesota. Submitted to Minneapolis Park and Recreation Board, Minnesota

Gronhovd, Amanda
2003 *Phase I, and Phase II Cultural Resources Investigations Along the Trunk Highway 36 Corridor Between McKnight Road and Century Avenue, in the City of North St. Paul (S.P. # 6211-81), Ramsey County, Minnesota.* Summit Envirosolutions, St. Paul, Minnesota. Submitted to Short Elliot Hendrickson, Vadnais Heights, Minnesota

Gronhovd, Amanda
2002 *Phase I Archaeological Survey for the Proposed Bridge Replacement and Road Widening Project in Aldrich, Wadena County, Minnesota.* Summit Envirosolutions, St. Paul, Minnesota. Submitted to Short Elliot Hendrickson, Vadnais Heights, Minnesota

Lyon, Mollie, Heidi Ekstrom, Amanda Gronhovd, Kent Bakken, Sigrid Arnott, and Jeff Anderson
2002 *Phase I Cultural Resources Investigation of a Tieback Levee Alignment, Two Borrow Areas, and the Valley Golf Course Relocation Area, and Phase II Evaluation of Site 21PL17, at the City of East Grand Forks, Polk County, Minnesota.* Summit Envirosolutions, St. Paul, Minnesota. Submitted to the U.S. Army Corps of Engineers St. Paul District, Minnesota.

Gronhovd, Amanda, and Michael Madson
2002 *Phase VI Historic Resources Reconnaissance Survey: St. Cloud, Minnesota.* Loucks Associates, Inc., Maple Grove, Minnesota. Submitted to the City of St. Cloud, Minnesota.

Gronhovd, Amanda
2002 *Architectural History Evaluation for Potential National Register Eligibility of a Proposed Cell Tower Site in Cedar, Iowa.* Loucks Associates, Inc., Maple Grove, Minnesota. Submitted to Seneca, Des Moines, Iowa.

Gronhovd, Amanda
2001 A Study in Industrial Archaeology: The Soudan Mine's #8 Engine House. Masters thesis, Department of Social Science: Industrial Archaeology, Michigan Technological University, Houghton, MI.

Sterner, Matthew A., Matt C. Bischoff, Amanda Gronhovd
2001 *The Brookside-Vache Winery: Architectural and Archaeological Testing at a Nineteenth-Century Winery in Redlands, California.* Statistical Research, Inc., Tucson, Arizona. Submitted to the U.S. Army Corps of Engineers, Los Angeles District, California.

O'Mack, Scott, Matt C. Bischoff, and Amanda Gronhovd
2000 *The Canals of Carlsbad: Historical and Archaeological Evaluation of the Carlsbad Irrigation District Distribution System.* Statistical Research, Inc., Tucson, Arizona. Submitted to the Bureau of Reclamation, Upper Colorado Region, Albuquerque, New Mexico.

Gronhovd, Amanda
1999 *An Archaeological Survey of 5225 East Wyoming Street (Parcel #140-01-015A9), Pima County, Tucson, Arizona.* Statistical Research, Inc., Tucson, Arizona. Submitted to R & S Holdings L.L.P., Tucson, Arizona.

Gronhovd, Amanda M. T. and Timothy A. Tumberg
1999 *Documenting Minnesota's Third Iron Range: A Collections Catalog and Management Recommendations for the Croft Mine Historical Park, Cuyuna State Recreation Area.* 10,000 Lakes Archeology, New York Mills, Minnesota. Submitted to the Minnesota Department of Natural Resources: Division of Parks and Recreation, St. Paul, Minnesota.

Gronhovd, Amanda
1996 *Phase I Archaeological Survey of CSAH 5 from its Southern Junction with CSAH 6 to its Junction with TH 10, Lake Park, Becker County, Minnesota.* BRW, Inc., Minneapolis, Minnesota. Submitted to the Becker County Highway Department, Minnesota.

Gronhovd, Amanda
1996 *Phase I Archaeological Survey of the Sauk Rapids Bike Trail, Benton County, Minnesota.* BRW, Inc., Minneapolis, Minnesota. Submitted to the Minnesota Department of Transportation, St. Paul, and the City of Sauk Rapids, Minnesota.

BRW, Inc. (Amanda Gronhovd, co-author)
1995 *T.H. 14 Corridor Study; Cultural Resources Technical Report. BRW, Inc., Minneapolis, Minnesota.* Submitted to the Minnesota Department of Transportation, St. Paul, Minnesota.

Maki, Chandra, Amanda Gronhovd, Jackie Sluss, Craig Johnson
1995 *Phase I and II Cultural Resources Investigation Along the CSAH 42 Corridor. (From County Road 87 to T.H. 61), Dakota County, Minnesota.* BRW, Inc., Minneapolis, Minnesota. Submitted to the Dakota County Highway Department, Minnesota.

Skaar, Kent, David Mather, Patrick Nunnally, Amanda Gronhovd
1994 *Draft Phase I Cultural Resources Reconnaissance Survey Report: S.P. 3101, Itasca County.* Minnesota Trunk Highway Cultural Resources Program, Minnesota Historical Society. Submitted to the Minnesota Department of Transportation, St. Paul, Minnesota.

Skaar, Kent, Patrick Nunnally, and Amanda Gronhovd
1994 *Draft Cultural Resources Reconnaissance Survey and Site Evaluation Report Volume I: Technical Report: S.P. 0505-17, Benton County.* Minnesota Trunk Highway Cultural Resources Program, Minnesota Historical Society. Submitted to the Minnesota Department of Transportation, St. Paul, Minnesota.

Skaar, Kent, and Amanda Gronhovd
1994 *Draft Phase I Cultural Resources Reconnaissance Survey Report: S.P. 1805-58, Crow Wing County.* Minnesota Trunk Highway Cultural Resources Program, Minnesota Historical Society. Submitted to the Minnesota Department of Transportation, St. Paul, Minnesota.

Mather, David, Patrick Nunnally, and Amanda Gronhovd
1994 *Draft Cultural Resources Reconnaissance Survey Report: S.P. 4704-42, Meeker County.* Minnesota Trunk Highway Cultural Resources Program, Minnesota Historical Society. Submitted to the Minnesota Department of Transportation, St. Paul, Minnesota.

Ryan P. Grohnke **Cultural Resource Specialist**

RESPONSIBILITIES

Ryan Grohnke participates in all aspects of cultural resources investigations. He writes proposals, performs background research, conducts all phases and classes of archaeological field investigations, and authors reports. He is responsible for implementing high-quality field procedures, supervising field crews, as well as analysis of materials and information recovered.

EDUCATION

- B.A. in Anthropology/Archaeology, Minnesota State University Moorhead
  Minors in Native American Studies and Western Civilization Humanities

EXPERIENCE

Mr. Grohnke has worked for various cultural resource firms in the Upper Midwest since 2002. He has identified, evaluated, and mitigated multiple prehistoric and historic sites. His experience ranges from conducting burial recoveries at an American Indian cemetery site, data recovery excavations at a historic hotel and general store, and large-scale Phase I surveys for proposed pipelines and wind farm projects. He has worked on multiple types of projects for a variety of clients in both the private and public sectors including small independent developers, large corporations, and government agencies. His experience is extensive in background research, all aspects of field work, and artifact curation. Mr. Grohnke also has a good understanding of preservation laws and is comfortable working on compliance issues at all levels of government.

REPRESENTATIVE PROJECTS

- Wapsi Wind Farm - Supervised field crew in southeastern Minnesota during a Phase I Reconnaissance Survey.
- Ridgewind Wind Farm – Supervised field crew in southwestern Minnesota during a Phase I Reconnaissance Survey.
- Borderwinds Wind Farm – Conducted literature and archival research. Assisted in creating critical analysis model for project area.
- Crane Creek Wind Farm – Assisted with GIS modeling of cultural resource constraints in project area. Mapped historic properties and archaeological sites.
- Gabriel Site – 32DI95 – Supervised field crew during the evaluation and data recovery of an NRHP eligible, multicomponent, prehistoric camp site in eastern North Dakota. Assisted the Principal Investigator with all aspects of project including the evaluation report, the research design and the data recovery plan. Performed construction monitoring of the site.
- Emily Telephone Cooperative – Conducted literature and archival research.
- TCI Wind – Assisted in developing predictive model for planning stages of a proposed project.
- Osakis Telephone– Conducted literature and archival research.
- Azure Properties – Conducted literature and archival research. Supervised Phase I field investigations at proposed development location in Anoka County, MN.
- Ryland Homes/Anoka – Conducted literature and archival research and authored a report on the findings.

- Empire Township – Performed background research and assisted with field investigations of a former county poor farm and the possibility of historic burials in Dakota County, MN.
- Tatanka Wind Power Project – Supervised field crew in eastern North and South Dakota during a Phase I survey of over 52 square miles of land where multiple prehistoric and historic sites were identified. Sites included turn of the century homesteads, stone circles, cairns, rock alignments, and lithic scatters. Involved with coordinating between ND SHPO, SD SHPO, and US Fish and Wildlife Service.
- Fenton Wind Farm – Supervised field crew in southwest Minnesota during a Phase II evaluation of two prehistoric sites.
- Harness Track – Participated in Phase III mitigation of a Woodland site in Minnesota.
- Northern Natural Gas Northern Lights Pipeline – Phase I identification survey of a pipeline corridor in Minnesota.
- Delano Highway Project – Assisted with Phase I identification survey and preliminary mound relocation at proposed highway location in Delano, MN.
- Lincoln Mounds – Participated in rescue and recovery excavation of human burials at a prehistoric mound site in Bloomington, MN.
- Rapids Lake Unit of the Minnesota Valley National Wildlife Refuge – Performed a Phase I identification survey on refuge land where a burial mound complex, a prehistoric village site, and a 19th Century standing structure were identified along the Minnesota River in Carver County, MN.
- Oxbow Estates – Assisted with Phase I identification survey and preliminary earthworks identification in Todd County, MN.
- SIRWA Pipeline – Participated in Phase I identification survey of rural water pipeline in southern Iowa and assisted in testing a landscape suitability predictive model.
- CSAH 52 – Assisted with Phase II evaluation of sites along CSAH 52 in Morrison County, MN.
- Great Lakes Gas Transmission Pipeline – Phase I identification survey of a pipeline corridor in Hiawatha National Forest, Michigan.
- Viets Hotel and Richardson Store –Assisted in Phase III data recovery in North Dakota at a site which included a late 19th Century hotel and a general store. Participated in artifact cleaning, treatment, and cataloging.

TECHNICAL EXPERIENCE

- Archaeological, Historic, and Cultural Resources
  - Cultural Resources Fieldwork Services –
    - Proficient in Background/Literature Research
    - Phase I Survey design and implementation
    - Phase II evaluation and Phase III mitigation field techniques
    - Field and lab supervisory experience
    - Pre-construction and construction monitoring
    - Identification, documentation and analysis of prehistoric, historic and multi-component sites
    - Small diameter soil core sampling
  - Cultural Resources Lab Analysis, Artifact Curation and Display –
    - Artifact cleaning, analysis, and cataloging

- Artifact photography
- Artifact treatment and curation for long term storage
- Museum-quality displays

- Cultural Resources Documentation –
  - Artifact data entry
  - Archaeological and historical site forms
  - Coauthored various Phase I and Phase II archaeological reports
  - Site photography

PROFESSIONAL MEMBERSHIPS

- Society for American Archaeology
- Society for Historical Archaeology
- Plains Anthropological Society

PROFESSIONAL TRAINING

- American Red Cross First Aid, and CPR Training, 2007-2008
- The Section 106 Essentials, ACHP, 2007
- NEPA Compliance and Cultural Resources, National Preservation Institute, 2007
- Forensic Field School, Moorhead State University, 1997
- Archaeological Field School, Moorhead State University, 1995

REPORTS

Grohnke, Ryan, Amanda Gronhovd, and Kent Bakken
2007 Draft Research Design and Data Recovery Plan for 32DI95. Westwood Professional Services, Eden Prairie, MN. Submitted to North Dakota SHPO.

Grohnke, Ryan and Amanda Gronhovd
2007 An Archaeological Evaluation of 32DI95, The Gabriel Site, Albertha Township, Dickey County, North Dakota. Westwood Professional Services, Eden Prairie, MN. Submitted to North Dakota SHPO and USFWS.

Grohnke, Ryan and Laura Kennedy
2007 Phase Ia Cultural Resource Assessment for Emily Telephone Cooperative Proposed Construction Routes; Crow Wing and Cass Counties, Minnesota. Westwood Professional Services, Eden Prairie, MN. Submitted to CC & I Engineering.

Grohnke, Ryan and Amanda Gronhovd
2007 Phase Ia Cultural Resource Assessment for Osakis Telephone Company Proposed Construction Routes; Douglas, Todd, and Pope Counties, Minnesota. Westwood Professional Services, Eden Prairie, MN. Submitted to CC & I Engineering.

Grohnke, Ryan and Amanda Gronhovd
2007 Phase Ia Cultural Resource Background Literature Search and Predictive Modeling for Ryland Homes Project, Anoka, Anoka County, Minnesota. Westwood Professional Services, Eden Prairie, MN. Submitted to Ryland Homes.

Grohnke, Ryan and Amanda Gronhovd
2007 Phase I Cultural Resource Survey for Azure Properties Proposed Development, City of Lino Lakes, Anoka County, MN. Westwood Professional Services, Eden Prairie, MN. Submitted to Azure Properties.

Blondo, Steven, Ryan Grohnke, Anne Anderson, and Amanda Gronhovd
2007 Cultural Resources Identification and Assessment Report, Fenton Wind Farm Project, Nobles and Murray Counties, Minnesota. Westwood Professional Services, Eden Prairie, MN. Submitted to enXco.

Grohnke, Ryan, Steven J. Blondo, Anne Anderson, and Amanda M. Gronhovd
2007 Class III/Level III Cultural Resource Report for the Proposed Tatanka Wind Farm Project. Westwood Professional Services, Eden Prairie, MN. Submitted to USFWS.

Halloran, Teresa and Ryan Grohnke
2005 A Phase I Archaeological Reconnaissance Survey of Potential Development Areas in the Rapids Lake Unit of the Minnesota Valley National Wildlife Refuge, Carver County, Minnesota. Loucks Associates, Maple Grove. Submitted to USFWS.

Artz, Joe, Teresa Halloran, Michael Kolb, and Ryan Grohnke
2004 Phase I Archaeological Investigation and Landscape Suitability Model for the Southern Iowa Rural Water Association (SIRWA). Loucks Associates, Minneapolis, Minnesota. Submitted to Southern Iowa Rural Water Associates, Creston, Iowa.

Grohnke, Ryan
2003 Phase I Archaeological Investigation of the Proposed Laundry Facilities Development at Grand Casino, Mille Lacs, Kathio Township, Mille Lacs County, MN. Loucks Associates, Maple Grove, MN. Submitted to the Mille Lacs Corporate Commission.

Grohnke, Ryan
2002 Phase I Archaeological Reconnaissance Survey of the Proposed Eagle Lake Development, Big Lake, Sherburne County, MN. Loucks Associates, Maple Grove, MN. Submitted to Eagle Lake Resort and Golf Community.

PRESENTATION

Grohnke, Ryan, Amanda Gronhovd, and Anne Anderson
2007 *A Petroform, Stone Circles, and Global Warming.* Presented at the Plains Anthropological Conference, Rapid City, SD.

STEVEN J. BLONDO
Senior Cultural Resource Specialist

Westwood

Overview
In the field of cultural resource management, Mr. Blondo has nearly ten years of experience as a field archaeologist and excavation crew member for various consulting firms throughout the United States. In that capacity, he has located, excavated and interpreted historic and prehistoric sites, researched site history and was the curator of artifact collections.
Mr. Blondo has conducted cultural resource assessments and investigations on large scale wind power and alternative energy projects. Teaming with a tribal liaison, he has incorporated Native American concerns and interests in the planning process. Thanks to this teaming approach, projects have moved smoothly toward completion.

Experience
Conestoga Wind Farm, Stevens County, Kansas – Project manager for Cultural Resource Survey for a 94-turbine wind farm and ancillary facilities, including agency consultation and involvement.

Deaf Smith Wind Farm, Deaf Smith County, Texas – Assisted with GIS modeling of cultural resource constraints within project area. Mapped previously surveyed areas and identified historic properties and archaeological sites.

Crane Creek Wind Farm, Howard County, Iowa – Assisted with GIS modeling of cultural resource constraints within project area. Mapped previously surveyed areas and identified historic properties and archaeological sites.

Ridgewind Wind Farm, Pipestone and Nobles Counties, Minnesota – Project manager for Phase IA literature search and assessment of archaeological potential, Phase I Cultural Resource Survey for a 16-turbine wind farm and ancillary facilities.

Fenton Wind Farm, Murray and Nobles Counties, Minnesota – Project manager for Phase IA literature search and assessment of archaeological potential, Phase I Cultural Resource Survey and Phase II Archaeological Assessment for a 137-turbine wind farm and ancillary facilities, including extensive tribal consultation and involvement.

Tatanka Wind Farm, North & South Dakota – Responsible for cultural resource investigations for a 51-square-mile, 120-turbine wind farm, 12-mile-long 230-kv transmission line and substations in one South Dakota and two North Dakota counties.

Advanced BioEnergy Ethanol Plant, Northfield, Minnesota – Responsible for background literature search and field assessment of archaeological potential. Assisted with preparation of an Environmental Assessment Worksheet.

Publications and Presentations

They'll Pay Me To Do This? Advice for making it in the world of CRM. Presentation to Hamline University Applied Archaeology Course, November 7, 2007.

Archaeology in Real Time: The Challenges of Cultural Resource Management Today. The Archaeology Consortium Friday Archaeology Lunch Talk Series, October 26, 2007.

A Proactive Approach to Cultural Resources in North American Windpower, Volume 4, Number 5, June 2007.

Poster Presentation: *a proactive approach to cul-tur-al re-sour-ces* AWEA Windpower 2007, Los Angeles, California.

Archaeological Survey in West Central Minnesota. Minnesota Archaeology Week Presentation at the Kandiyohi County Historical Museum, Willmar, Minnesota, May 8, 2007.

Education

Currently Pursuing MA in Cultural Heritage Studies, University of MN-Minneapolis
BA in Anthropology, Moorhead State University
AA in Culinary Arts, Le Cordon at Brown College

Training and Certifications

American Red Cross First Aid, CPR and Defibrillator Training, 2007-2008
Advisory Council on Historic Preservation Section 106 Training, St. Paul, 2007
Minnesota Statewide Historic Preservation Workshop, 2007
Minnesota Historical Society Repository Training, St. Paul, 2006, 2007
Cooperative Stewardship Workshop, Red Wing, 2006
Amtrak Safety Certification, 2000
Geological Field School, Moorhead State University 1997
Forensic Field School, Moorhead State University, 1997
Archaeological Field School, Moorhead State University, 1996

Associations

Society for American Archaeology
American Cultural Resource Association
Minnesota Archaeological Society
Council For Minnesota Archaeology
Plains Anthropological Society

Chronology

Westwood Professional Services, February 2006 – Present
Peterson Environmental Consulting, Inc., 2005-2006
A.D. Marble & Company, 2001-2003
URS Greiner Woodward Clyde, 1999-2000
BRW, Inc., 1999
Tetra Tech, Inc., 1999
MAAR Associates, Inc., 1998-1999
KCI Technologies, Inc., 1998

APPENDIX C: PHOTOS

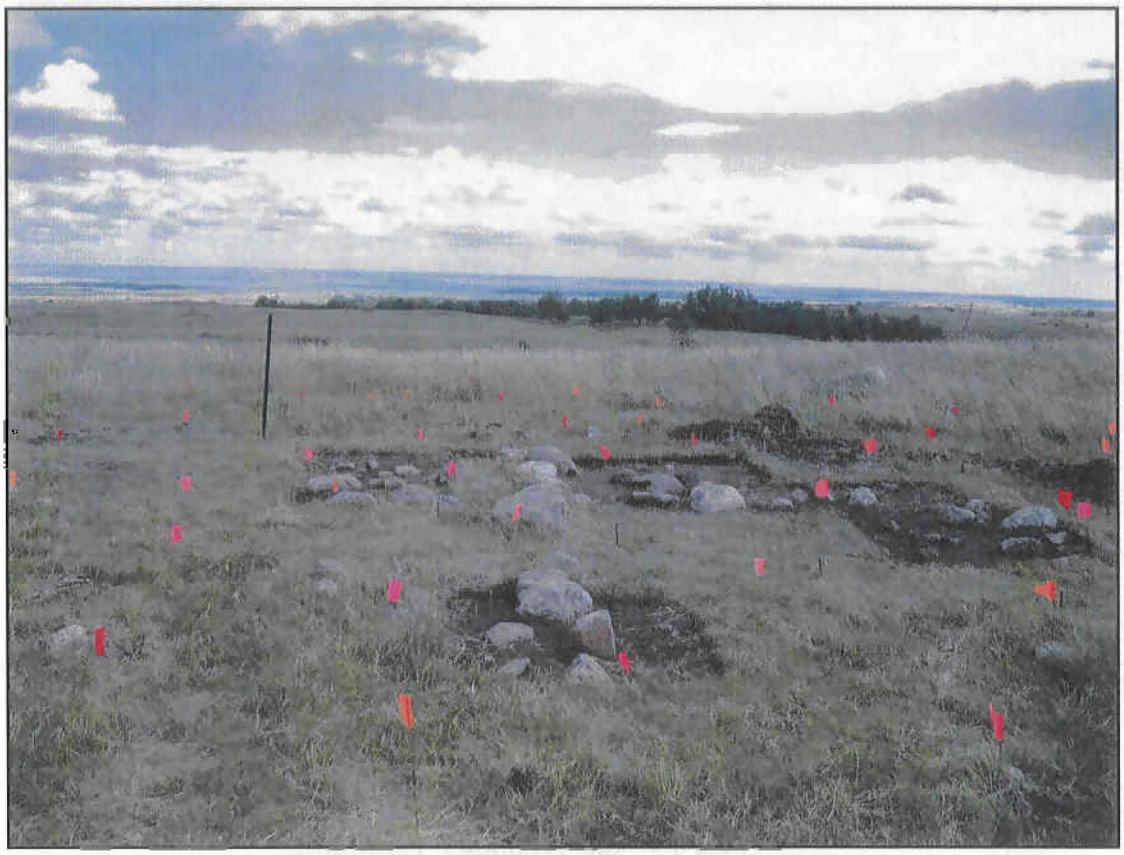


Photo 1: Site 32DI0095: Petroform.



Photo 2: Site 32DI0095: Petroform.



Photo 3: Site 32DI0095: Petroform.



Photo 4: Site 32DI0095: Petroform.

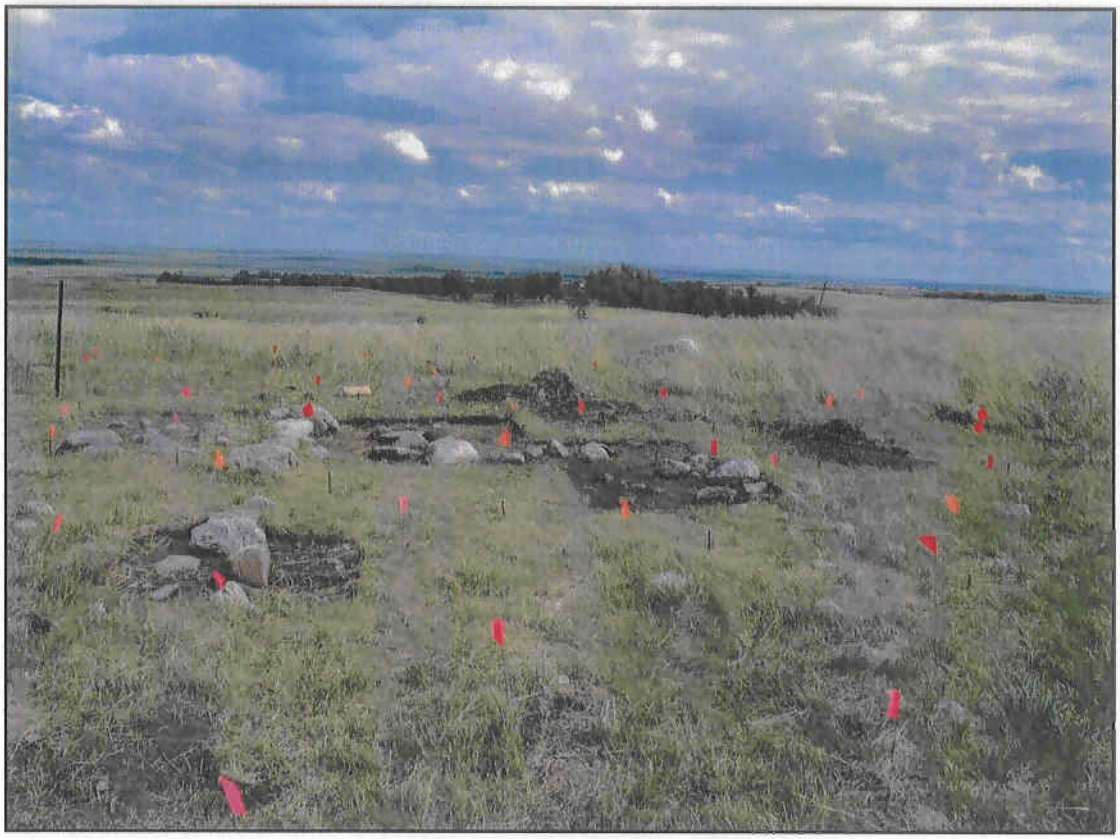


Photo 5: Site 32DI0095: Petroform.

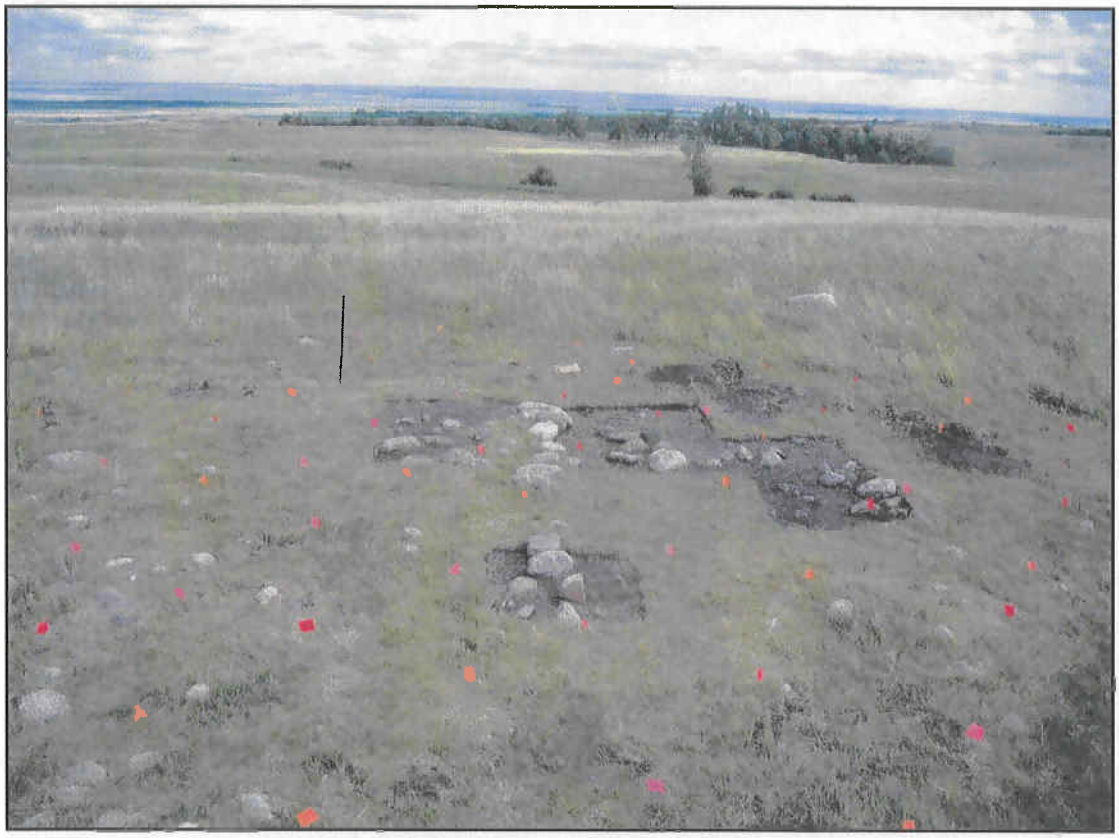


Photo 6: Site 32DI0095: Petroform.



Photo 7: Site 32DI0095: Cairn 1.



Photo 8: Site 32DI0095: Cairn 1.



Photo 9: Site 32DI0095: Cairn 2.



Photo 10. Site 32DI0095: Rock alignment RL.



Photo 11: Site 32DI0095: Stone circle I3.



Photo 12: Site 32DI0095: Stone Circle.

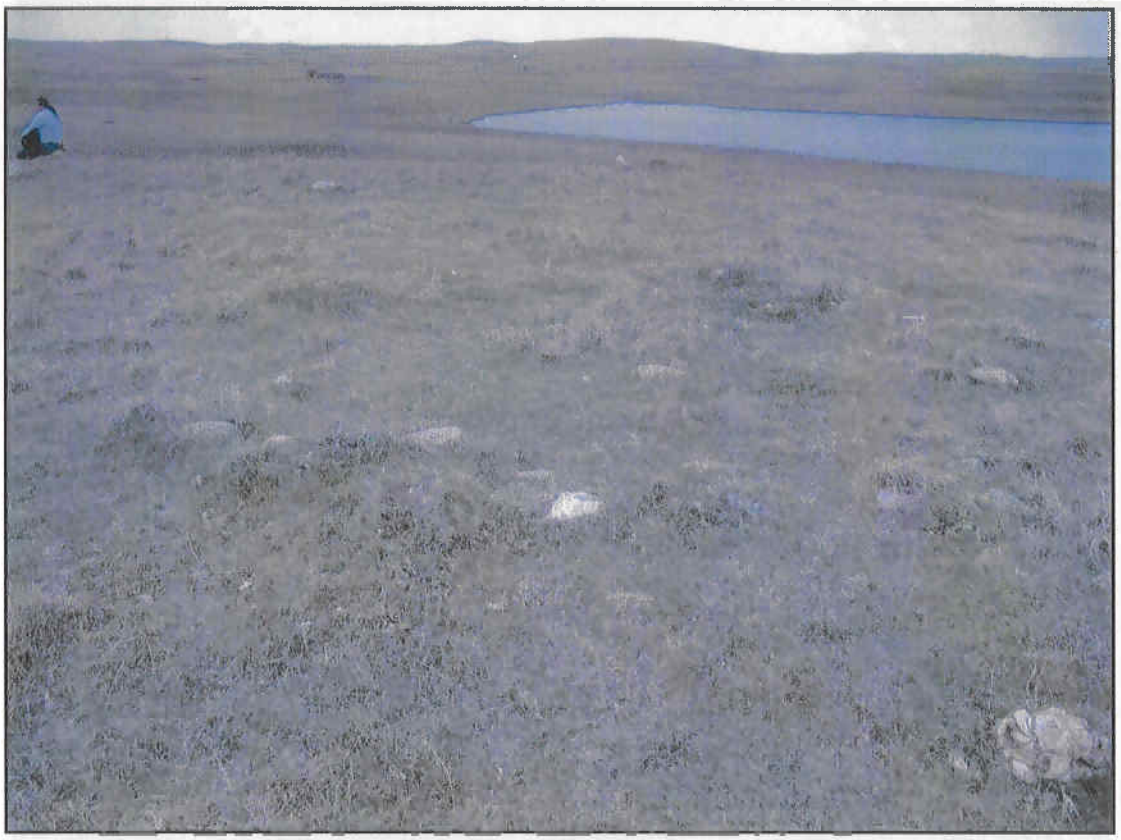


Photo 13: Site 32DI0095: Stone Circle C3.



Photo 14: Site 32DI0095: Partial Stone Circle I1.



Photo 15: Site 32DI0095: Depression D2.



Photo 16: Site 32DI0095: Depression D1.



Photo 17. Site 32DI0095: Stone Circle.



Photo 18: Site 32DI0095*:* View east from site.



Photo 19: Site 32DI0095: View west from site.



Photo 20: Site 32DI0095: View south from site.



Photo 21: Site 32DI0095: View north from site.

APPENDIX D: ARTIFACT CATALOG

32DI0095 Artifact Catalog

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
1							
	1	1	One tertiary flake of Knife River Flint.	11	0.2		1006.1
	3	1	One tertiary flake of Knife River Flint.	9.7	0.1		1008.1
	3	3	Three tertiary flakes of gray Swan River Chert.	4	30.6		1008.2-4
	3	1	One tertiary flake of gray and orange Swan River Chert.	13.1	13.1		1008.5
	4	1	One tertiary flake of Swan River Chert.	15.2	0.6		1007.1
	4	1	One tertiary flake of Knife River Flint.	12.4	0.1		1007.2
	4	1	One projectile point base of Knife River Flint.	26.6	1.8		1007.3
	5	1	One tertiary flake of Knife River Flint.	9.7	0.1		1009.1
2							
	2	2	Two tertiary flakes of Knife River Flint.	13.4	0.3		1010.1-2
	2	2	Two tertiary flakes of Fine Gray Tongue River Chert.	15.2	0.9		1010.3-4
	2	1	One tertiary flake of pink Swan River Chert.	31.2	7.2		1010.5
	2	1	One tertiary flake of gray Swan River Chert.	14.1	0.4		1010.6
	2	1	One tertiary flake of red-brown quartzite.	12.6	0.2		1010.7
	3	7	Seven tertiary flakes of Knife River Flint.	15	0.9		1011.1-7
	4	1	One secondary flake of gray Swan River Chert.	60.1	82.8		1012.1
	4	1	One secondary flake of gray-brown Red River Chert.	19.7	1.7		1012.2
	4	1	One secondary flake of gray Swan River Chert.	22.8	2.3		1012.3
	4	1	One core of Knife River Flint.	58.5	98.5		1012.4
3							
	1	1	One tertiary flake of Knife River Flint.	17.3	0.9		1013.1

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	2	Two tertiary flakes of Knife River Flint.	12.3	0.5		1014.1-2
	2	1	One shatter of Knife River Flint.	18.9	2.1		1014.3
	2	1	One tertiary flake of Knife River Flint.	11.3	0.2		1014.4
	3	3	Three tertiary flakes of Knife River Flint.	11.6	0.4		1015.1-3
	3	1	One tertiary flake of Rainy Buttes Silicified Wood.	8.2	0.1		1015.4
	4	1	One tertiary flake of Swan River Chert.	19.6	1.8		1016.1
4							
	1	2	Two tertiary flakes of Knife River Flint.	11.9	0.4		1017.1-2
	2	2	Two tertiary flakes of Knife River Flint.	13.1	0.3		1018.1-2
	2	1	One shatter of transparent silicified wood.	16.8	0.9		1018.3
	3	5	Five tertiary flakes of Knife River Flint.	20	1.2		1019.1-5
	3	1	One tertiary flake of Swan River Chert.	13.3	0.1		1019.6
	3	1	One tertiary flake of jasper	13.9	0.3		1019.7
	3	1	One shatter of Red River Chert.	12.9	0.7		1019.8
	4	2	Two tertiary flakes of Knife River Flint.	15.7	0.5		1020.1-2
	4	2	Two tertiary flakes of Red River Chert.	11.9	0.4		1020.3-4
	4	1	One shatter of Red River Chert.	14.7	0.4		1020.5
	4	1	One primary flake of Rainy Buttes Silicified Wood.	76.1	156.1		1020.6
	4	1	One shatter of caramel-colored jasper	12.1	0.7		1020.7
	Wall	1	One tertiary flake of white Swan River Chert.	22.2	2.6		1021.1
	scrapings						
5							
	2	1	One shatter of white Swan River Chert.	10.6	0.3		1022.1

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	1	One tertiary flake of white granite.	20.9	1.9		1022.2
	3	1	One shatter of white quartz.	11.8	0.5		1023.1
	3	1	One core fragment of gray silica.	20.8	4.1		1023.2
	4	1	One primary flake of Knife River Flint.	32	2.6		1024.1
6							
	2	1	One tool fragment of Knife River Flint. Edge is bifacially worked and worn.	22.1	0.8		1025.1
	2	2	One secondary flake of pink Swan River Chert.	22.7	1.5		1025.2
	3	4	Four tertiary flakes of white-pink Swan River Chert.	23.1	2.5		1026.1-4
	3	2	Two secondary flakes of Swan River Chert.	48.5	37.9		1026.5-6
	3	3	Three primary flakes of Swan River Chert.	61.5	47.8		1026.7-9
	4	1	One tertiary flake of olive Red River Chert.	13.3	0.5		1027.1
	4	26	Twenty-six tertiary flakes of Swan River Chert.	29.5	31.9		1027.11-36
	4	3	Three shatter of Swan River Chert.	17	2.1		1027.2-4
	4	4	Four secondary flakes of Swan River Chert.	29.7	9.3		1027.5-8
	4	2	Two primary flakes of Swan River Chert.	46.3	26.2		1027.9-10
7							
	1	1	One primary flake of Knife River Flint.	29.2	8.2		1028.1
	1	1	One tertiary flake of Swan River chert.	16	0.8		1028.2
	2	1	One projectile point base of silicified wood with possible impact fracture.	22.9	1.9		1029.1
	2	1	One tertiary flake of gray Swan River Chert.	15.6	0.8		1029.2
	3	1	One utilized flake of Knife River Flint.	13.8	0.7		1030.1
	3	1	One tertiary flake of Knife River Flint.	11.5	0.1		1030.2

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	3	1	One secondary flake of Knife River Flint.	9.5	0.1		1030.3
	3	1	One tertiary flake of Swan River Chert.	19.2	1.4		1030.4
	3	1	One secondary flake of Red River Chert.	13	0.8		1030.5
8							
	2	1	One tertiary flake of Red River Chert.	12.1	0.1		1031.1
	3	1	One tertiary flake of Knife River Flint.	9.4	0.1		1032.1
	4	1	One tertiary flake of Knife River Flint.	15.5	0.3		1033.1
	4	1	Two tertiary flakes of Swan River Chert.	42.5	6.7		1033.2-3
	4	1	One shatter of Swan River Chert.	13.4	0.3		1033.4
	5	1	One rough biface of red Tongue River Silica.	70.6	6.9		1034.1
	5	1	One tertiary flake of Swan River Chert.	8.5	0.2		1034.2
	5	1	One tertiary flake of Knife River Flint.	13.9	0.3		1034.3
	5	1	One primary flake of quartzite.	37.4	7.7		1034.4
	5	1	One primary flake of agate.	13.5	0.5		1034.5
	7	1	One tertiary flake of Knife River Flint.	16.5	0.4		1035.1
	7	1	One secondary flake of jasper.	24	2.3		1035.2
9							
	4	1	One tertiary flake of Knife River Flint.	12.9	0.2		1036.1
	4	1	One tertiary flake of Tongue River Silica.	11.2	0.2		1036.2
	5	1	One secondary flake of agate.	25.3	3.4		1037.1
	6	1	One tertiary flake of Knife River Flint.	14.9	0.3		1038.1
10							
	1	2	Two tertiary flakes of Swan River Chert.	16.5	0.7		1039.1-2

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	2	Two tertiary flakes of Knife River Flint.	17.7	0.7		1040.1-2
	2	2	Two tertiary flakes of chalcedony.	12.8	0.2		1040.3-4
	2	1	One secondary flake of Tongue River Silica.	15.2	0.9		1040.5
	3	1	One utilized flake of Knife River Flint.	18.4	0.3		1041.1
	3	1	One tertiary flake of Knife River Flint.	16.9	0.3		1041.2
	3	1	One tertiary flake of Swan River Chert.	16.9	0.9		1041.3
	3	2	Two tertiary flakes of Tongue River Silica.	16.4	1.2		1041.4-5
	3	1	One secondary flake of Tongue River Silica.	13.4	0.7		1041.6
	3	1	One secondary flake of Red River Chert.	12.9	0.2		1041.7
	4	2	Two tertiary flakes of Swan River Chert.	34	7.4		1042.1-2
	4	1	One primary flake of Swan River Chert.	12.7	0.3		1042.3
	4	1	One secondary flake of Tongue River Silica.	10.5	0.3		1042.4
	4	1	One shatter of quartz.	13.7	0.5		1042.5
	4	1	One shatter of Swan River Chert.	9.8	0.2		1042.6
	5	1	One tertiary flake of Knife River Flint.	16.3	0.1		1043.1
	7	1	One tertiary flake of Knife River Flint.	10.9	0.2		1044.1
	7	1	One tertiary flake of Swan River Chert.	28.5	4.6		1044.2
	7	1	One tertiary flake of Red River Chert.	8.9	0.1		1044.3
	7	1	One secondary flake of Red River Chert.	21.1	1.7		1044.4
	7	1	One secondary flake of Knife River Flint.	15.9	0.5		1044.5
	7	1	One secondary flake of Red River Chert.	16	0.7		1044.6
	7	1	One shatter of Knife River Flint.	11.8	0.4		1044.7
	8	1	One utilized flake of Knife River Flint.	22.3	0.9		1045.1
	8	1	One shatter of Swan River Chert.	15	0.7		1045.2

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	8	1	One tertiary flake of Fine Gray Tongue River Silica.	9.1	0.1		1045.3
	10	1	One tertiary flake of Knife River Flint.	11.7	0.1		1046.1
	Wall	1	One tertiary flake of Knife River Flint.	12	0.2		1047.1
	scrapings						
11							
	2	1	One shatter of quartz.	40.4	9.9		1048.11
	2	1	One shatter of jasper.	10.3	0.3		1048.12
	2	3	Three secondary flakes of Swan River Chert.	43.6	21.4		1048.1-3
	2	2	Two tertiary flakes of Swan River Chert.	16.4	1.4		1048.4-5
	2	3	Three tertiary flakes of Knife River Flint.	13.3	0.7		1048.6-8
	2	2	Two shatter of Tongue River Silica.	18.3	1.9		1048.9-10
	3	3	Three tertiary flakes of Knife River Flint.	13.1	0.6		1049.1-3
	3	1	One tertiary flake of Tongue River Silica.	17	0.6		1049.4
	3	2	Two tertiary flake of chalcedony.	15.1	0.6		1049.5-6
	3	1	One secondary flake of Knife River Flint.	17.5	0.6		1049.7
	4	1	One scraper of Knife River Flint.	27.6	2.9		1050.1
	4	1	One retouched flake of Tongue River Silica.	45.1	16		1050.2
	4	2	Two tertiary flakes of Swan River Chert.	14.1	0.5		1050.3-4
	4	1	One tertiary flake of Lake of the Woods Chert.	11.4	0.2		1050.5
	4	1	One tertiary flake of Tongue River Chert.	9.3	0.1		1050.6
	4	1	One secondary flake of Knife River Flint.	14.5	0.3		1050.7
	4	1	One shatter of Swan River Silica.	47.7	10.7		1050.8
	5	2	Two utilized flakes of Knife River Flint.	37.6	1.9		1051.1-2
	5	1	One unidentifiable projectile point fragment of Knife River Flint.	14.7	0.6		1051.3

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	5	1	One tertiary flake of white-pink Swan River Chert.	8.2	0.1		1051.4
	5	1	One tertiary flake of Knife River Flint.	12.5	0.1		1051.5
	5	1	One secondary flake of Swan River Chert.	52.1	19.8		1051.6
	5	1	One primary flake of Knife River Flint.	20.1	1.0		1051.7
	5	1	One shatter of Tongue River Silica.	17	1.1		1051.8
	6	1	On utilized flake of Knife River Flint.	16.1	0.5		1052.1
	6	2	Two tertiary flakes of Knife River Flint.	12.3	0.3		1052.2-3
	6	1	One tertiary flake of chalcedony.	17.7	0.5		1052.4
	6	1	One secondary flake of Knife River Flint.	15.9	0.8		1052.5
	6	1	One secondary flake of Swan River Chert.	40.5	12.9		1052.6
	6	1	One core of Swan River Chert.	111.4	708.7381		1052.7
	7	5	Five tertiary flakes of Knife River Flint.	15.2	1.1		1053.1-5
	7	1	One tertiary flake of Red River Chert.	10.2	0.1		1053.6
	7	1	One secondary flake of Fine Gray Tongue River Silica.	13.6	0.1		1053.7
	8	2	Two tertiary flakes of Knife River Flint.	12.8	0.3		1054.1-2
	8	1	One tertiary flake of Swan River Chert.	10.8	0.1		1054.3
	9	1	One tertiary flake of Knife River Flint.	18.6	0.6		1055.1
12							
	4	1	One tertiary flake of Knife River Flint.	17	0.6		1056.1
13							
	2	3	Three tertiary flakes of Knife River Flint.	19.1	0.9		1057.1-3
	2	1	One tertiary flake of chalcedony.	21.6	1.0		1057.4
	3	1	One tertiary flake of Knife River Flint.	12.1	0.4		1058.1
	3	1	One tertiary flake of Swan River Chert.	10.2	0.3		1058.2

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	5	1	One tertiary flake of Knife River Flint.	11.7	0.1		1059.1
	5	1	One tertiary flake of Red River Chert.	12.6	0.2		1059.2
	6	1	One tertiary flake of Knife River Flint.	9.3	0.2		1060.1
	6	1	One shatter of Knife River Flint.	6.7	0.1		1060.2
	6	1	One tertiary flake of Red River Chert.	14.8	0.3		1061.3
14							
	1	2	Two tertiary flakes of Swan River Chert.	13	0.5		1062.1-2
	1	2	Two tertiary flakes of Tongue River Silica.	19.9	2.2		1062.3-4
	1	1	One shatter of Knife River Flint.	9.6	0.1		1062.5
	1	1	One shatter of Fusilinid Chert.	13.1	0.4		1062.6
	2	2	Two tertiary flakes of Swan River Chert.	12.2	0.5		1061.1-2
15							
	1	1	One utilized flake of Swan River Chert.	28	3.3		1063.1
	1	3	Three tertiary flakes of Tongue River Silica.	32.6	11.8		1063.15-17
	1	2	Two secondary flakes of Swan River Chert.	38.6	16		1063.18-19
	1	1	One primary flake of pink quartzite.	26	2.7		1063.20
	1	1	One shatter of Swan River Chert.	15.4	0.9		1063.21
	1	13	Thirteen tertiary flakes of Swan River Chert.	26.4	14.9		1063.2-14
	1	1	One shatter of Tongue River Silica.	15.5	0.5		1063.22
	1	1	One shatter of Fusilinid Chert.	19.9	1.9		1063.23
	1	1	One shatter of jasper.	16.6	0.8		1063.24
	2	1	One tertiary flake of Tongue River Silica.	12.1	0.4		1064.12
	2	1	One secondary flake of Knife River Flint.	12.2	0.4		1064.13
	2	1	One secondary flake of jasper.	13.7	0.2		1064.14

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	1	One shatter of Swan River Chert.	12.8	0.7		1064.15
	2	8	Eight tertiary flakes of Swan River Chert.	19.9	3.9		1064.1-8
	2	3	Three tertiary flakes of Knife River Flint.	13.4	1.0		1064.9-11
	3	1	One secondary flake of Swan River Chert.	11.1	0.1		1066.1
	4	1	One tertiary flake of Swan River Chert.	13.2	0.3		1065.1
	4	1	One tertiary flake of Knife River Flint.	11.2	0.1		1065.2
	4	1	One tertiary flake of quartzite.	22.8	1.1		1065.3
16							
	3	1	One utilized flake of Knife River Flint.	15.3	0.5		1067.1
	3	4	Four undecorated, smoothed grit-tempered sherds.	15.1	3.8		1067.12-15
	3	2	Two tertiary flakes of Knife River Flint.	12.7	0.1		1067.2-3
	3	1	One tertiary flake of Swan River Chert.	9.3	0.1		1067.4
	3	7	Seven cord-wrapped stick impressed grit-tempered sherds.	16.4	5.5		1067.5-11
	4	2	Two tertiary flakes of Knife River Flint.	10.5	0.1		1068.1-2
	4	2	Two crumbs of grit-tempered ceramic.	7.7	0.2		1068.14-15
	4	1	One tertiary flake of Swan River Chert.	11.2	0.2		1068.3
	4	1	One tertiary flake of Red River Chert.	15.3	0.3		1068.4
	4	1	One primary flake of Red River Chert.	42.1	10.5		1068.5
	4	1	Two shatters of Red River Chert.	17.2	2.3		1068.6
	4	7	Seven undecorated, smoothed grit-tempered sherds.	15.1	4.0		1068.7-13
	5	1	One tertiary flake of Knife River Flint.	16.4	0.3		1069.1
	5	1	One tertiary flake of chalcedony	8.9	0.1		1069.2
	5	1	One tertiary flake of Red River Chert.	13.1	0.3		1069.3
	6	1	One tertiary flake of Swan River Chert.	14.3	0.7		1071.1

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	6	1	One tertiary flake of Knife River Flint.	13.3	0.3		1071.2
	6	2	Two secondary flakes of Knife River Flint.	24.8	2.3		1071.3-4
	6	1	One primary flake of Knife River Flint.	22.7	3.0		1071.5
	7	1	One tertiary flake of Swan River Chert.	22	0.7		1070.1
	7	1	One tertiary flake of Knife River Flint.	14.5	0.3		1070.2
	7	1	One tertiary flake of jasper.	10.9	0.1		1070.3
	8	3	Three primary flakes of Swan River Chert.	21.3	3.6		1072.1-3
	8	1	One secondary flake of Knife River Flint.	23.9	1.7		1072.4
	9	2	Two tertiary flakes of Swan River Chert.	13.1	0.5		1073.1-2
	10	5	Five tertiary flakes of Swan River Chert.	28.7	6.4		1074.1-5
	10	1	One secondary flake of Swan River Chert.	11.2	0.3		1074.6
	11	1	One tertiary flake of Swan River Chert.	10.1	0.1		1075.1
	11	1	One secondary flake of chalcedony	15.4	0.5		1075.2
	11	1	One tertiary flake of Swan River Chert.	19.7	1.0		1076.1
17							
	3	1	One utilized flake of Knife River Flint.	17.7	1.0		1077.1
	3	3	Three tertiary flakes of Knife River Flint.	25.7	3.5		1077.2-4
	3	1	One tertiary flake of Swan River Chert.	16.5	0.6		1077.5
	3	1	One undecorated, smoothed grit-tempered body sherd.	12.4	0.9		1077.6
	3	2	Two grit-tempered crumbs.	8.1	0.1		1077.7-8
	4	1	One tertiary flake of Knife River Flint.	25.8	5.1		1078.1
	5	1	One tertiary flake of Knife River Flint.	17.9	0.5		1079.1
	6	1	One secondary flake of Swan River Chert.	16.2	0.6		1080.1
	8	2	Two tertiary flakes of Swan River Chert.	20.6	1.3		1081.1-2

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	9	1	One utilized flake of Knife River Flint.	24	0.8		1082.1
	9	3	Three tertiary flakes of Knife River Flint.	21.6	1.8		1082.2-4
	9	1	One shatter of Knife River Flint.	32.7	6.7		1082.5
	9	4	Four tertiary flakes of Swan River Chert.	17.9	2.3		1082.6-9
	10	1	One tertiary flake of Swan River Chert.	22.8	2.5		1083.1
18							
	3	1	One scraper of Knife River Flint.	37.6	3.4		1084.1
	3	1	One tertiary flake of Swan River Chert.	39.9	8.5		1084.2
19							
	2	1	One utilized flake of Knife River Flint.	18.4	1.4		1085.1
	3	1	One biface of Fusilinid Chert.	50.8	17.6		1086.1
	3	1	One tertiary flake of Knife River Flint.	15.3	0.6		1086.2
	4	1	One scraper of Knife River Flint.	24.8	4.0		1087.1
20							
	1	3	Three tertiary flakes of Knife River Flint.	11.1	0.3		1088.1-3
	1	2	Two shatter of Knife River Flint.	29.7	4.2		1088.4-5
	2	1	One retouched chunk of Knife River Flint.	33.8	15.9		1089.1
	3	1	One utilized flake of Knife River Flint.	21.7	1.3		1090.1
	4	1	One shatter of Knife River Flint.	11.1	0.1		1091.1
	4	1	One shatter of Tongue River Silica.	6.5	0.1		1091.2
21							
	2	1	One secondary flake of Knife River Flint.	19.3	1.5		1092.1
	2	1	One shatter of Red River Chert.	10.1	0.4		1092.2
22							

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	1	1	One tertiary flake of Swan River Chert.	7.9	0.1		1093.1
	2	1	One utilized flake of Swan River Chert.	17.7	0.7		1094.1
	2	1	One tertiary flake of Knife River Flint.	19	0.6		1094.2
	2	1	One tertiary flake of Swan River Chert.	12	0.5		1094.3
	2	1	One secondary flake of Knife River Flint.	13.1	0.3		1094.4
	2	1	One secondary flake of Swan River Chert.	10.8	0.4		1094.5
	2	1	One shatter of Swan River Chert.	13.6	0.3		1094.6
	2	1	One shatter of chalcedony.	9.6	0.1		1094.7
	3	1	One tertiary flake of Knife River Flint.	10.5	0.1		1095.1
	3	1	One secondary flake of Knife River Flint.	17.3	0.5		1095.2
	3	1	One shatter of Tongue River Silica.	18	0.9		1095.3
	4	1	One utilized flake of chalcedony.	18.8	1.1		1096.1
	4	1	One tertiary flake of Swan River Chert.	13.5	0.3		1096.2
	4	1	One tertiary flake of Tongue River Silica.	12.7	0.2		1096.3
	4	1	One tertiary flake of Red River Chert.	8.8	0.1		1096.4
	4	1	One tertiary flake of Tongue River Silica.	13.7	0.4		1096.5
	5	1	One tertiary flake of Swan River Chert.	11.9	0.5		1097.1
23							
	1	1	One tertiary flake of Knife River Flint.	16.3	0.4		1098.1
	2	1	One primary flake of Knife River Flint.	17.9	1.2		1099.1
	2	1	One primary flake of agate.	17.1	0.5		1099.2
	2	1	One tertiary flake of Red River Chert.	14.7	0.5		1099.3
	3	4	Four tertiary flakes of Knife River Flint.	16.6	0.8		1100.1-4
	3	1	One tertiary flake of Red River Chert.	11.8	0.1		1100.5

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	3	1	One secondary flake of Knife River Flint.	16.3	0.4		1100.6
	3	1	One primary flake of jasper.	11.4	0.3		1100.7
	3	1	One shatter of Knife River Flint.	14	0.5		1100.8
	3	2	Two shatters of Swan River Chert.	18.2	2.0		1100.9-10
	4	5	Five tertiary flakes of Knife River Flint.	14.5	1.2		1101.1-5
	4	2	Two shatter of Tongue River Silica.	12.4	0.5		1101.6-7
	5	1	One tertiary flake of Swan River Chert.	16.2	1.0		1102.1
	5	1	One tertiary flake of Knife River Flint.	13.5	0.3		1102.2
	5	1	One secondary flake of Knife River Flint.	17.6	0.3		1102.3
	5	4	One secondary flake of chalcedony.	15.9	0.4		1102.4
25							
	2	1	One tertiary flake of Swan River Chert.	16.8	0.5		1103.1
	2	4	Four tertiary flakes of Knife River Flint.	17.5	1.5		1103.2-5
	2	1	One shatter of Knife River Flint.	18.8	0.7		1103.6
	2	1	One shatter of Swan River Chert.	21.5	1.3		1103.7
	2	1	One shatter of Tongue River Silica.	25.6	2.0		1103.8
	3	1	One uniface tip of Knife River Flint.	10.4	0.1		1104.1
	3	2	Two tertiary flakes of Knife River Flint.	23.4	2.2		1104.2-3
	3	2	Two tertiary flakes of Swan River Chert.	12.8	0.6		1104.4-5
	3	1	One tertiary flake of chalcedony.	9.6	0.1		1104.6
	3	1	One tertiary flake of jasper.	12.7	0.1		1104.7
	3	2	Two shatter of Swan River Chert.	12.7	0.7		1104.8-9
	4	3	Three utilized flakes of Knife River Flint.	22.7	4.8		1105.1-3
	4	2	Two tertiary flakes of Swan River Chert.	17.2	0.7		1105.4-5

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	4	2	Two shatter of quartz.	13.7	0.5		1105.6-7
	5	1	One scraper of Knife River Flint.	27.6	1.9		1106.1
	5	1	One scraper of jasper.	22.9	2.3		1106.2
	5	1	One retouched flake of Swan River Chert.	23.3	2.1		1106.3
	5	1	One tertiary flake of Swan River Chert.	11.6	2.0		1106.4
	5	1	One shatter of Swan River Chert.	21	1.3		1106.5
	5	1	One shatter of Tongue River Silica.	24.7	3.3		1106.6
	5	1	One undecorated, smoothed grit-tempered body sherd.	21.5	1.7		1106.7
	6	1	One tertiary flake of Swan River Chert.	27.8	2.4		1107.1
	6	1	One secondary flake of Swan River Chert.	21.4	0.8		1107.2
	6	1	One fragment of tooth enamel of a large ungulate, possibly bison.	32.6	1.2		1107.3
	7	5	Five tertiary flakes of Swan River Chert.	16	0.9		1108.1-5
	7	1	Two shatter of Swan River Chert.	17.6	2.2		1108.6
	7	1	One bipolar core of Knife River Flint.	36.1	3.0		1108.7
	8	1	One tertiary flake of Swan River Chert.	8.1	0.1		1109.1
	Wall scrapings	1	One retouched flake of Swan River Chert.	67.2	60.4		1110.1
26							
	1	1	One tertiary flake of Swan River Chert.	10.3	0.1		1111.1
	1	1	One tertiary flake of Knife River Flint.	10	0.1		1111.2
	1	2	Two secondary flake of Knife River Flint.	47	11.1		1111.3-4
	1	2	Two undiagnostic long bone fragments of a large ungulate.	73.0	16.8		1111.5-6
	1	2	Two fragments of undiagnostic bone from a large ungulate.	17.6	1.2		1111.7-8

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	1	One shatter of quartz.	16.8	1.1		1112.10
	2	2	Two tertiary flake of Knife River Flint.	9.8	0.2		1112.1-2
	2	1	One tertiary flake of quartzite.	20.5	1.1		1112.3
	2	1	One tertiary flake of Swan River Chert.	11.8	0.3		1112.4
	2	2	Two tertiary flakes of Tongue River Silica.	26.5	4.6		1112.5-6
	2	3	Three shatter of Tongue River Silica.	25.7	4.1		1112.7-9
	3	1	One retouched flake of Tongue River Silica.	40	11.4		1113.1
	3	1	One tertiary flake of chalcedony.	12.3	0.1		1113.11
	3	1	One shatter of Knife River Flint.	11.4	0.2		1113.12
	3	1	One shatter of Tongue River Silica.	11.3	0.3		1113.13
	3	1	One shatter of Red River Chert.	11.4	0.7		1113.14
	3	3	Three shatter of Swan River Chert.	17.5	2.9		1113.15-17
	3	2	Two primary flakes of Swan River Chert.	16.6	1.5		1113.18-19
	3	1	One retouched flake of basalt.	50.3	18.3		1113.2
	3	1	One primary flake of Tongue River Silica.	23.5	1.6		1113.20
	3	4	Four tertiary flake of Knife River Flint.	15.8	1.0		1113.3-6
	3	4	Four tertiary flake of Swan River Chert.	34.5	9.7		1113.7-10
	4	1	One tertiary flake of Swan River Chert.	14.7	0.5		1114.1
	4	2	Two tertiary flakes of Tongue River Silica.	13.7	0.6		1114.15-16
	4	1	One tertiary flake of Gray Tongue River Silica.	10	0.1		1114.17
	4	1	One tertiary flake of Red River Chert.	13	0.2		1114.18
	4	1	One tertiary flake of quartzite.	11.3	0.1		1114.19
	4	1	One tertiary flake of chalcedony.	11.6	0.1		1114.20
	4	1	One tertiary flake of quartzite.	17.4	0.5		1114.21

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	4	13	Thirteen tertiary flakes of Knife River Flint.	16.6	2.3		1114.2-14
	4	2	Two tertiary flakes of Tongue River Silica.	22.1	2.0		1114.22-23
	5	1	One utilized flake of quartzite.	44.7	20.6		1115.1
	5	2	Two tertiary flakes of chalcedony.	21.1	1.4		1115.10-11
	5	2	Two tertiary flakes of Agate.	23.6	1.9		1115.12-13
	5	1	One tertiary flake of Swan River Chert.	11.9	0.2		1115.14
	5	1	One tertiary flake of Tongue River Silica.	18.6	0.4		1115.15
	5	1	One shatter of Tongue River Silica.	13.4	0.2		1115.16
	5	1	One shatter of quartz.	12.7	0.6		1115.17
	5	1	One shatter of Red River Chert.	10.8	0.2		1115.18
	5	1	One shatter of porcellanite.	11.4	0.2		1115.19
	5	2	One utilized flake of Red River Chert.	23.2	1.4		1115.2
	5	1	One shatter of Knife River Flint.	14	0.2		1115.20
	5	2	Two shatter of Swan River Chert.	10.7	0.5		1115.21-22
	5	1	One secondary flake of chalcedony.	16	0.3		1115.23
	5	1	One secondary flake of agate.	11.1	0.1		1115.24
	5	1	One secondary flake of Knife River Flint.	26.1	1.3		1115.25
	5	1	One secondary flake of Fine Gray Tongue River Silica.	18.2	0.7		1115.26
	5	1	One tested cobble of Tongue River Silica.	95.4	359		1115.27
	5	7	Seven tertiary flakes of Knife River Flint.	18.1	1.2		1115.3-9
	6	1	One utilized flake of Knife River Flint.	21.1	1.9		1116.1
	6	1	One primary flake of jasper.	18.1	0.4		1116.11
	6	1	One shatter of Red River Chert.	12	0.3		1116.12
	6	1	One shatter of Tongue River Silica.	15.4	0.4		1116.13

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	6	1	One tertiary flake of Swan River Chert.	9.9	0.1		1116.2
	6	1	One tertiary flake of jasper.	12.9	0.1		1116.3
	6	1	One tertiary flake of agate.	11.8	0.2		1116.4
	6	6	Six tertiary flakes of Knife River Flint.	25.5	2.7		1116.5-10
	7	1	One utilized flake fragment of Knife River Flint.	21.5	1.0		1117.1
	7	2	Two tertiary flakes of Knife River Flint.	11.9	0.4		1117.2-3
	7	1	One tertiary flake of agate.	15.1	0.3		1117.4
	7	1	One tertiary flake of jasper.	10.3	0.3		1117.5
	7	1	One shatter of Knife River Flint.	18.6	1.1		1117.6
	7	1	One shatter of quartz.	41.6	14.6		1117.7
	8	1	One utilized flake of Knife River Flint.	31	5.4		1118.1
	8	1	One tertiary flake of Knife River Flint.	14.8	0.3		1118.2
	8	1	One tertiary flake of agate.	11	0.1		1118.3
	8	1	One shatter of Swan River Chert.	22.9	2.3		1118.4
	8	1	One shatter of quartz.	25.6	5.5		1118.5
	9	1	One shatter of quartz.	19.8	7.0		1119.1
	9	1	One shatter of Swan River Chert.	24.4	1.2		1119.1
	10	1	One tertiary flake of Knife River Flint.	12	0.2		1120.1
	10	1	One tertiary flake of Tongue River Silica.	15.1	0.4		1120.2
27							
	1	1	One tertiary flake of agate.	10.7	0.1		1121.1
	1	1	One shatter of Swan River Chert.	16.6	0.5		1121.2
	2	1	One tertiary flake of Swan River Chert.	17.8	0.7		1122.1
	2	2	Two tertiary flakes of Knife River Flint.	12.4	0.4		1122.2-3

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	1	One shatter of Knife River Flint.	8.9	0.3		1122.4
	2	1	One secondary flake of Tongue River Silica.	27	3.1		1122.5
	3	1	One basalt hammerstone with a possible grinding surface.	133.6	1276.0		1123.1
	3	1	One tertiary flake of Lake of the Woods Chert.	11.4	0.2		1123.10
	3	2	Two tertiary flakes of Swan River Chert.	23.7	1.4		1123.11-12
	3	2	Two tertiary flakes of Silicified Wood.	15.3	0.7		1123.13-14
	3	9	Nine tertiary flakes of Knife River Flint.	12.5	1.0		1123.15-23
	3	1	One unidentified projectile point tip of Knife River Flint.	41.6	3.1		1123.2
	3	1	One tertiary flake of Knife River Flint.	15.4	0.3		1123.3
	3	1	One tertiary flake of chalcedony.	15.8	0.4		1123.4
	3	1	One shatter of agate.	9.9	0.6		1123.5
	3	1	One shatter of Red River Chert.	9.3	0.2		1123.6
	3	2	One shatter of Swan River Chert.	10.6	0.4		1123.7-8
	3	1	One tertiary flake of Red River Chert.	11.5	0.2		1123.9
	4	1	One tertiary flake of Gray Tongue River Silica.	10.2	0.1		1124.14
	4	4	Four tertiary flakes of Swan River Chert.	35.6	9.1		1124.1-4
	4	1	One secondary flake of Knife River Flint.	9.8	0.1		1124.15
	4	1	One shatter of Swan River Chert.	14.2	0.5		1124.16
	4	1	One shatter of quartz.	20.1	1.6		1124.17
	4	9	Nine tertiary flakes of Knife River Flint.	15.1	1.7		1124.5-13
	5	4	Four tertiary flakes of Knife River Flint.	16.5	0.7		1125.1-4
	5	1	One tertiary flake of granite.	15.8	0.4		1125.5
	5	1	One secondary flake of Knife River Flint.	27.4	2.9		1125.6
	5	1	One secondary flake of Swan River Chert.	10.4	0.1		1125.7

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	5	1	One shatter of Swan River Chert.	15.6	0.4		1125.8
	5	1	One shatter of jasper.	17.2	0.6		1125.9
	6	1	One tertiary flake of Swan River Chert.	16.7	0.5		1126.1
	6	1	One tertiary flake of Tongue River Silica.	21.7	1.0		1126.13
	6	1	One tertiary flake of quartzite.	14.8	0.5		1126.14
	6	5	Five secondary flakes of Knife River Flint.	18.5	1.3		1126.15-19
	6	1	One secondary flake of Tongue River Silica.	12.5	0.3		1126.20
	6	1	One shatter of Tongue River Silica.	18.5	1.6		1126.21
	6	11	Eleven tertiary flakes of Knife River Flint.	17.9	1.8		1126.2-12
	6	1	One shatter of granite.	10.8	0.4		1126.22
	6	1	One shatter of Knife River Flint.	12.1	0.7		1126.23
	7	1	One scraper of Knife River Flint.	19.7	1.4		1127.1
	7	1	One shatter of Swan River Chert.	16.4	0.6		1127.2
	7	10	Ten tertiary flakes of Knife River Flint.	17	1.7		1127.3-12
	8	1	One tertiary flake of Knife River Flint.	10.7	0.1		1128.1
	9	1	One tertiary flake of Knife River Flint.	11.3	0.1		1129.1
	9	1	One tertiary flake of chalcedony.	15.6	0.6		1129.2
	10	1	One utilized flake of Knife River Flint.	21	1.0		1130.1
	10	2	Two tertiary flakes of Swan River Chert.	16.5	0.7		1130.2-3
	10	1	One tertiary flake of Tongue River Silica.	15.4			1130.4
	10	1	One secondary flake of Knife River Flint.	16	0.8		1130.5
	10	1	One shatter of Knife River Flint.	11.9	0.4		1130.6
	11	1	One tertiary flake of Swan River Chert.	24.9	2.6		1131.1

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	1	1	One utilized flake of Knife River Flint.	15.8	0.4		1132.1
	1	2	Two tertiary flakes of Knife River Flint.	12.9	0.7		1132.2-3
	1	1	One tertiary flake of Swan River Chert.	16.9	0.5		1132.4
	1	1	One tertiary flake of Tongue River Silica.	16.6	0.8		1132.5
	3	1	One tertiary flake of Swan River Chert.	13.7	0.4		1133.1
	3	2	Two tertiary flakes of Tongue River Silica.	17.7	0.9		1133.2-3
	4	1	One tertiary flake of Swan River Chert.	11.4	0.1		1134.1
	4	1	One tertiary flake of Knife River Flint.	13	0.4		1134.2
	4	1	One tertiary flake of Tongue River Silica.	9.3	0.2		1134.3
	4	1	One secondary flake of Knife River Flint.	11.1	0.2		1134.4
	4	1	One secondary flake of Red River Chert.	15.3	0.3		1134.5
29							
	1	1	One tertiary flake of Knife River Flint.	9.9	0.1		1143.1
	3	1	One tertiary flake of Knife River Flint.	21.7	1.4		1135.1
	3	2	Two cord-impressed grit-tempered bodysherds.	28.7	5.5		1135.2-3
	4	1	One tertiary flake of Knife River Flint.	14.5	0.3		1136.1
	4	1	One tertiary flake of Tongue River Silica.	13.2	0.3		1136.2
	4	1	One shatter of Tongue River Silica.	19.2	1.9		1136.3
	4	1	One shatter of Swan River Chert.	18.5	1.4		1136.4
	5	1	One tertiary flake of Swan River Chert.	14.2	0.3		1137.1
	5	1	One shatter of Swan River Chert.	31.8	9.8		1137.2
	5	1	One tertiary flake of Red River Chert.	10.2	0.1		1137.3
	5	1	One secondary flake of Tongue River Silica.	11.9	0.5		1137.4
	6	1	One tertiary flake of Swan River Chert.	14.3	0.2		1138.1

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	6	1	One tertiary flake of Tongue River Silica.	21.7	1.1		1138.2
	6	1	One tertiary flake of jasper.	12	0.6		1138.3
	6	1	One shatter of Swan River Chert.	19	0.7		1138.4
	7	1	One shatter of Knife River Flint.	47.5	18.3		1139.1
	7	9	Nine tertiary flakes of Swan River Chert.	21.3	5.6		1139.2-10
	8	1	Two secondary flakes of Swan River Chert.	26.7	2.3		1140.1-2
	8	12	Twelve tertiary flakes of Swan River Chert.	22.1	5.3		1140.3-14
	9	1	One tertiary flake of Red River Chert.	16.1	0.4		1141.1
	9	4	Four tertiary flakes of Swan River Chert.	25.2	2.8		1141.2-5
	9	4	Four secondary flakes of Swan River Chert.	23.5	2.6		1141.6-9
	10	1	One secondary flake of Swan River Chert.	17.9	1.0		1142.1
	10	3	Three tertiary flakes of Swan River Chert.	26.2	1.4		1142.2-4
30							
	1	1	One tertiary flake of Knife River Flint.	7	0.1		1144.1
	2	1	One tertiary flake of Rainy Buttes Silicified Wood.	21.9	1.7		1145.1
	2	5	Five secondary flakes of Knife River Flint.	23.6	2.9		1145.15-19
	2	1	One tertiary flake of chalcedony.	12.9	0.4		1145.2
	2	3	Three secondary flakes of agate.	23.2	3.8		1145.20-22
	2	1	One secondary flake of jasper.	11.6	0.2		1145.23
	2	1	One shatter of Knife River Flint.	18.4	1.0		1145.24
	2	3	Three tertiary flakes of Red River Chert.	14.6	0.9		1145.3-5
	2	9	Nine tertiary flakes of Knife River Flint.	14.1	1.6		1145.6-14
	3	1	Two tertiary flakes of Knife River Flint.	18.3	0.8		1146.1-2
	3	1	One tertiary flake of chalcedony.	12.1	0.1		1146.3

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	3	1	One tertiary flake of Swan River Chert.	9.1	0.1		1146.4
	3	1	One primary flake of Knife River Flint.	25	2.8		1146.5
	4	1	One primary flake of Knife River Flint.	24.8	2.6		1147.1
32							
	2	1	One tertiary flake of Knife River Flint.	11.3	0.1		1148.1
	2	2	Two secondary flakes of Knife River Flint.	36	4.7		1148.2-3
	2	1	One shatter of Hixton Silicified Sandstone.	16.8	1.1		1148.4
	3	5	Five tertiary flakes of Knife River Flint.	19.1	0.9		1149.1-5
	3	3	Three secondary flakes of Knife River Flint.	15.7	1.1		1149.6-8
	3	1	One primary flake of Knife River Flint.	13.7	0.3		1149.9
	4	2	Two tertiary flakes of Knife River Flint.	18.2	1.0		1150.1-2
	4	2	Two tertiary flakes of Swan River Chert.	17.3	1.5		1150.3-4
	4	2	Two secondary flakes of Swan River Chert.	31.8	10		1150.5-6
	4	2	Two shatter of Swan River Chert.	22.4	1.2		1150.7-8
	Wall	1	One shatter of Swan River Chert.	9.3	0.1		1151.1
	scrapings						
33							
	1	1	One tertiary flake of Tongue River Silica.	14.8	0.8		1152.1
	2	1	One tertiary flake of chalcedony.	11.2	0.2		1153.1
	2	1	One tertiary flake of Knife River Flint.	7.1	0.1		1153.2
	2	1	One secondary flake of Knife River Flint.	14.7	0.3		1153.3
	2	1	One secondary flake of Red River Chert.	14.3	0.4		1153.4
	2	1	One shatter of Knife River Flint.	15.8	0.5		1153.5
	3	1	One utilized flake of Knife River Flint.	20.3	0.4		1154.1

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	3	1	One secondary flake of Red River Chert.	21	1.4		1154.10
	3	4	Four secondary flakes of Knife River Flint.	27.8	6.8		1154.11-14
	3	2	Two shatter of Swan River Chert.	28.7	6.3		1154.15-16
	3	1	One tertiary flake of Swan River Chert.	29.4	3.4		1154.2
	3	2	Two tertiary flakes of Knife River Flint.	11.3	0.1		1154.3-4
	3	3	Three tertiary flakes of Tongue River Silica.	14.7	0.5		1154.5-7
	3	2	Two tertiary flakes of chalcedony.	11.4	0.3		1154.8-9
	4	1	One tertiary flake of Swan River Chert.	26.2	2.0		1155.1
	4	1	One tertiary flake of Tongue River Silica.	11.2	0.2		1155.2
	6	1	One McKean complex projectile flake point of Tongue River Silica.	27.3	1.8		1291.1
34							
	2	1	One utilized flake of Silicified Wood.	19	0.8		1156.1
	2	2	Two tertiary flakes of chalcedony.	13.3	0.4		1156.12-13
	2	1	One tertiary flake of Swan River Chert.	12.6	0.1		1156.14
	2	1	One secondary flake of Knife River Flint.	11.2	0.1		1156.15
	2	1	One primary flake of Knife River Flint.	23.1	1.9		1156.16
	2	1	One shatter of agate.	18.4	0.3		1156.17
	2	1	One shatter of Tongue River Silica.	12.4	0.1		1156.18
	2	1	One bipolar core of Knife River Flint.	36.2	15.0		1156.2
	2	9	Nine tertiary flakes of Knife River Flint.	21.6	3.5		1156.3-11
	3	1	One utilized flake of Knife River Flint.	24.9	1.9		1157.1
	3	1	One tertiary fragment of agate.	13	0.3		1157.10
	3	1	One tertiary fragment of chalcedony.	12	0.1		1157.11

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	3	3	Three secondary flakes of agate.	15.8	1.3		1157.12-14
	3	1	One shatter of Knife River Flint.	9.9	0.2		1157.15
	3	2	Two tool fragments of Knife River Flint.	18.7	1.4		1157.2-3
	3	4	Four tertiary fragments of Knife River Flint.	15.3	0.7		1157.4-7
	3	2	Two tertiary fragments of Gray Tongue River Silica.	12.9	0.3		1157.8-9
	4	1	One tertiary flake of Knife River Flint.	13.2	0.3		1158.1
	4	1	One secondary flake of Knife River Flint.	18.4	1.0		1158.2
	4	1	One primary flake of Knife River Flint.	23	1.1		1158.3
	4	1	One shatter of Red River Chert.	13.1	0.7		1158.4
35							
	1	1	One tertiary flake of Knife River Flint.	12.8	0.3		1292.1
	2	1	One drill tip of Knife River Flint.	20.8	0.6		1293.1
	2	2	Two tertiary flakes of Swan River Chert.	12.4	0.7		1293.12-13
	2	2	Two tertiary flakes of Tongue River Silica.	17.8	1.2		1293.14-15
	2	2	Two tertiary flakes of jasper.	15.9	0.5		1293.16-17
	2	1	One tertiary flake of chalcedony.	13.0	0.3		1293.18
	2	1	One tertiary flake of chert.	13.6	0.4		1293.19
	2	2	One large utilized primary flake of quartzite.	100.5	236.7		1293.2
	2	4	Four secondary flakes of Swan River Chert.	32.7	14.4		1293.20-23
	2	4	Four secondary flakes of Knife River Flint.	27.3	3.3		1293.24-27
	2	2	Two secondary flakes of agate.	13.1	0.5		1293.28-29
	2	1	One primary flake of jasper.	11.4	0.3		1293.30
	2	1	One shatter of Tongue River Silica.	13.9	0.7		1293.31
	2	9	Nine tertiary flakes of Knife River Flint.	21.9	4.6		1293.3-11

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	1	One shatter of Swan River Chert.	8.3	0.2		1293.32
	3	2	Two secondary flakes of Knife River Flint.	26.4	2.2		1294.10-11
	3	1	One secondary flake of Red River Chert.	10.9	0.5		1294.12
	3	1	One primary flake of Quartz.	31.1	5.1		1294.13
	3	4	Four tertiary flakes of Knife River Flint.	19.5	2.7		1294.1-4
	3	3	Three tertiary flakes of Swan River Chert.	15.5	1.5		1294.5-7
	3	1	One tertiary flake of Red River Chert.	13.7	0.7		1294.8
	3	1	One tertiary flake of chalcedony.	10.7	0.2		1294.9
	5	1	One tertiary flake of Swan River Chert.	12.6	0.4		1295.1
	5	1	One tertiary flake of Knife River Flint.	12.4	0.1		1295.2
	5	1	One tertiary flake of agate.	10.1	0.3		1295.3
	5	1	One secondary flake of agate.	14.0	1.0		1295.4
	5	1	One secondary flake of Knife River Flint.	12.5	0.5		1295.5
36							
	1	1	One shatter of agate.	10.3	0.5		1159.1
	2	2	Two tertiary flakes of Knife River Flint.	14.6	0.5		1160.1-2
	2	1	One secondary flake of Knife River Flint.	17	0.8		1160.3
	2	1	One shatter of Knife River Flint.	23.1	2.0		1160.4
	3	4	Four tertiary flakes of Knife River Flint.	13.7	0.7		1161.1-4
	3	2	Two tertiary flakes of chalcedony.	16.6	0.8		1161.5-6
	3	2	Two shatter of Knife River Flint.	16.6	1.2		1161.7-8
	4	1	One utilized flake of Knife River Flint.	29.4	1.7		1162.1
	4	3	Three tertiary flakes of Knife River Flint?	13.2	0.7		1162.2-4
	6	1	One tertiary flake Knife River Flint.	11	0.1		1163.1

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
37							
	2	1	One shatter of Swan River Chert.	20.6	1.7		1164.1
	3	3	Three tertiary flakes of Swan River Chert.	36.3	6.6		1165.1-3
	3	1	One shatter of Swan River Chert.	16	0.7		1165.4
	3	1	One shatter of jasper.	30	2.3		1165.5
	4	1	One scraper of Knife River Flint.	20.5	1.8		1166.1
	4	1	One utilized flake of Swan River Chert.	38.5	10.9		1166.2
	4	2	Two tertiary flakes of Swan River Chert.	15.9	1.4		1166.3-4
	4	2	Two tertiary flakes of Tongue River Silica.	14.2	0.3		1166.5-6
	4	1	One tertiary flake of Knife River Flint.	11.4	0.1		1166.7
	4	1	One shatter of Swan River Chert.	11.3	0.3		1166.8
	5	1	One tertiary flake of Swan River Chert.	17.9	0.5		1167.1
	5	1	One secondary flake of Swan River Chert.	20.7	1.8		1167.12
	5	2	Two shatter of Swan River Chert.	20.4	1.2		1167.13-14
	5	1	One shatter of Knife River Flint.	11.3	0.3		1167.15
	5	2	Two tertiary flakes of Knife River Flint.	17.6	1.3		1167.2-3
	5	1	One tertiary flake of Jasper.	16.3	0.5		1167.4
	5	7	Seven tertiary flakes of Tongue River Silica.	12.2	0.9		1167.5-11
	6	3	Three tertiary flakes of Tongue River Silica.	16.4	1.1		1168.1-3
	6	1	One tertiary flake of Swan River Chert.	17.9	0.6		1168.4
	6	1	One shatter of Swan River Chert.	36.6	7.0		1168.5
	6	1	One shatter of Tongue River Silica.	24.8	2.9		1168.6
	7	1	One utilized flake of Knife River Flint.	12.6	0.2		1169.1
38							

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	3	1	One projectile point tip of Hixton Silicified Sandstone,	21.5	1.0		1170.1
	3	1	One shatter of quartz.	16	1.1		1170.10
	3	1	One shatter of chert.	8.9	0.2		1170.11
	3	1	One tertiary flake of Swan River Chert.	19.4	1.3		1170.2
	3	1	One tertiary flake of Knife River Flint.	17.3	0.6		1170.3
	3	1	One primary flake of Swan River Flint.	18.6	1.3		1170.4
	3	4	Four shatter of Swan River Chert.	20.4	4.0		1170.5-8
	3	1	One shatter of Knife River Flint.	21	1.1		1170.9
	4	1	One tertiary flake of Swan River Chert.	14.5	0.7		1171.1
	4	2	Two tertiary flakes of Knife River Flint.	19.1	1.6		1171.2-3
	4	2	Two tertiary flakes of Tongue River Silica.	27.7	1.4		1171.4-5
	4	1	One tertiary flake of Red River Chert.	11.9	0.3		1171.6
	4	2	Two shatter of Swan River Chert.	14	0.8		1171.7-8
	4	2	Two shatter of Knife River Flint.	13	1.0		1171.9-10
	5	1	One scraper of Tongue River Silica.	19.2	1.7		1172.1
	5	1	One tertiary flake of Swan River Chert.	14.2	0.8		1172.2
	5	1	One tertiary flake of Knife River Flint.	22.9	2.4		1172.3
	5	1	One tertiary flake of agate.	16.3	0.7		1172.4
	5	1	One secondary flake of quartzite.	29.2	5.4		1172.5
	5	1	One secondary flake of agate.	20.6	1.9		1172.6
	6	1	One tertiary flake of Swan River Chert.	12.2	0.2		1173.1
	6	1	One tertiary flake of Knife River Flint.	17.7	0.5		1173.2
	6	1	One tertiary flake of Swan River Chert.	11.5	0.2		1173.3
	6	1	One tertiary flake of Red River Chert.	9.2	0.1		1173.4

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	8	1	One tertiary flake of quartz.	13.5	0.3		1174.1
39							
	3	1	One tertiary flake of Swan River Chert.	21.1	1.5		1175.1
	3	1	One tertiary flake of Knife River Flint.	20.3	0.6		1176.1
	3	1	One tertiary flake of Tongue River Silica.	8.3	0.1		1176.2
	3	1	One undecorated grit-tempered body sherd.	14.3	0.7		1176.3
40							
	2	1	One retouched flake of Red River Chert.	30.8	5.2		1177.1
	2	2	Two tertiary flakes of Knife River Flint.	13.7	0.5		1177.10-11
	2	5	Five tertiary flakes of Tongue River Silica.	13.4	1.4		1177.12-16
	2	1	One tertiary flake of Fine Gray Tongue River Silica.	11.9	0.3		1177.17
	2	1	One tertiary flake of agate.	9.8	0.1		1177.18
	2	1	One tertiary flake of chalcedony.	9.7	0.1		1177.19
	2	1	One retouched flake of Knife River Flint.	24.7	2.4		1177.2
	2	1	One secondary flake of Red River Chert.	15.4	0.8		1177.20
	2	1	One secondary flake of Knife River Flint.	20	0.4		1177.21
	2	1	One primary flake of Tongue River Silica.	23.3	1.7		1177.22
	2	1	One shatter of Knife River Flint.	22.5	3.2		1177.23
	2	1	One shatter of Tongue River Silica.	10.3	0.3		1177.24
	2	7	Seven tertiary flakes of Swan River Chert.	17.3	3.1		1177.3-9
	3	1	One scraper of Knife River Flint.	24.9	3.2		1178.1
	3	1	One tertiary flake of chalcedony.	13.1	0.2		1178.12
	3	1	One secondary flake of Swan River Chert.	25.6	5.4		1178.13
	3	1	One secondary flake of Knife River Flint.	17.3	0.7		1178.14

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	3	1	One primary flake of agate.	39	17.6		1178.15
	3	5	Five shatter of Swan River Chert.	16.4	2.5		1178.16-20
	3	1	One scraper of Tongue River Silica.	24.1	3.3		1178.2
	3	2	Three shatter of Tongue River Silica.	20.7	2.4		1178.21-22
	3	1	One shatter of chert.	11.4	0.4		1178.23
	3	1	One tertiary flake of Swan River Chert.	22.3	2.4		1178.3
	3	5	Five tertiary flakes of Knife River Flint.	13.5	0.9		1178.4-8
	3	3	Three tertiary flakes of Tongue River Silica.	14.1	1.0		1178.9-11
	4	1	One scraper of Knife River Flint.	22.8	3.2		1179.1
	4	1	One tertiary flake of Tongue River Silica.	12.4	0.4		1179.2
	4	1	One tertiary flake of Red River Chert.	17.9	1.4		1179.3
	4	1	One primary flake of Swan River Chert.	15.5	0.7		1179.4
	4	1	One shatter of Red River Chert.	26.8	4.7		1179.5
	5	1	One tertiary flake of Swan River Chert.	14.9	0.3		1180.1
	5	1	One secondary flake of Red River Chert.	36.8	9.1		1180.2
	Wall scrapings	1	One secondary flake of Red River Chert.	28.2	4.1		1181.1
41							
	1	1	One tool fragment of Tongue River Silica.	17.1	1.4		1182.1
	1	1	One tertiary flake of Knife River Flint.	9	0.1		1182.2
	2	1	One tertiary flake of Swan River Chert.	35.2	7.7		1183.1
	2	2	Two secondary flakes of Knife River Flint.	13.2	0.5		1183.14-15
	2	1	One secondary flake of Tongue River Silica.	16.1	0.5		1183.16
	2	1	One secondary flake of Red River Chert.	18.8	1.5		1183.17

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	1	One shatter of Tongue River Silica.	16.4	1.0		1183.18
	2	1	One shatter of chalcedony.	18	0.6		1183.19
	2	1	One tertiary flake of Red River Chert.	24.3	2.3		1183.2
	2	1	One shatter of quartz.	24.9	3.1		1183.20
	2	3	Three tertiary flakes of Knife River Flint.	13.2	0.7		1183.3-5
	2	8	Eight tertiary flakes of Tongue River Silica.	22.3	5.8		1183.6-13
	3	2	Two tertiary flakes of Swan River Chert.	11.7	0.5		1184.1-2
	3	2	Two tertiary flakes of Tongue River Silica	22.8	2.1		1184.3-4
	3	2	Two secondary flakes of Red River Chert.	19.8	3.4		1184.5-6
	3	1	One shatter of Red River Chert.	19.5	1.6		1184.7
	3	1	One shatter of Tongue River Silica.	25.5	4.3		1184.8
	3	1	One shatter of Swan River Chert.	18.1	1.5		1184.9
	4	1	One tertiary flake of Swan River Chert.	14.5	0.3		1185.1
	4	1	One tertiary flake of Red River Chert.	11.3	0.3		1185.2
42							
	1	1	One tertiary flake of agate.	11.3	0.1		1186.1
	2	1	One shatter of Red River Chert.	20.4	0.9		1187.11
	2	3	Three refit fragments, possibly of a vertebral drum of a large ungulate.	54.2	9.5		1187.12-14
	2	3	Three tertiary flakes of Knife River Flint.	20.4	1.0		1187.1-3
	2	2	Two refit undiagnostic fragments of bone, probably from a large ungulate.	30.6	1.8		1187.15-16
	2	5	Five undiagnostic cortical bone fragments, probably from a large ungulate.	30.6	3.2		1187.17-21

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	1	One secondary flake of Knife River Flint.	15	0.3		1187.4
	2	1	One secondary flake of Swan River Chert.	30.5	4.0		1187.5
	2	1	One primary flake of Tongue River Silica.	25.4	2.7		1187.6
	2	2	Two shatter of Knife River Flint.	13.4	0.9		1187.7-8
	2	2	Two shatter of Swan River Chert.	37.3	11.4		1187.9-10
	3	3	Three tertiary flakes of Knife River Flint.	13.3	0.7		1188.1-3
	3	1	One tertiary flake of Hixton Silicified Sandstone.	11.3	0.2		1188.4
	3	1	One tertiary flake of agate.	10	0.1		1188.5
	3	1	One secondary flake of Knife River Flint.	17.5	0.8		1188.6
	3	1	One shatter of Swan River Chert.	16.1	0.6		1188.7
	4	2	Two shatter of Swan River Chert.	18.7	1.9		1189.11-12
	4	1	One shatter of Jasper.	19.8	1.0		1189.13
	4	1	One shatter of Silicified Wood.	15.5	0.6		1189.14
	4	7	Seven tertiary flakes of Knife River Flint.	15.3	1.6		1189.1-7
	4	1	One tertiary flake of Tongue River Silica.	24.7	2.6		1189.8
	4	2	Two shatter of quartz.	19.7	2.1		1189.9-10
	5	2	Two tertiary flakes of Swan River Chert.	22.7	1.9		1190.1-2
	5	1	Three tertiary flakes of agate.	17	0.9		1190.20-22
	5	1	One tertiary flake of Lake of the Woods Chert.	9.6	0.1		1190.23
	5	1	One tertiary flake of chalcedony.	10.3	0.1		1190.24
	5	1	One secondary flake of Red River Chert106..2	10.6	0.2		1190.25
	5	1	One shatter of Knife River Flint.	10.9	0.3		1190.26
	5	2	Two shatter of Swan River Chert.	23.5	2.8		1190.27-28
	5	17	Sixteen tertiary flakes of Knife River Flint.	22.6	4.2		1190.3-19

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	6	14	Fourteen tertiary flakes of Knife River Flint.	23.5	3.0		1191.1-14
	6	9	Nine tertiary flakes of chalcedony.	13.3	1.2		1191.15-23
	6	1	One tertiary flake of Tongue River Silica.	9.2	0.1		1191.24
	6	1	One tertiary flake of jasper.	11.3	0.2		1191.25
	7	6	Six tertiary flakes of Knife River Flint.	16.8	1.0		1192.1-6
	7	1	One tertiary flake of Swan River Chert.	17	0.6		1192.7
	7	1	One tertiary flake of chalcedony.	10.4	0.1		1192.8
	8	1	One tertiary flake of Knife River Flint.	8.1	0.1		1193.1
	8	1	One tertiary flake of Tongue River Silica.	18.6	0.8		1193.2
	9	1	One tertiary flake of Knife River Flint.	9.8	0.2		1194.1
	Wall scrapings	1	One tertiary flake of Knife River Flint.	10.8	0.1		1195.1
43							
	1	1	One tool fragment of Knife River Flint.	25.4	2.6		1196.1
	1	1	One secondary flake of Knife River Flint.	32.1	6.1		1196.10
	1	1	One primary flake of Swan River Chert.	25.5	2.9		1196.11
	1	2	Two shatter of Tongue River Silica.	13.9	0.6		1196.12-13
	1	4	Four tertiary flakes of Knife River Flint.	14.3	0.8		1196.2-5
	1	2	Two tertiary flakes of Swan River Chert.	22.1	2.2		1196.6-7
	1	1	One tertiary flake of agate.	12.1	0.1		1196.8
	1	1	One tertiary flake of jasper.	13.3	0.3		1196.9
	2	1	One hammerstone of basalt.	104	562		1197.1
	2	2	Two tertiary flakes of Swan River Chert.	20.3	1.2		1197.2-3
	2	1	One tertiary flake of Knife River Flint.	11.8	0.1		1197.4

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	1	One tertiary flake of quartzite.	11.2	0.1		1197.5
	2	1	One secondary flake of Knife River Flint.	27.5	5.2		1197.6
	2	1	One shatter of Knife River Flint.	12.4	1.3		1197.7
	2	1	One shatter of Swan River Chert.	14.3	0.5		1197.8
	2	1	One long bone fragment from large ungulate. Some scrape marks on concave side. Destroyed for AMS dating by Beta Analytic, LLC.	84.0	12.0		1197.9
	3	1	One tool fragment of Knife River Flint.	18.5	0.5		1198.1
	3	1	One tertiary flake of Tongue River Silica.	10.1	0.1		1198.10
	3	1	One tertiary flake of chalcedony.	10	0.1		1198.11
	3	1	One secondary flake of Swan River Chert.	16.8	1.2		1198.12
	3	1	One shatter of Swan River Chert.	17.7	0.9		1198.13
	3	6	Six tertiary flakes of Knife River Flint.	19.1	1.0		1198.2-7
	3	2	Two tertiary flakes of Swan River Chert.	17.7	0.7		1198.8-9
	4	2	Two tertiary flakes of Knife River Flint.	15.1	0.5		1199.1-2
	4	1	Two tertiary flakes of Tongue River Silica.	10.6	0.3		1199.3-4
	4	1	One tertiary flake of Agate.	11	0.1		1199.5
	4	2	Two shatter of Tongue River Silica.	37.3	17.0		1199.6-7
	5	1	One shatter flake of jasper.	12.9	0.3		1200.10
	5	1	One shatter flake of Tongue River Silica.	15.7	0.5		1200.11
	5	5	Five tertiary flakes of Knife River Flint.	16.4	0.6		1200.1-5
	5	3	Three tertiary flakes of chalcedony.	11.7	0.2		1200.6-8
	5	1	One tertiary flake of jasper.	8.9	0.1		1200.9
	6	11	Eleven tertiary flakes of Knife River Flint.	11.6	0.9		1201.1-11

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	6	2	Two tertiary flakes of chalcedony.	12.6	0.2		1201.12-13
	6	2	Two shatter of jasper.	15.9	0.4		1201.14-15
	7	4	Four tertiary flakes of jasper.	12.1	0.3		1202.11-14
	7	3	Three tertiary flakes of chalcedony.	11.6	0.3		1202.15-17
	7	1	One tertiary flake of Tongue River Silica.	29.2	3.1		1202.18
	7	8	Eight tertiary flakes of Knife River Flint.	18.1	1.2		1202.1-8
	7	1	One shatter of Tongue River Silica.	31.8	3.9		1202.19
	7	1	One shatter of granite.	26.1	2.8		1202.20
	7	2	Two tertiary flakes of Swan River Chert.	14.3	0.8		1202.9-10
	8	1	One tertiary flake of Swan River Chert.	12.9	0.5		1203.1
	8	1	One tertiary flake of jasper.	8.9	0.1		1203.2
	9	1	One shatter of Swan River Chert.	20.9	2.3		1204.1
	11	1	One tertiary flake of jasper	11	0.1		1205.1
	11	1	One tertiary flake of chalcedony.	15.4	0.3		1205.2
	12	1	Two tertiary flakes of Knife River Flint.	10.1	0.1		1206.1
44							
	2	1	One secondary flake of Knife River Flint.	12.8	0.3		1207.10
	2	2	Two shatter of Red River Chert.	19.7	1.5		1207.11-12
	2	1	One shatter of Swan River Chert.	17.1	0.6		1207.13
	2	3	Three tertiary flakes of Knife River Flint.	17.1	1.1		1207.1-3
	2	1	One shatter of jasper.	15	0.6		1207.14
	2	1	One shatter of Tongue River Silica.	18.5	3.1		1207.15
	2	2	Two tertiary flakes of Tongue River Silica.	17.4	1.4		1207.4-5
	2	2	Two tertiary flakes of Swan River Chert.	13.4	0.5		1207.6-7

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	1	One tertiary flake of Lake of the Woods Chert.	15.9	0.4		1207.8
	2	1	One tertiary flake of jasper.	12	0.2		1207.9
	3	2	Two shatter of Tongue River Silica.	15.9	0.7		1208.1-2
	3	1	One tertiary flake of Gray Tongue River Silica.	15	0.3		1208.3
	3	1	One tertiary flake of Red River Chert.	17.1	1.1		1208.4
	3	1	One tertiary flake of Agate.	10.2	0.1		1208.5
	3	1	One tertiary flake of Swan River Chert.	11.9	0.4		1209.1
45							
	2	5	Five tertiary flakes of Knife River Flint.	11	0.5		1210.1-5
	2	1	One tertiary flake of Swan River Chert.	9.9	0.1		1210.6
	3	1	One scraper fragment of Knife River Flint.	24.5	1.8		1211.1
	3	1	One tertiary flake of chalcedony.	9.4	0.1		1211.10
	3	1	One shatter of Swan River Chert.	19.3	0.9		1211.11
	3	2	Two shatter of Tongue River Silica.	22.7	3.6		1211.12-13
	3	3	Three tertiary flakes of Swan River Chert.	22.2	4.8		1211.2-4
	3	3	Three tertiary flakes of Knife River Flint.	17	1.0		1211.5-7
	3	1	One tertiary flake of Tongue River Silica.	13.3	0.3		1211.8
	3	1	One tertiary flake of jasper.	16.1	0.6		1211.9
	4	1	One tool fragment of Tongue River Silica.	18.5	1.4		1212.1
	4	1	One tertiary flake of Swan River Chert.	11.6	0.3		1212.11
	4	1	One tertiary flake of Red River Chert.	10.8	0.2		1212.12
	4	1	One tertiary flake of Tongue River Silica.	9.6	0.1		1212.13
	4	1	One tertiary flake of chalcedony.	10.7	0.1		1212.14
	4	2	Two shatter of Tongue River Silica.	30	2.7		1212.15-16

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	4	9	Nine tertiary flakes of Knife River Flint.	11.5	1.0		1212.2-10
	5	3	Three tertiary flakes of Tongue River Silica.	25.5	5.1		1213.10-12
	5	3	Three tertiary flakes of chalcedony.	18.2	0.9		1213.13-15
	5	2	Two tertiary flakes of jasper.	13.9	0.2		1213.16-17
	5	1	One tertiary flake of agate.	18	0.3		1213.18
	5	1	One secondary flake of agate.	11.9	0.1		1213.19
	5	9	Nine tertiary flakes of Knife River Flint.	1.4	1.2		1213.1-9
	5	1	One secondary flake of Knife River Flint.	12	0.1		1213.20
	5	2	Two shatter of Tongue River Silica.	11.9	0.5		1213.21-22
	6	3	Three tertiary flakes of Knife River Flint.	22.9	1.9		1214.1-3
	6	1	One primary flakes of tongue River Silica.	20.5	1.0		1214.4
	7	2	Two tertiary flakes of Swan River Chert.	32.5	6.1		1215.1-2
	7	1	One tertiary flake of Tongue River Silica.	8.2	0.1		1215.3
	7	1	One tertiary flake of Quartz.	19.7	1.4		1215.4
	8	1	One tertiary flake of Burlington Chert.	.9	0.1		1216.1
	8	1	One tertiary flake of Red River Chert.	13.6	0.3		1216.2
	10	1	One core fragment of very fine-grained Swan River Chert.	38.3	10.2		1217.1
	10	1	One tertiary flake of Swan River Chert.	13.1	0.2		1217.2
	10	1	One tertiary flake of Knife River Flint.	20.1	0.4		1217.3
	10	1	One tertiary flake of Swan River Chert.	13.6	0.2		1218.1
	Wall	1	One primary flake Swan River Chert.	51.5	35.2		1219.1
	scrapings						
46							
	2	2	Two tertiary flakes Swan River Chert.	18.7	1.4		1220.1-2

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	2	Two tertiary flakes Knife River Flint.	10.3	0.3		1220.3-4
	3	1	One utilized flake of Knife River Flint.	21	1.3		1221.1
	3	1	One tertiary flake of Knife River Flint.	7.9	0.1		1221.2
	3	2	Two tertiary flakes Swan River Chert.	15.8	0.9		1221.3-4
	4	1	One tertiary flake of Knife River Flint.	10.4	0.1		1222.1
	4	1	One core of Swan River Chert.	45.1	38.0		1222.2
	5	2	Two tertiary flakes of Knife River Flint.	13.6	0.4		1223.1-2
	6	1	One tertiary flake of Tongue River Silica.	12.4	0.4		1224.1
	6	1	One shatter of Knife River Flint.	17.1	0.7		1224.2
47							
	1	1	One undiagnostic bone fragment, probably from a large Ungulate.	38.1	3.6		1289.1
	2	1	One tertiary flake of Knife River Flint.	12.6	0.1		1225.1
	2	1	One secondary flake of Tongue River Silica.	20.2	1.4		1225.2
	2	1	One core fragment of Swan River Chert.	29.9	6.5		1225.3
	3	3	Three tertiary flakes of Knife River Flint.	12	0.3		1226.1-3
	3	1	One tertiary flake of Tongue River Silica.	13.4	0.1		1226.4
	3	1	One secondary flake of Swan River Chert.	12.9	0.1		1226.5
	3	1	One shatter of Swan River Chert.	26	2.6		1226.6
	4	4	Four shatter of Swan River Chert.	33.5	17.6		1227.10-13
	4	2	Two tertiary flakes of Swan River Chert.	12.5	0.7		1227.1-2
	4	3	Three shatter of Knife River Flint.	16.6	2.8		1227.14-16
	4	2	Two tertiary flakes of Knife River Flint.	14.9	0.2		1227.3-4
	4	2	Two tertiary flakes of jasper.	13.5	0.2		1227.5-6

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	4	1	One secondary flake of Knife River Flint.	10.5	0.1		1227.7
	4	1	One secondary flake of Swan River Chert.	15.7	0.2		1227.8
	4	1	One primary flake of Swan River Chert.	36.3	10.9		1227.9
	5	1	One tertiary flake of chalcedony.	12.5	0.1		1228.10
	5	2	Two tertiary flakes of Swan River Chert.	22.1	2.0		1228.1-2
	5	5	Five tertiary flakes of Knife River Flint.	22	1.5		1228.3-7
	5	1	One shatter of Knife River Flint.	21.7	1.4		1228.8
	5	1	One shatter of quartz.	11.9	0.3		1228.9
	6	1	One core of Swan River Chert.	83	229.7		1229.1
	6	3	Three tertiary flakes of Swan River Chert.	11.7	0.3		1229.2-4
	6	3	Three tertiary flakes of Knife River Flint.	12	0.1		1229.5-7
	6	1	One tertiary flake of Tongue River Silica.	17.5	0.7		1229.8
	6	1	One secondary flake of Swan River Chert.	13.7	0.2		1229.9
	7	1	One tertiary flake of basalt.	17.8	0.5		1230.1
	8	3	Three tertiary flakes of Knife River Flint.	10	0.2		1231.1-3
	8	1	One tertiary flake of Swan River Chert.	10.6	0.1		1231.4
	8	1	One secondary flake of jasper.	13.2	0.4		1231.5
	8	1	One shatter of Swan River Chert.	13.8	0.7		1231.6
	Wall scrapings	1	One tertiary flake of Agate.	24	1.2		1232.1
48							
	1	1	One tertiary flake of Knife River Flint.	10.5	0.3		1233.1
	2	1	One biface fragment of Swan River Chert.	30	5.2		1234.1
	3	3	Three tertiary flakes of Knife River Flint.	10.7	0.3		1235.1-3

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	3	1	One primary flake of Quartzite.	59.8	36.4		1235.4
	4	1	One tool fragment of quartz.	22.9	2.0		1236.1
	4	3	Three tertiary flakes of quartz.	29.4	3.9		1236.2-4
	4	2	Two secondary flakes of quartz.	28.3	10.7		1236.5-6
	4	2	Two shatter of quartz.	13.9	0.9		1236.7-8
	4	1	One tertiary flake of Red River Chert.	10.5	0.2		1236.9
	6	1	One tertiary flake of Knife River Flint.	14.5	0.3		1237.1
	6	1	One tertiary flake of chalcedony.	19.2	0.6		1237.2
	6	2	Two shatter of Swan River Chert.	20.2	2.2		1237.3-4
	6	1	One shatter of jasper.	15.7	0.7		1237.5
49							
	2	1	One tool fragment of Knife River Flint.	17.4	0.7		1238.1
	2	2	Two tertiary flakes of Swan River Chert.	18	1.5		1238.2-3
	2	2	Two tertiary flakes of Knife River Flint.	17.7	1.1		1238.4-5
	2	1	One shatter of Swan River Chert.	11.8	0.2		1238.6
	2	1	One shatter of Tongue River Silica.	12.2	0.3		1238.7
	3	1	One utilized flake of Knife River Flint.	16.9	0.5		1239.1
	3	4	Four tertiary flakes of Knife River Flint.	16.3	0.9		1239.2-5
	3	1	One tertiary flake of Fine Gray Tongue River Silica.	8.4	0.1		1239.6
	3	2	One secondary flake of Swan River Chert.	19.9	0.6		1239.7
	3	2	Two shatter of Swan River Chert.	12.9	0.7		1239.8-9
	4	2	Two tertiary flakes of Swan River Chert.	15	0.9		1240.1-2
	4	2	Two tertiary flakes of Knife River Flint.	23.6	1		1240.3-4
	4	1	One tertiary flake of chalcedony.	9.9	0.1		1240.5

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	4	1	One tertiary flake of Tongue River Silica.	58.2	46.6		1240.6
	4	1	One secondary flake of Knife River Flint.	26.9	0.1		1240.7
	5	1	One tool fragment of tool fragment of Knife River Flint.	16.6	0.8		1241.1
	5	4	Four tertiary flakes of chalcedony.	11	0.4		1241.14-17
	5	2	Two tertiary flakes of Tongue River Silica.	23.9	1.9		1241.18-19
	5	1	One tool fragment of tool fragment of Knife River Flint.	24.1	2.0		1241.2
	5	1	One secondary flake of Knife River Flint.	9.5	0.1		1241.20
	5	2	Two utilized flakes of Knife River Flint.	14.7	0.5		1241.3-4
	5	9	Nine tertiary flakes of Knife River Flint.	19.1	2.4		1241.5-13
	6	2	Two tertiary flakes of Knife River Flint.	12.1	0.4		1242.1-2
	6	2	Two tertiary flakes of Tongue River Silica.	15.5	0.7		1242.3-4
	6	1	One secondary flake of Knife River Flint.	14.9	0.3		1242.5
	6	2	Two shatter of Swan River Chert.	26.2	4.0		1242.6-7
	7	3	Three tertiary flakes of Knife River Flint.	14.1	0.4		1243.1-3
	7	1	One primary flake of quartzite.	35.8	5.4		1243.4
	8	2	Two tertiary flakes of Swan River Chert.	19.4	0.8		1244.1-2
1II							
	1	1	One tertiary flake of Swan River Chert.	10.1	0.2		1250.1
	1	1	One tertiary flake of Knife River Flint.	7.3	0.1		1250.2
	2	3	Three tertiary flakes of Swan River Chert.	16	1.3		1251.1-3
	2	1	One tertiary flake of jasper.	11.5	0.1		1251.4
	2	1	One tertiary flake of Tongue River Silica.	13.4	0.5		1251.5
	2	1	One tertiary flake of chalcedony.	8	1.0		1251.6
	2	1	One secondary flake of Knife River Flint.	23.8	1.0		1251.7

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	2	1	One secondary flake of jasper.	28.7	2.6		1251.8
	2	1	One secondary flake of Swan River Chert.	17	1.0		1251.9
	3	1	One primary flake of Swan River Chert.	66	31.2		1252.10
	3	1	One biface fragment of Swan River Chert.	37.7	9.2		1252.11
	3	4	Four tertiary flakes of Swan River Chert.	16.9	1.1		1252.1-4
	3	2	Two tertiary flakes of Knife River Flint.	20.5	1.1		1252.5-6
	3	3	Three tertiary flakes of Tongue River Silica.	17.1	1.2		1252.7-8
	3	1	One tertiary flake of chert.	21.8	1.6		1252.9
	4	4	Four tertiary flakes of Swan River Chert.	32.1	11.5		1253.1-4
	4	2	Two tertiary flakes of Knife River Flint.	14.4	0.3		1253.5-6
	4	2	Two tertiary flakes of Tongue River Silica.	12	0.6		1253.7-8
	4	1	One shatter of Swan River Chert.	30.5	9.1		1253.9
	5	1	One secondary flake of Knife River Flint.	23.7	2.1		1254.1
	5	2	Two tertiary flakes of Tongue River Silica.	10.7	0.1		1254.2-3
	5	1	One tertiary flake of chert.	9.2	0.1		1254.4
	5	1	One tertiary flake of jasper.	8.5	0.1		1254.5
	5	1	One tertiary flake of Knife River Flint.	8.2	0.1		1254.6
	5	10	Ten tertiary flakes of Swan River Chert.	20	6.9		1254.7-16
	6	1	One secondary flake of Tongue River Silica.	16.4	0.7		1255.1
	6	1	One tertiary flake of Tongue River Silica.	11.4	0.1		1255.10
	6	1	One fully grooved maul of basalt. Exhibits pecking and grinding on distal surfaces.	114.2	963.8		1255.11
	6	2	Two secondary flakes of Swan River Chert.	24.3	2.1		1255.2-3
	6	3	Three tertiary flakes of Swan River Chert.	14	0.8		1255.4-6

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	6	2	Two tertiary flakes of Knife River Flint.	10.4	0.1		1255.7-8
	6	1	One tertiary flake of chert.	16.9	0.4		1255.9
	7	3	Three tertiary flakes of Swan River Chert.	18.3	0.8		1256.1-3
	7	1	One tertiary flake of Tongue River Silica.	10.4	0.2		1256.4
	7	1	One tertiary flake of jasper.	9.4	0.1		1256.5
	7	1	One tertiary flake of Knife River Flint.	8.8	0.1		1256.6
	7	2	Two primary flake fragments of Swan River Chert.	78.4	134.8		1256.7-8
2II							
	1	1	One shatter of Knife River Flint.	15.4	0.5		1257.1
	1	2	Two tertiary flakes of Knife River Flint.	10.6	0.1		1257.2-3
	2	8	Eight tertiary flakes of Knife River Flint.	13.2	1.5		1258.1-8
	3	1	One Besant projectile point of fusilinid chert.	38.2	5.0		1259.1
	3	2	Two tertiary flakes of chalcedony.	9.2	0.1		1259.19-20
	3	1	One secondary flake of Swan River Chert.	24.2	3.9		1259.21
	3	3	Three secondary flakes of Knife River Flint.	24.1	1.7		1259.22-24
	3	2	Two tertiary flakes of Swan River Chert.	9.4	1.1		1259.2-3
	3	15	Fifteen tertiary flakes of Knife River Flint.	13.6	1.6		1259.4-18
	4	4	Four tertiary flakes of Knife River Flint.	15.6	0.7		1260.1-4
	4	2	Two tertiary flakes of Swan River Chert.	11.5	0.1		1260.5-6
	4	1	One tertiary flake of Fine Gray Tongue River Silica.	7.3	0.1		1260.7
	5	1	One tip of a biface of red Porcellanite.	12.8	0.4		1261.1
	5	2	Two shatter Knife River Flint.	18.3	1.2		1261.2-3
	5	2	Two tertiary flakes of Swan River Chert.	11.3	0.4		1261.4-5
	5	6	Six tertiary flakes of Knife River Flint.	15.1	1		1261.6-11

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	6	6	Six tertiary flakes of Knife River Flint.		15.7	0.9	1262.1-6
	6	2	Two tertiary flakes of Swan River Chert.		23	2.1	1262.7-8
	7	2	Two tertiary flakes of Knife River Flint.		17	0.4	1263.1-2
	7	1	One tertiary flake of Tongue River Silica.	16.8	0.4	1263.3	
	7	1	One tertiary flake of Swan River Chert.		14.7	0.3	1263.4
	Wall scrapings	2	Two tertiary flakes of Knife River Flint.		10.7	0.1	1263.5-6
3II							
	1	4	Four tertiary flakes of Knife River Flint.		25.1	3.3	1264.1-4
	1	2	Two tertiary flakes of Tongue River Silica.		18.6	1.3	1264.5-6
	1	2	One tertiary flake of Swan River Chert.		12.4	0.1	1264.7
	1	1	One secondary flake of Swan River Chert.		16.8	0.7	1264.8
	2	2	Two pieces of a Duncan/McKean projectile point of Knife River Flint.		46.9	6.3	1265.1-2
	2	8	Eight tertiary flakes of Swan River Chert.		28	9.9	1265.16-23
	2	13	Thirteen tertiary flakes of Swan River Chert.		14.1	2.8	1265.24-36
	2	1	One primary flake of agate.		22	2.6	1265.3
	2	1	One shatter of Knife River Flint.		9.1	0.3	1265.4
	2	1	One tertiary flake of Fusilinid Chert.		32.9	5.9	1265.5
	2	1	One tertiary flake of quartz.		24.1	2.5	1265.6
	2	1	One tertiary flake of chert.		9	0.2	1265.7
	2	1	One utilized flake of Knife River Flint.		21.3	0.7	1265.8
	2	7	Seven tertiary flakes of Tongue River Silica.		28.8	12.8	1265.9-15
	3	1	One primary flake of Red River Chert.		24.6	1.9	1266.1

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	3	3	Three tertiary flakes of Red River Chert.	34.5	9.3		1266.10-12
	3	4	Four tertiary flakes of Knife River Flint.	37.6	9.4		1266.13-16
	3	1	One secondary flake of Knife River Flint.	12.2	0.1		1266.2
	3	2	Two secondary flakes of agate.	12.9	0.5		1266.3-4
	3	2	Two tertiary flakes of Swan River Chert.	11.6	0.5		1266.5-6
	3	3	Three tertiary flakes of Tongue River Silica.	23.8	2.2		1266.7-9
	4	1	One tertiary flake of quartz.	13.9	0.4		1267.1
	4	1	One tertiary flake of Knife River Flint.	7.6	0.1		1267.2
	4	1	One tertiary flake of Knife River Flint.	10	0.2		1268.1
	4	1	One tertiary flake of chalcedony.	12.2	0.3		1268.2
	4	1	One shatter of Knife River Flint.	12.6	0.7		1268.3
4II							
	3	1	One tertiary flake of Knife River Flint.	13.8	0.1		1269.1
	3	2	One tertiary flake of agate.	19.2	1.0		1269.2
	4	1	One retouched flake of Knife River Flint.	15.6	0.4		1270.1
	4	2	Two tertiary flakes of Knife River Flint.	11.1	0.2		1270.2-3
	5	3	Three tertiary flakes of Knife River Flint.	15.9	0.9		1271.1-3
	6	6	Six tertiary flakes of Knife River Flint.	22.1	1.2		1272.1-6
	6	4	Four secondary flakes of Knife River Flint.	20.9	2.5		1272.7-10
	7	2	Two tertiary flakes of Fine Gray Tongue River Silica.	10.1	0.2		1273.12-13
	7	8	Eight tertiary flakes of Knife River Flint.	21.3	1.6		1273.1-8
	7	3	Three tertiary flakes of agate.	25.1	3.4		1273.9-11
	10	5	Five tertiary flakes of Swan River Chert.	15.1	1.4		1274.1-5
	10	1	One tertiary flake of Fusilinid Chert.	7.6	0.1		1274.6

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	10	2	Two tertiary flakes of Fusilinid Chert.	12	0.3		1275.1-2
Surface Finds							
	Surface	1	One tertiary flake of Knife River Flint.	11.6	0.3	Rock alignment, SE corner	1245.1
	Surface	3	Three tertiary flakes of Knife River Flint.	12.3	0.6	Rock alignment, NW corner	1246.1-3
	Surface	1	One shatter of Knife River Flint.	15.8	0.5	Rock alignment, NW corner	1246.4
	Surface	1	One core of quartzite.	78.6	127.1	Cairn Find	1247.1
	Surface	1	One core of Swan River Chert.	66.4	89.1	2 track, April	1248.1
	Surface	1	One primary flake quartzite.	44.7	16.0	2 track, April	1248.10
	Surface	1	One retouched flake of Knife River Flint.	15.1	0.4	2 track, April	1248.11
	Surface	1	One tertiary flake of Lake of the Woods Chert.	29.8	5.2	2 track, April	1248.12
	Surface	2	Two tertiary flakes of chert.	13.1	0.3	2 track, April	1248.13-14
	Surface	1	One tertiary flake of jasper.	8.1	0.1	2 track, April	1248.15
	Surface	1	One tertiary flake of Tongue River Silica.	16.8	1.2	2 track, April	1248.16
	Surface	2	Two tertiary flakes of Swan River Chert.	14.5	0.7	2 track, April	1248.17-18
	Surface	15	Fifteen tertiary flakes of Knife River Flint.	20.7	6.8	2 track, April	1248.19-33
	Surface	1	One tested cobble of Swan River Chert.	93.7	270.9	2 track, April	1248.2
	Surface	1	One shatter of chert.	8.6	0.2	2 track, April	1248.3
	Surface	18	Eighteen tertiary flakes of Swan River Chert.	34	52.0	2 track, April	1248.34-51
	Surface	1	One utilized flake of Knife River Flint.	17.9	1.0	2 track, April	1248.4
	Surface	1	One secondary flake of Knife River Flint.	18.3	1.1	2 track, April	1248.52

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	Surface	1	One utilized flake of Knife River Flint.	20	1.4	2 track, April	1248.53
	Surface	1	One unidentifiable projectile point tip of Red River Chert.	16.3	1.0	2 track, April	1248.54
	Surface	1	One secondary flake of Swan river Chert.	42.3	14.6	2 track, April	1248.55
	Surface	1	One biface of Red River Chert.	44.4	17.2	2 track, April	1248.56
	Surface	2	Two shatter of Knife River Flint.	19	1.8	2 track, April	1248.5-6
	Surface	1	One drill fragment of Knife River Flint.	23.9	1.4	2 track, April	1248.57
	Surface	2	Two primary flakes of Agate.	37.7	11.1	2 track, April	1248.7-8
	Surface	1	One primary flake Knife River Flint.	13.7	0.5	2 track, April	1248.9
	Surface	1	One tool fragment of Knife River Flint.	14.9	0.6	2 track, April	1249.1
	Surface	2	Two tertiary flakes of Knife River Flint.	11.3	0.5	2 track, April	1249.2-3
	Surface	1	One primary flake of Quartzite.	38.3	13	2 track, April	1249.4
	Surface	1	One shatter of Swan River Chert.	11.4	0.3	2 track, April	1249.5
Construction							
Monitoring							
		1	One piece of either a radial carpal or vertebra fragment,	35.2	13		1290.1
			probably from a large ungulate.				
Shovel Test							
	ND20-E	1	One tertiary flake of Knife River Flint.	15.9	0.6		1283.1
	ND20-E	1	One shatter of Knife River Flint.	13.7	0.5		1283.2
	ND20-S	3	Three tertiary flakes of Knife River Flint.	25	1.7		1287.1-3
	P2-2	1	One tertiary flake of Fine Gray Tongue River Silica.	16.3	0.3		1276.1
	P2-2	1	One tertiary flake of chert.	20.3	1.7		1276.2
	P2-3	1	One tertiary flake of Knife River Flint.	11.8	0.3		1277.1
	P2-8	1	One shatter of agate.	8.5	0.1		1278.1

Test Unit (TU)	Level	Item Count	Description	Maximum Length (mm)	Weight(g)	Location	Catalog #
	P2-11	1	One bipolar flake of Knife River Flint.	24.7	1.8		1279.1
	P2-11	1	One tertiary flake of Knife River Flint.	11.2	0.1		1279.2
	P2-11	1	One tertiary flake of Swan River Chert.	14.7	0.5		1279.3
	P2-12	2	Two tertiary flakes of Swan River Chert.	17.8	1.3		1280.1-2
	P2-12	1	One tertiary flake of Knife River Flint.	10	0.1		1280.3
	P2-13	3	Three tertiary flakes of Knife River Flint.	13.1	0.3		1281.1-3
	P2-15	2	Two tertiary flakes of Knife River Flint.	17.3	0.5		1288.1-2
	P2-15	2	Two tertiary flakes of Swan River Chert.	13.5	0.6		1288.3-4
	P2-16	1	One tertiary flake of Knife River Flint.	7.1	0.1		1282.10
	P2-16	3	Three tool fragments of Swan River Chert.	35.6	28		1282.1-3
	P2-16	1	One secondary flake of chert.	12.4	0.2		1282.4
	P2-16	4	Four Tertiary flakes of Swan River Chert.	24.4	4.8		1282.5-8
	P2-16	1	One tertiary flake of agate.	12.6	0.2		1282.9
	P2-18	3	Three tertiary flakes of Knife River Flint.	16.7	0.5		1284.1-3
	P2-18	1	One tertiary flake of Red River Chert.	11.3	0.1		1284.4
	P2-23	1	One secondary flake of Knife River Flint.	10.3	0.1		1285.1
	P2-31	1	One tertiary flake of Knife River Flint.	17.4	0.3		1286.1

APPENDIX E: LITHIC MATERIAL BY TEST UNIT

The following table is a catalog of the number of raw material types per test unit by 5 cm level. Depths of stratigraphic levels are also described in this table. The test units are in order by geographic distribution from southwest to northeast. Following is a key for the abbreviation of various material types.

SRC - Swan River Chert
HT - Heat Treated
KRF - Knife River Flint
TRS - Tongue River Silica
RRC - Red River Chert
HSS - Hixton Silicified Sediment
LWC - Lake of the Woods Chert

Munsell 10YR	32DI95	Lithic	Diagnostics/Tools	basalt	SRC	SRC, HT	KRF	KRF, burned	TRS	TRS, HT	Gray TRS	RRC	RRC, HT	Quartz	Quartzite	HSS	LWC	cf. Rainy Buttes Silic. Wood	chert	granite	Burlington Chert	porcellanite	Fusilinid Chert	Agate	Jasper	Chalcedony	Silicified Wood	unknown	Lvl Subtotal
	32DI95																												
	TU31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/2	L1:0-5											Gradual Change 1-0 Artifacts below																	0
	L2:5-10					Munsell, 10YR																							0
	L3:10-15					2/1						Abrupt Change 1-0 Artifacts below																	0
	L4:15-20																												0
3/3	L5:20-25																												0
	L6:25-30					Depleted, Inverted, Unusual Soil Profiles																							0
3/6	L7:30-35																												0
	TU32	22	0	0	7	0	14	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	22
2/2	L1:0-5																												0
	L2:5-10	4					3									1													4
	L3:10-15	9					9																						9
	L4:15-20	8			6		2																						8
3/3	L5:20-25																												0
	L6:25-30																												0
	N&W Wall Scrapings	1			1																								1
	TU3	10	0	0	0	1	7	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	10
2/2	L1:0-5	1					1																						1
	L2:5-10	4					3								1														4
	L3:10-15	4					3											1											4
	L4:15-20	1				1																							1
5/3	L5:20-25																												0
	L6:25-30																												0
	TU2	18	0	0	0	4	10	0	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	18
2/2	L1:0-5																												0
	L2:5-10	7				2	2				2				1														7
	L3:10-20	7					7																						7
5/3	L4:20-30	4	1 large core of KRF.			2	1					1																	4
3/4	L5:30-35																												0
BLOCK total		50	0	0	7	5	31	0	0	0	2	1	0	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	50
	TU1	10	1	0	0	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
2/2	L1:0-5																												0
	L2:5-10	1					1																						1
	L3:10-15	5				4	1																						5
	L4:15-20	3	1 KRF concave point base.			1	2																						3
	L5:20-25	1					1																						1
	L6:25-30																												0
3/2-3/3	L7:30-35																												0
	TU46	14	1	0	1	4	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
2/1	L1:0-5																												0
	L2:5-10	4				2	2																						4
	L3:10-15	4	1 KRF utilized flake.			2	2																						4
	L4:15-20	2			1		1																						2
3/3	L5:20-25	2					2																						2
	L6:25-30	2					1		1																				2
	L7:30-35																												0
	L8:35-40																												0
	TU4	21	0	0	2	0	11	0	0	0	0	3	0	0	0	0	0	1	1	0	0	0	0	2	0	1	0		21
3/1	L1:0-5	2					2																						2
	L2:5-10	3					2																				1		3
	L3:10-15	8			1		5												1					1					8
	L4:15-20	7	1 large primary flake of Rainy Buttes.				2					3						1						1					7
3/2	L5:20-25																												0
	L6:25-30																												0
	L3-4 Wall scrapings	1			1																								1
	TU5	5	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1		5
3/1	L1:0-5																												0
	L2:5-10	2			1															1									2
	L3:10-15	2	1 possible core bottom.											1													1		2
3/2	L4:15-20	1					1																						1
	L5:20-25																												0
	L6:25-30																												0
	TU6	47	1	0	15	30	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		47
2/1	L1:0-5																												0
	L2:5-10	2	1 KRF tool fragment.			1	1																						2
	L3:10-15	9			9																								9
	L4:15-20	36			6	29						1																	36
3/2	L5:20-25																												0
	L6:25-30																												0
	TU7	9	1	0	1	2	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0		9
2/1	L1:0-5	2				1	1																						2
	L2:5-10	2	Silicified wood side-notched point base.		1																						1		2
	L3:10-15	5				1	3					1																	5
	L4:15-20																												0
3/2	L5:20-25																												0
	TU25	42	9	0	12	8	13	0	2	0	0	0	0	2	0	1	0	0	0	0	1	0	0	2	1	0	0		42
2/2	L1:0-5	0																											0
	L2:5-10	8			1		5		1												1								8
	L3:10-15	9	1 KRF uniface tip.			4	3																	1	1				9
	L4:15-20	7	3 possible KRF expedient flake tools.		2		3							2															7
	L5:20-25	6	2 scrapers. 1 retouched SRC flake.		2		1		1							1								1					6
	L6:25-30	2				2																							2
3/3	L7:30-35	8	1 bipolar KRF pebble fragment.		7		1																						8
	L8:35-40	1				1																							1
	L9:40-45																												0
	L4 Wall scrapings	1	1 retouched flake SRC.			1																							1
	TU37	36	3	0	1	14	5	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0		36
3/2	L1:0-5																												0
	L2:5-10	1				1																							1
	L3:10-15	5				4																		1					5
	L4:15-20	8	KRF uniface scraper, 1 utilized SRC flake.			3	2		3																				8
	L5:20-25	15			1	3	3		7															1					15
	L6:25-30	6				2			4																				6
	L7:30-35	1	1 utilized flake KRF.			1																							1
3/3	L8:35-40																												0

Munsell 10YR	32DI95	Lithic	Diagnostics/Tools	basalt	SRC	SRC, HT	KRF	KRF, burned	TRS	TRS, HT	Gray TRS	RRC	RRC, HT	Quartz	Quartzite	HSS	LWC	cf. New Boston Side Notch	chert	granite	Burlington Chert	porcellanite	Fusilinid Chert	Agate	Jasper	Chalcedony	Silicified Wood	unknown	Lvl Subtotal
3/2	**TU38**	**32**	2	0	6	6	8	0	3	0	0	2	0	2	1	1	0	0	1	0	0	0	0	2	0	0	0	0	32
	L1:0-5																												0
	L2:5-10																												0
	L3:10-15	11	1 projectile pt tip, HSS		3	3	2							1		1			1										11
	L4:15-20	10			3		4		2			1																	10
	L5:20-25	6	1 TRS uniface scraper			1	1		1						1										2					6
	L6:25-30	4				2	1					1																	4
	L7:30-35																												0
3/3	L8:35-40	1												1															1
	L9:40-45																												0
	TU1, Phll	**67**	2	0	4	32	11	0	10	0	0	1	0	0	0	0	0	0	4	1	0	0	0	0	4	0	0	0	67
	L1 0-5	2			1		1																						2
	L2:5-10	9				4	1		1										1						2				9
	L3:10-15	12	1 SRC biface fragment.		1	5	2		2			1							1										12
	L4:15-20	9				5	2		2																				9
	L5:20-25	16				10	2		2										1						1				16
	L6 25-30	11	1 grooved maul		2	3	2		2										1	1									11
	L7:30-35	8				5	1		1																1				8
	L8 35-40																												0
	L9:40-45																												0
	L10:45-50																												0
BLOCK total		177	16	0	23	60	37	0	29	0	0	3	0	4	1	2	0	0	5	1	1	0	0	2	8	1	0	0	177
	TU8	**13**	1	0	0	4	4	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	13
2/1	L1:0-5																												0
	L2:5-10	1										1																	1
	L3:10-15	1					1																						1
	L4:15-20	4				3	1																						4
	L5:20-25	5	1 TRS Biface.			1	1		1						1										1				5
3/4	L6:25-30																												0
	L7:30-35	2					1																			1			2
	L8:35-40																												0
	L9:40-45																												0
	TU9	**4**	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4
2/1	L1:0-5																												0
	L2:5-10																												0
	L3:10-15																												0
	L4:15-20	2					1		1																				2
	L5:20-25	1																							1				1
	L6:25-30	1					1																						1
	L7:30-35																												0
3/4	L8:35-40																												0
	TU10	**33**	2	0	2	8	11	0	5	0	1	3	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	33
2/1	L1:0-5	2				2																							2
	L2:5-10	5					2		1																	2			5
	L3:10-15	7	1 utilized flake KRF.		1		2		3			1																	7
	L4:15-20	6			1	3			1					1															6
	L5:20-25	1					1																						1
	L6:25-30																												0
3/2	L7:30-35	7				2	3					2																	7
	L8:35-40	3	1 untilized flake of KRF			1	1				1																		3
	L9:40-45																												0
	L10:45-50	1					1																						1
	L11:50-55																												0
	Wall scrapings	1					1																						1
	TU11	**53**	6	0	5	8	26	0	6	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	1	3	0	0	53
2/1	L1:0-5																												0
	L2:5-10	12			1	4	3		2					1												1			12
	L3:10-15	7					4		1																		2		7
	L4:15-20	8	1 KRF scraper/knife. 1 TRS retouched flake.		3		2		2								1												8
	L5:20-25	8	1 KRF proj pt frag. 2 utilized KRF flakes.			2	5		1																				8
	L6:25-30	7	1 KRF utilized flake. 1 SRC core.			2	4																				1		7
3/2	L7:30-35	7					5				1	1																	7
	L8:35-40	3			1		2																						3
	L9:40-45	1					1																						1
	L10:45-50																												0
	TU26	**113**	5	1	1	16	45	1	17	0	2	6	0	5	4	0	0	0	0	0	0	1	0	6	3	5	0	0	113
3/2	L1:0-5	4					3					1																	4
	L2:5-10	10				1	2		5					1	1														10
	L3:10-15	20	1 retouched flake. 1 utilized flake.	1		9	5		3			1															1		20
	L4:15-20	23				1	13		4		1	1			2												1		23
	L5:20-25	27	2 utilized flakes. 1 tested cobble.			3	9		3		1	2		1	1							1		3		3			27
3/1	L6:25-30	13				1	7		1			1												1	2				13
	L7:30-35	7	1 utilzed flake KRF.				3	1						1										1	1				7
	L8:35-40	5	1 utllized flake KRF.		1		2							1										1					5
	L9:40-45	2				1								1															2
	L10:45-50	2					1		1																				2
	L11:50-55	0																											0
	L12:55-60	0																											0
2/1	L13:60-65	0																											0
	TU42	**98**	0	0	0	11	57	1	4	0	0	2	0	2	0	1	1	0	0	0	0	0	0	5	2	11	1	0	98
2/1	L1:0-5	1																						1					1
	L2:5-10	11				3	6		1			1																	11
	L3:10-15	7				1	4									1								1					7
	L4:15-20	14				2	7		1					2											1		1		14
3/3	L5:20-25	28				4	17	1				1					1							3		1			28
	L6:25-30	25					14		1																1	9			25
	L7:30-35	8				1	6																			1			8
2/1	L8:35-40	2					1		1																				2
	L9:40-45	1					1																						1
	Wall scrapings	1					1																						1

Munsell 10YR	32DI95	Lithic	Diagnostics/Tools	basalt	SRC	SRC, HT	KRF	KRF, burned	TRS	TRS, HT	Gray TRS	RRC	RRC, HT	Quartz	Quartzite	HSS	LWC	Cf. Kerr Dunes Silic. Wood	chert	granite	Burlington Chert	porcellanite	Fusilinid Chert	Agate	Jasper	Chalcedony	Silicified Wood	unknown	Lvl Subtotal
	TU47	**52**	**0**	**1**	**1**	**19**	**22**	**0**	**3**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**1**	**0**	**0**	**52**
2/1	L1:0-5																												0
	L2:5-10	3	1 core.			1	1		1																				3
	L3:10-15	6				2	3		1																				6
	L4:15-20	16				8	6																		2				16
3/2	L5:20-25	10				2	6							1												1			10
	L6:25-30	9			1	4	3		1																				9
	L7:30-35	1	1 core.	1																									1
	L8:35-40	6				2	3																		1				6
	L9:40-45																												0
	L10:45-50																												0
	Wall scrapings	1																							1				1
	TU2, Phil	**67**	**2**	**0**	**2**	**8**	**50**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**2**	**1**	**0**	**67**
	L1:0-5	3					3																						3
	L2:5-10	8					7																			1			8
	L3:10-15	24	1 Fusilinid chert point w/o tip.		1	2	18																	1		1	1		24
	L4:15-20	7			1	1	4		1																				7
	L5:20-25	11	1 Porcellanite biface tip.			2	8																1						11
	L6:25-30	8				2	6																						8
	L7:30-35	4				1	2		1																				4
	L8:35-40																												0
	L9:40-45																												0
	Wall scrapings	2					2																						2
	TU49	**56**	**6**	**0**	**1**	**11**	**31**	**0**	**6**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**56**
2/1	L1:0-5																												0
	L2:5-10	7	1 KRF tool fragment.			3	3		1																				7
	L3:10-15	9	1 utilized flake of KRF.				3	5			1																			9
	L4:15-20	7			1	1	3		1																	1				7
3/2	L5:20-25	20	2 KRF tool frags. 2 utilized KRF flakes.				14		2																	4				20
	L6:25-30	7				2	3		2																				7
	L7:30-35	4					3								1														4
	L8:35-40	2				2																							2
	L9:40-45																												0
	L10:45-50																												0
	TU43	**94**	**2**	**1**	**6**	**9**	**44**	**0**	**9**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**11**	**10**	**0**	**0**	**94**
2/1	L1:0-5	13	1 KRF tool fragment (knife?).			4	6		1																1	1			13
	L2:5-10	8	1 basalt hammerstone.	1	3		3								1														8
	L3:10-15	13	1 tool fragment KRF.			4	7		1																	1			13
	L4:15-20	7					2		4																1				7
	L5:20-25	11					5		1																	2	3		11
	L6:25-30	15					11																			2	2		15
	L7:30-35	20			2		8		2												1					4	3		20
	L8:35-40	2				1																				1			2
	L9:40-45	1			1																								1
	L10:45-50																												0
2/2	L11:50-55	2																								1	1		2
	L12:55-60	2					2																						2
	L13:60-65																												
	L14:65-70																												
	L15:70-75																												
	TU27	**101**	**3**	**1**	**6**	**12**	**61**	**1**	**5**	**0**	**1**	**2**	**0**	**1**	**1**	**0**	**1**	**0**	**0**	**2**	**0**	**0**	**0**	**2**	**1**	**2**	**2**	**0**	**101**
3/2	L1:0-5	2				1																			1				2
	L2:5-10	5				1	3		1																				5
	L3:10-15	23	1 KRF point tip. 1 hammerstone.	1	4		11					2					1								1		1	2		23
	L4:15-20	17				5	10				1			1																17
	L5:20-25	9				2	4	1														1				1				9
3/1	L6:25-30	23				1	17		3						1							1								23
	L7:30-35	12	1 KRF scraper.			1	11																							12
	L8:35-40	1					1																							1
	L9:40-45	2					1																				1			2
	L10:45-50	6	1 utilized flake KRF.		2		3		1																					6
	L11:50-55	1				1																								1
	L12:55-60																													
2/1	L13:60-65																													
	TU45	**72**	**2**	**0**	**10**	**2**	**32**	**0**	**14**	**0**	**0**	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**4**	**3**	**3**	**0**	**0**	**72**
2/1	L1:0-5																													0
	L2:5-10	6			1		5																							6
	L3:10-15	13	1 KRF scraper fragment.		4		4		3																1	1				13
	L4:15-20	16	1 TRS tool fragment.		1		9		4			1													1					16
3/2	L5:20-25	22					10		5																2	2	3			22
	L6:25-30	4					3		1																					4
	L7:30-35	4			2				1					1																4
	L8:35-40	2										1										1								2
	L9:40-45																													0
	L10:45-50	3	1 core.		2		1																							3
	L11:50-55	1				1																								1
	L12:55-60																													
	L13:60-65																													
	S Wall scrapings	1				1																								1
BLOCK total		739	28	4	34	104	379	3	71	0	6	16	0	12	7	1	3	0	0	3	1	2	1	20	24	44	4	0	739
	TU13	**11**	**0**	**0**	**1**	**0**	**7**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**11**
3/2	L1:0-5																													0
	L2:5-10	4					3																			1			4
	L3:10-15	2			1		1																						2
	L4:15-20																												0
	L5:20-25	2					1					1																	2
4/3	L6:25-30	3					2		1																				3
	L7:30-35																												0
	L8:35-40																												0

Munsell 10YR	32DI95	Lithic	Diagnostics/Tools	basalt	SRC	SRC, HT	KRF	KRF, burned	TRS	TRS, HT	Gray TRS	RRC	RRC, HT	Quartz	Quartzite	HSS	LWC	Ref. Rainy Buttes Silic. Wood	chert	granite	Burlington Chert	porcellanite	Fusilinid Chert	Agate	Jasper	Chalcedony	Silicified Wood	unknown	Lvl Subtotal
	TU12	**1**	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3/2	L1:0-5																												0
	L2:5-10																												0
	L3:10-15																												0
	L4:15-20	1					1																						1
	L5:20-25																												0
4/3	L6:25-30																												0
	L7:30-35																												0
	L8:35-40																												0
	TU40	**55**	5	0	0	16	13	0	14	0	1	6	0	0	0	0	0	0	1	0	0	0	0	2	0	2	0	0	55
2/2	L1:0-5																												0
	L2:5-10	24	2 retouched flakes; 1 RRC, 1 KRF.			7	5		7		1	2												1		1			24
	L3:10-15	23	2 scrapers; 1 TRS, 1 KRF.			7	7		6										1					1		1			23
3/3	L4:15-20	5	1 KRF scraper.			1	1		1			2																	5
3/3	L5:20-25	2				1						1																	2
	L6:25-30																												0
	L7:30-35																												0
	Wall scrapings	1										1																	1
	TU33	**25**	1	0	0	4	10	0	6	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	25
2/2	L1:0-5	1							1																				1
	L2:5-10	5					3					1														1			5
	L3:10-15	16				3	7		3			1														2			16
3/3	L4:15-20	2				1			1																				2
	L5:20-25																												0
	L6:25-30	1	1 projectile point, missing tip.						1																				1
	L7:30-35																												0
	L8:35-40																												0
	TU34	**37**	3	0	1	1	23	0	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	4	0	3	1	0	37
2/2	L1:0-5																												0
	L2:5-10	18	1 utilized flake. 1 bipolar core.			1	12		1															1		2	1		18
3/3	L3:10-15	15	2 tool frag.s KRF, 1 utilized flake KRF.				9				2													3		1			15
	L4:15-20	4			1		2					1																	4
	L5:20-25																												0
	L6:25-30																												0
	TU30	**31**	0	0	1	0	20	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	3	1	2	0	0	31
2/2	L1:0-5	1					1																						1
	L2:5-10	24					15					3						1						3	1	1			24
	L3:10-15	5			1		3																			1			5
	L4:15-20	1					1																						1
3/3-5/6	L5:20-25																												0
	L6:25-30																												0
	TU35	**51**	1	0	11	0	23	0	3	0	0	2	0	1	1	0	0	0	1	0	0	0	0	4	3	2	0	0	51
2/2	L1:0-5	1					1																						1
	L2:5-10	32	1 KRF drill tip. 1 utilized primary flake.		7		14		3						1				1					2	3	1			32
3/3	L3:10-15	13			3		6					2		1												1			13
	L4:15-20	5			1		2																	2					5
	L5:20-25																												0
	L6:25-30																												0
	L7:30-35																												0
	TU44	**21**	0	0	0	4	4	0	5	0	1	3	0	0	0	0	0	1	0	0	0	0	0	1	2	0	0	0	21
2/1	L1:0-5																												0
	L2:5-10	15				3	4		3			2						1							2				15
	L3:10-15	5							2		1	1												1					5
	L4:15-20																												0
3/3	L5:20-25	1					1																						1
	L6:25-30																												0
	L7:30-35																												0
	TU41	**33**	1	0	0	5	6	0	14	0	0	6	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	33
2/1	L1:0-5	2	1 TRS tool fragment.				1		1																				2
	L2:5-10	20				1	5		10			2		1												1			20
	L3:10-15	9				3			3			3																	9
	L4:15-20	2				1						1																	2
3/3	L5:20-25																												0
	L6:25-30																												0
	TU3, Phil	**62**	2	0	1	12	27	0	3	9	0	4	0	2	0	0	0	0	1	0	0	0	0	3	0	0	0	0	62
	L1:0-5	8				2	4		1	1																			8
	L2:5-10	36	2 piecs of KRF McKean proj. point.		1	8	17		2	5				1					1					1					36
	L3:10-15	16				2	5			3		4												2					16
	L4:15-20	2					1							1															2
	L5:20-25																												0
	L6:25-30																												0
	L7:30-35																												0
	L8:35-40																												0
	L9:40-45																												0
	L10:45-50																												0
BLOCK total		315	13	0	14	42	126	0	46	9	4	27	0	4	1	0	0	2	3	0	0	0	0	17	6	13	1	0	315
	TU14	**8**	0	0	4	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	8
2/2	L1:0-5	6			2		1		2														1						6
	L2:5-10	2			2																								2
3/4	L3:10-15																												0
	L4:15-20																												0
	TU15	**43**	1	0	8	20	5	0	5	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	2	0	0	0	43
2/2	L1:0-5	24	1 SRC utilized flake.		4	13			4						1								1		1				24
	L2:5-10	15			3	6	4		1																1				15
3/4	L3:10-15	1			1																								1
	L4:15-20	3				1	1								1														3
	L5:20-25																												0
	L6:25-30																												0
	TU28	**13**	1	0	2	1	5	0	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
2/2	L1:0-5	5	1 KRF utilized flake.		1		3		1																				5
	L2:5-10																												0
3/3-5/3	L3:10-15	3			1				2																				3
	L4:15-20	5				1	2		1			1																	5
	L5:20-25																												0
	L6:25-30																												0

Munsell 10YR	32DI95	Lithic	Diagnostics/Tools	basalt	SRC	SRC, HT	KRF	KRF, burned	TRS	TRS, HT	Gray TRS	RRC	RRC, HT	Quartz	Quartzite	HSS	LWC	cf. Ramy Rattles Silic. Wood	chert	granite	Burlington Chert	porcellanite	Fusilinid Chert	Agate	Jasper	Chalcedony	Silicified Wood	unknown	Lvl Subtotal
	Pedestrian	62	5	0	3	20	26	0	1	0	0	2	0	0	3	0	1	0	3	0	0	0	0	2	1	0	0	0	62
	2-Track	62	1 proj. pt, 1 biface, 2 tools, 1 core.		3	20	26		1			2			3		1		3					2	1				62
	Cairn Finds	6	0	0	0	0	4	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	Rock align., NW	4					3	1																					4
	Rock align., SE	1					1																						1
	Cairn find 1	1	1 core of quartzite												1														1
	TU39	3		0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
2/1	L1:0-5	1				1																							1
	L2:5-10																												0
	L3:10-15	2						1	1																				2
	L4:15-20																												0
3/3	L5:20-25																												0
	L6:25-30																												0
	TU29	51	0	0	9	31	3	0	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	51
2/1	L1:0-5																												0
	L2:5-10	1					1																						1
	L3:10-15	1					1																						1
	L4:15-20	4				1	1		2																				4
	L5:20-25	4				2			1			1																	4
	L6:25-30	4				2			1																1				4
3/3	L7:30-35	10			9				1																				10
	L8:35-40	14				14																							14
	L9:40-45	9				8						1																	9
	L10:45-50	4				4																							4
	L11:50-55																												0
4/4	L12: 55-60																												0
	TU16	37	1	0	2	14	12	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	37
2/1	L1:0-5																												0
	L2:5-10																												0
	L3:10-15	4	1 utilized KRF tertiary flake.				3																			1			4
	L4:15-20	7				1	2					4																	7
	L5:20-25	3					1					1														1			3
	L6:25-30	5				1	4																						5
	L7:30-35	3				1	1																		1				3
3/3	L8:35-40	4				3	1																						4
	L9:40-45	2				2																							2
	L10:45-50	6				6																							6
	L11:50-55	2			1																					1			2
	L12: 55-60	1			1																								1
5/4	L13:60-65																												0
	TU17	20	2	0	4	5	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
2/1	L1:0-5																												0
	L2:5-10																												0
	L3:10-15	5	1 utilized secondary flake of KRF.			1	4																						5
	L4:15-20	1					1																						1
	L5:20-25	1					1																						1
	L6:25-30	1			1																								1
	L7:30-35																												0
3/3	L8:35-40	2			2																								2
	L9:40-45	9	1 utilized tertiary flake of KRF.			4	5																						9
	L10:45-50	1			1																								1
	L11: 50-55																												0
	L12: 55-60																												0
5/4	L13:60-65																												0
	L14:65-70																												0
	TU4, Phil	42	1	0	5	0	27	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	4	0	1	0	0	42
	L1:0-5																												0
	L2:5-10	3					2																			1			3
	L3:10-15	2					1																	1					2
	L4:15-20	3	1 retouched KRF flake fragment.				3																						3
	L5:20-25	3					3																						3
	L6:25-30	10					10																						10
	L7:30-35	13					8				2													3					13
	L8:35-40																												0
	L9:40-45																												0
	L10:45-50	6			5																		1						6
	L11:50-55	2																					2						2
	TU18	2	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
2/2	L1:0-5																												0
	L2:5-10																												0
	L3:10-15	2	1 KRF concave scraper.			1	1																						2
3/2	L4:15-20																												0
	L5:20-25																												0
	L6:25-30																												0
	TU19	4	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4
2/2	L1:0-5																												0
	L2:5-10	1	1 KRF utilized flake.				1																						1
	L3:10-15	2	1 fusilinid chert biface.				1																1						2
	L4:15-20	1	1 KRF scraper with cortex.				1																						1
3/2	L5:20-25																												0
	L6:25-30																												0
	L7:30-35																												0
	TU20	9	1	0	0	0	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
2/2	L1:0-5	5					5																						5
	L2:5-10	1	1 retouched chunk KRF.				1																						1
3/3	L3:10-15	1	1 KRF tool.				1																						1
	L4:15-20	2					1		1																				2
	L5:20-25																												0
	TU21	2	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
2/2	L1:0-5																												0
	L2:5-10	2					1					1																	2
3/3	L3:10-15																												0
4/4	L4:15-20																												0
	L5:20-25																												0
	SE site																												

Munsell 10YR	32DI95	Lithic	Diagnostics/Tools	basalt	SRC	SRC, HT	KRF	KRF, burned	TRS	TRS, HT	Gray TRS	RRC	RRC, HT	Quartz	Quartzite	HSS	LWC	cf. Ferry Butte Silic. Wood	chert	granite	Burlington Chert	porcellanite	Fusilinid Chert	Agate	Jasper	Chalcedony	Silicified Wood	unknown	Lvl Subtotal
3/2	**TU48**	**20**	2	**0**	**1**	**2**	**5**	**0**	**0**	**0**	**0**	**1**	**0**	**8**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**20**
	L1:0-5	1					1																						1
	L2:5-10	1	1 SRC biface tip.		1																								1
	L3:10-15	4					3								1														4
	L4:15-20	9	1 quartz tool fragment.									1		8															9
3/2	L5:20-25	0																											0
	L6:25-30	5				2	1																			1	1		5
3/3-3/4	L7:30-35																												0
	L8:35-40																												0
	L9:40-45																												0
	L10:45-50																												0
	TU36	**18**	1	**0**	**0**	**0**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**0**	**0**	**18**
2/2	L1:0-5	1																						1					1
	L2:5-10	4					4																						4
3/3	L3:10-15	8					6																			2			8
	L4:15-20	4	1 utilized flake.				4																						4
	L5:20-25																												0
	L6:25-30	1					1																						1
	L7:30-35																												0
	L8:35-40																												0
	TU22	**17**	1	**0**	**0**	**6**	**5**	**0**	**3**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**17**
2/2	L1:0-5	1				1																							1
	L2:5-10	7	1 utilized flake.			3	3																			1			7
	L3:10-15	3					2		1																				3
	L4:15-20	5	1 utilized flake of Chalcedony.			1			2			1														1			5
3/3	L5:20-25	1				1																							1
	L6:25-30																												0
	L7:30-35																												0
	TU23	**25**	0	**0**	**2**	**1**	**15**	**0**	**2**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**25**
2/2	L1:0-5	1					1																						1
	L2:5-10	3					1					1												1					3
	L3:10-15	10			1	1	6					1													1				10
3/3	L4:15-20	7					5		2																				7
	L5:20-25	4			1		2																			1			4
	L6:25-30																												0
	L7:30-35																												0
	TU24	**0**	0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	L1:0-5																												0
	Const. monit.	**0**	0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	15-20	0																											0
	Totals	**1798**	83	**4**	**139**	**358**	**764**	**5**	**174**	**9**	**14**	**69**	**0**	**29**	**19**	**4**	**4**	**4**	**12**	**5**	**2**	**2**	**7**	**49**	**48**	**69**	**7**	**1**	**1798**

APPENDIX F: LITHIC TOOL AND DEBITAGE BY TEST UNIT

The following table is a catalog of the number of lithic tools and debitage per test unit by 5 cm level. Depths of stratigraphic levels are also described in this table. The test units are in order by geographic distribution from southwest to northeast and not test unit number.

Munsell 10YR	32DI95	Lithic	Point	Biface	Scraper	Tool (fragment)	Retouched flake	Utilized Flake (expedient)	Tertiary	Secondary	Primary	Shatter	Core	Hammerstone	Tested Cobble	Lvl Subtotal
	32DI95															
	TU31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/2	L1:0-5															0
	L2:5-10			2/1			Munsell, 10YR									0
	L3:10-15															0
	L4:15-20															0
3/3	L5:20-25				Depleted, Inverted,											0
	L6:25-30				Unusual Soil Profiles											0
3/6	L7:30-35															0
	TU32	22	0	0	0	0	0	0	9	8	1	4	0	0	0	22
2/2	L1:0-5															0
	L2:5-10	4							1	2		1				4
	L3:10-15	9							4	4	1					9
	L4:15-20	8							4	2		2				8
3/3	L5:20-25															0
	L6:25-30															0
	Wall Scrapings, N&W wall	1										1				1
	TU3	10	0	0	0	0	0	0	9	0	0	1	0	0	0	10
2/2	L1:0-5	1							1							1
	L2:5-10	4							3			1				4
	L3:10-15	4							4							4
	L4:15-20	1							1							1
5/3	L5:20-25															0
	L6:25-30															0
	TU2	18	0	0	0	0	0	0	12	3	0	2	1	0	0	18
2/2	L1:0-5															0
	L2:5-10	7							6			1				7
	L3:10-20	7							6	1						7
5/3	L4:20-30	4								2		1	1			4
3/4	L5:30-40															0
	Block Total	50	0	0	0	0	0	0	30	11	1	7	1	0	0	50
	TU1	10	1	0	0	0	0	0	9	0	0	0	0	0	0	10
2/2	L1:0-5															0
	L2:5-10	1							1							1
	L3:10-15	5							5							5
	L4:15-20	3	1						2							3
	L5:20-25	1							1							1
	L6:25-30															0
3/2-3/3	L7:30-35															0
	TU46	14	0	0	0	0	0	1	11	0	0	1	1	0	0	14
2/1	L1:0-5															0
	L2:5-10	4							4							4
	L3:10-15	4						1	3							4
	L4:15-20	2							1				1			2
3/3	L5:20-25	2							2							2
	L6:25-30	2							1			1				2
	L7:30-35															0
	L9:35-40															0
	TU4	21	0	0	0	0	0	0	16	1	1	3	0	0	0	21
3/1	L1:0-5	2							2							2
	L2:5-10	3							2			1				3
	L3:10-15	8							7			1				8
	L4:15-20	7							4	1	1	1				7
3/2	L5:20-25															0
	L6:25-30															0
	wall scrapings, 10-20cmbs	1							1							1
	TU5	5	0	0	0	0	0	0	1	0	1	2	1	0	0	5
3/1	L1:0-5															0
	L2:5-10	2							1			1				2
	L3:10-15	2										1	1			2
3/2	L4:15-20	1									1					1
	L5:20-25															0
	L6:25-30															0
	TU6	47	0	0	0	1	0	0	31	7	5	3	0	0	0	47
2/1	L1:0-5															0
	L2:5-10	2				1				1						2
	L3:10-15	9							4	2	3					9
	L4:15-20	36							27	4	2	3				36
3/2	L5:20-25															0
	L6:25-30															0
	TU7	9	1	0	0	0	0	1	4	2	1	0	0	0	0	9
2/1	L1:0-5	2							1		1					2
	L2:5-10	2	1						1							2
	L3:10-15	5						1	2	2						5
	L4:15-20															0
3/2	L5:20-25															0
	TU25	42	0	0	2	1	2	3	21	1	0	11	1	0	0	42
2/2	L1:0-5															0
	L2:5-10	8							5			3				8
	L3:10-15	9				1			6			2				9
	L4:15-20	7						3	2			2				7
	L5:20-25	6			2		1		1			2				6
	L6:25-30	2							1	1						2
3/3	L7:30-35	8							5			2	1			8
	L8:35-40	1							1							1
	L9:40-45															0
	Wall Scrapings-W wall, 20cmbs	1					1									1
	TU37	36	0	0	1	0	0	2	23	3	0	7	0	0	0	36
3/2	L1:0-5															0
	L2:5-10	1										1				1
	L3:10-15	5							3			2				5
	L4:15-20	8			1			1	5			1				8
	L5:20-25	15							11	1		3				15
	L6:25-30	6							4	2						6
	L7:30-35	1						1								1
3/3	L8:35-40															0

Munsell 10YR	32DI95	Lithic	Point	Biface	Scraper	Tool (fragment)	Retouched flake	Utilized Flake (expedient)	Tertiary	Secondary	Primary	Shatter	Core	Hammerstone	Tested Cobble	Lvl Subtotal
	TU38	32	1	0	1	0	0	0	15	2	1	12	0	0	0	32
3/2	L1:0-5															0
	L2:5-10															0
	L3:10-15	11	1						2		1	7				11
	L4:15-20	10							6			4				10
	L5:20-25	6			1				3	2						6
	L6:25-30	4							3			1				4
	L7:30-35															0
3/3	L8:35-40	1							1							1
	L9:40-45															0
	TU1, Phil	67	0	1	0	1	0	0	54	7	3	1	0	0	0	67
	L1:0-5	2							2							2
	L2:5-10	9							6	3						9
	L3:10-15	12		1					10		1					12
	L4:15-20	9							8			1				9
	L5:20-25	16							15	1						16
	L6:25-30	11				1			7	3						11
	L7:30-35	8							6		2					8
	L8:35-40															0
	L9:40-45															0
	L10:45-50															0
	Block Total	177	1	1	4	2	2	5	113	13	4	31	1	0	0	177
	TU8	13	0	1	0	0	0	0	8	1	2	1	0	0	0	13
2/1	L1:0-5															0
	L2:5-10	1							1							1
	L3:10-15	1							1							1
	L4:15-20	4							3			1				4
	L5:20-25	5		1					2		2					5
3/4	L6:25-30															0
	L7:30-35	2							1	1						2
	L8:35-40															0
	L9:40-45															0
	TU9	4	0	0	0	0	0	0	3	1	0	0	0	0	0	4
2/1	L1:0-5															0
	L2:5-10															0
	L3:10-15															0
	L4:15-20	2							2							2
	L5:20-25	1								1						1
	L6:25-30	1							1							1
	L7:30-35															0
3/4	L8:35-40															0
	TU10	33	0	0	0	0	0	2	19	7	1	4	0	0	0	33
2/1	L1:0-5	2							2							2
	L2:5-10	5							4	1						5
	L3:10-15	7						1	4	2						7
	L4:15-20	6							2	1	1	2				6
	L5:20-25	1							1							1
	L6:25-30															0
3/2	L7:30-35	7							3	3		1				7
	L8:35-40	3						1	1			1				3
	L9:40-45															0
	L10:45-50	1							1							1
	L11:50-55															0
	Wall Scraping	1							1							1
	TU11	53	1	0	1	0	1	3	30	9	1	6	1	0	0	53
2/1	L1:0-5															0
	L2:5-10	12							5	3		4				12
	L3:10-15	7							6	1						7
	L4:15-20	8			1		1		4	1		1				8
	L5:20-25	8	1					2	2	1	1	1				8
	L6:25-30	7						1	3	2			1			7
3/2	L7:30-35	7							6	1						7
	L8:35-40	3							3							3
	L9:40-45	1							1							1
	L10:45-50															0
	TU26	113	0	0	0	0	1	6	64	6	4	31	0	0	1	113
3/2	L1:0-5	4							2	2						4
	L2:5-10	10							6			4				10
	L3:10-15	20					1	1	9		3	6				20
	L4:15-20	23							17			6				23
	L5:20-25	27						2	13	4		7			1	27
3/1	L6:25-30	13						1	9		1	2				13
	L7:30-35	7						1	4			2				7
	L8:35-40	5						1	2			2				5
	L9:40-45	2										2				2
	L10:45-50	2							2							2
	L11:50-55															0
	L12:55-60															0
2/1	L13:60-65															0
	TU42	98	0	0	0	0	0	0	77	5	1	15	0	0	0	98
2/1	L1:0-5	1							1							1
	L2:5-10	11							3	2	1	5				11
	L3:10-15	7							5	1		1				7
	L4:15-20	14							8			6				14
3/3	L5:20-25	28							24	1		3				28
	L6:25-30	25							25							25
	L7:30-35	8							8							8
2/1	L8:35-40	2							2							2
	L9:40-45	1							1							1
	Wall Scraping	1								1						1

Munsell 10YR	32DI95	Lithic	Point	Biface	Scraper	Tool (fragment)	Retouched flake	Utilized Flake (expedient)	Tertiary	Secondary	Primary	Shatter	Core	Hammerstone	Tested Cobble	Lvl Subtotal
	TU47	52	0	0	0	0	0	0	32	6	1	11	2	0	0	52
2/1	L1:0-5															0
	L2:5-10	3							1	1			1			3
	L3:10-15	6							4	1		1				6
	L4:15-20	16							6	2	1	7				16
3/2	L5:20-25	10							8			2				10
	L6:25-30	9							7	1			1			9
	L7:30-35	1							1							1
	L8:35-40	6							4	1		1				6
	L9:40-45															0
	L10:45-50															0
	Wall Scraping	1							1							1
	TU2, Phil	67	1	1	0	0	0	0	58	4	0	3	0	0	0	67
	L1:0-5	3							2			1				3
	L2:5-10	8							8							8
	L3:10-15	24	1						19	4						24
	L4:15-20	7							7							7
	L5:20-25	11		1					8			2				11
	L6:25-30	8							8							8
	L7:30-35	4							4							4
	L8:35-40															0
	L9:40-45															0
	Wall Scraping	2							2							2
	TU49	56	0	0	0	3	0	3	36	5	4	5	0	0	0	56
2/1	L1:0-5															0
	L2:5-10	7				1			4			2				7
	L3:10-15	9						1	5	1		2				9
	L4:15-20	7							6	1						7
3/2	L5:20-25	20				2		2	12	2	1	1				20
	L6:25-30	7							4	1	2					7
	L7:30-35	4							3		1					4
	L8:35-40	2							2							2
	L9:40-45															0
	L10:45-50															0
	TU43	94	0	0	0	2	0	0	75	5	1	10	0	1	0	94
2/1	L1:0-5	13				1			8	1	1	2				13
	L2:5-10	8							4	1		2		1		8
	L3:10-15	13				1			10	1		1				13
	L4:15-20	7							5			2				7
	L5:20-25	11							11							11
	L6:25-30	15							13	2						15
	L7:30-35	20							18			2				20
	L8:35-40	2							2							2
	L9:40-45	1										1				1
	L10:45-50															0
2/2	L11:50-55	2							2							2
	L12:55-60	2							2							2
	L13:60-65															0
	L14:65-70															0
	L15:70-75															0
	TU27	101	1	0	1	0	0	1	69	13	0	15	0	1	0	101
3/2	L1:0-5	2							1			1				2
	L2:5-10	5							3	1		1				5
	L3:10-15	23	1						15	2		4		1		23
	L4:15-20	17							14	1		2				17
	L5:20-25	9							5	2		2				9
3/1	L6:25-30	23							14	6		3				23
	L7:30-35	12			1				10			1				12
	L8:35-40	1							1							1
	L9:40-45	2							2							2
	L10:45-50	6						1	3	1		1				6
	L11:50-55	1							1							1
	L12:55-60															0
2/1	L13:60-65															0
	TU45	72	0	0	1	1	0	0	57	3	1	8	1	0	0	72
2/1	L1:0-5															0
	L2:5-10	6							6							6
	L3:10-15	13			1				9			3				13
	L4:15-20	16				1			13			2				16
3/2	L5:20-25	22							18	2		2				22
	L6:25-30	4							3	1						4
	L7:30-35	4							3			1				4
	L8:35-40	2							2							2
	L9:40-45															0
	L10:45-50	3							2				1			3
	L11:50-55	1							1							1
	Wall scraping- 5 wall	1									1					1
	Block Total	739	3	1	3	6	2	15	517	63	14	108	4	2	1	739
	TU13	11	0	0	0	0	0	0	10	0	0	1	0	0	0	11
3/2	L1:0-5															0
	L2:5-10	4							4							4
	L3:10-15	2							2							2
	L4:15-20															0
	L5:20-25	2							2							2
4/3	L6:25-30	3							2			1				3
	L7:30-35															0
	L8:35-40															0
	TU12	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1
3/2	L1:0-5															0
	L2:5-10															0
	L3:10-15															0
	L4:15-20	1							1							1
	L5:20-25															0
4/3	L6:25-30															0
	L7:30-35															0
	L8:35-40															0

Munsell 10YR	32DI95	Lithic	Point	Biface	Scraper	Tool (fragment)	Retouched flake	Utilized Flake (expedient)	Tertiary	Secondary	Primary	Shatter	Core	Hammerstone	Tested Cobble	Lvl Subtotal
	TU40	**55**	**0**	**0**	**3**	**0**	**2**	**0**	**31**	**6**	**2**	**11**	**0**	**0**	**0**	**55**
2/2	L1:0-5															0
	L2:5-10	24					2		17	2	1	2				24
	L3:10-15	23			2				11	1	1	8				23
3/3	L4:15-20	5				1			2			1				5
3/3	L5:20-25	2							1	1						2
	L6:25-30															0
	L7:30-35															0
	Wall Scraping	1								1						1
	TU33	**25**	**1**	**0**	**0**	**0**	**0**	**1**	**13**	**7**	**0**	**3**	**0**	**0**	**0**	**25**
2/2	L1:0-5	1							1							1
	L2:5-10	5							2	2		1				5
	L3:10-15	16						1	8	5		2				16
3/3	L4:15-20	2							2							2
	L5:20-25															0
	L6:25-30	1	1													1
	L7:30-35															0
	L8:35-40															0
	TU34	**37**	**0**	**0**	**0**	**2**	**0**	**2**	**21**	**5**	**2**	**4**	**1**	**0**	**0**	**37**
2/2	L1:0-5															0
	L2:5-10	16						1	12	1	1	2	1			18
3/3	L3:10-15	15				2		1	8	3		1				15
	L4:15-20	4							1	1	1	1				4
	L5:20-25															0
	L6:25-30															0
	TU30	**31**	**0**	**0**	**0**	**0**	**0**	**0**	**19**	**9**	**2**	**1**	**0**	**0**	**0**	**31**
2/2	L1:0-5	1							1							1
	L2:5-10	24							14	9		1				24
	L3:10-15	5							4		1					5
	L4:15-20	1									1					1
3/3-5/6	L5:20-25															0
	L6:25-30															0
	TU35	**51**	**0**	**0**	**0**	**0**	**0**	**1**	**30**	**16**	**2**	**2**	**0**	**0**	**0**	**51**
2/2	L1:0-5	1							1							1
	L2:5-10	32						1	17	11	1	2				32
3/3	L3:10-15	13							9	3	1					13
	L4:15-20	5							3	2						5
	L5:20-25															0
	L6:25-30															0
	L7:30-35															0
	TU44	**21**	**0**	**0**	**0**	**0**	**0**	**0**	**13**	**1**	**0**	**7**	**0**	**0**	**0**	**21**
2/1	L1:0-5															0
	L2:5-10	15							9	1		5				15
	L3:10-15	5							3			2				5
	L4:15-20															0
3/3	L5:20-25	1							1							1
	L6:25-30															0
	L7:30-35															0
	TU41	**33**	**0**	**0**	**0**	**1**	**0**	**0**	**20**	**6**	**0**	**6**	**0**	**0**	**0**	**33**
2/1	L1:0-5	2				1			1							2
	L2:5-10	20							13	4		3				20
	L3:10-15	9							4	2		3				9
	L4:15-20	2							2							2
3/3	L5:20-25															0
	L6:25-30															0
	TU3, Phll	**62**	**0**	**0**	**0**	**0**	**0**	**0**	**55**	**4**	**2**	**1**	**0**	**0**	**0**	**62**
	L1:0-5	8							7	1						8
	L2:5-10	36							34		1	1				36
	L3:10-15	16							12	3	1					16
	L4:15-20	2							2							2
	L5:20-25															0
	L6:25-30															0
	L7:30-35															0
	L8:35-40															0
	L9:40-45															0
	L10:45-50															0
	Block Total	**315**	**1**	**0**	**3**	**3**	**2**	**4**	**202**	**54**	**10**	**35**	**1**	**0**	**0**	**315**
	TU14	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**0**	**2**	**0**	**0**	**0**	**8**
2/2	L1:0-5	6							4			2				6
	L2:5-10	2							2							2
3/4	L3:10-15															0
	L4:15-20															0
	TU15	**43**	**0**	**0**	**0**	**0**	**0**	**1**	**30**	**6**	**1**	**5**	**0**	**0**	**0**	**43**
2/2	L1:0-5	24						1	16	2	1	4				24
	L2:5-10	15							11	3		1				15
3/4	L3:10-15	1								1						1
	L4:15-20	3							3							3
	L5:20-25															0
	L6:25-30															0
	TU28	**13**	**0**	**0**	**0**	**0**	**0**	**1**	**10**	**2**	**0**	**0**	**0**	**0**	**0**	**13**
2/2	L1:0-5	5						1	4							5
	L2:5-10															0
3/3-5/3	L3:10-15	3							3							3
	L4:15-20	5							3	2						5
	L5:20-25															0
	L6:25-30															0
	Pedestrian	**62**	**1**	**1**	**0**	**2**	**1**	**2**	**42**	**2**	**5**	**4**	**1**	**0**	**1**	**62**
	2-Track	62	1	1		2	1	2	42	2	5	4	1		1	62
	Cairn Finds	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**0**	**1**	**1**	**0**	**0**	**6**
	Rock alignment, NW	4							3			1				4
	Rock alignment, SE	1							1							1
	Cairn find 1	1											1			1

Munsell 10YR	32DI95	Lithic	Point	Biface	Scraper	Tool (fragment)	Retouched flake	Utilized Flake (expedient)	Tertiary	Secondary	Primary	Shatter	Core	Hammerstone	Tested Cobble	Lvl Subtotal
	TU39	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**3**
2/1	L1:0-5	1							1							1
	L2:5-10															0
	L3:10-15	2							2							2
	L4:15-20															0
3/3	L5:20-25															0
	L6:25-30															0
	TU29	**51**	**0**	**0**	**0**	**0**	**0**	**0**	**37**	**9**	**0**	**5**	**0**	**0**	**0**	**51**
2/1	L1:0-5															0
	L2:5-10	1							1							1
	L3:10-15	1								1						1
	L4:15-20	4							2			2				4
	L5:20-25	4							2	1		1				4
	L6:25-30	4							3			1				4
3/3	L7:30-35	10							9			1				10
	L8:35-40	14							12	2						14
	L9:40-45	9							5	4						9
	L10:45-50	4							3	1						4
	L11:50-55															0
4/4	L12:55-60															0
	TU16	**37**	**0**	**0**	**0**	**0**	**0**	**1**	**27**	**5**	**2**	**2**	**0**	**0**	**0**	**37**
2/1	L1:0-5															0
	L2:5-10															0
	L3:10-15	4						1	3							4
	L4:15-20	7							4		1	2				7
	L5:20-25	3							3							3
	L6:25-30	5							2	2	1					5
	L7:30-35	3							3							3
3/3	L8:35-40	4							3	1						4
	L9:40-45	2							2							2
	L10:45-50	6							5	1						6
	L11:50-55	2							1	1						2
	L12:55-60	1							1							1
5/4	L13:60-65															0
	TU17	**20**	**0**	**0**	**0**	**0**	**0**	**2**	**15**	**1**	**0**	**2**	**0**	**0**	**0**	**20**
2/1	L1:0-5															0
	L2:5-10															0
	L3:10-15	5						1	4							5
	L4:15-20	1										1				1
	L5:20-25	1							1							1
	L6:25-30	1								1						1
	L7:30-35															0
3/3	L8:35-40	2							2							2
	L9:40-45	9						1	7			1				9
	L10:45-50	1							1							1
	L11:50-55	0														0
	L12:55-60	0														0
5/4	L13:60-65	0														0
	L14:65-70	0														0
	TU4, PhII	**42**	**0**	**0**	**0**	**0**	**1**	**0**	**35**	**5**	**0**	**1**	**0**	**0**	**0**	**42**
	L1:0-5															0
	L2:5-10	3							2			1				3
	L3:10-15	2							1	1						2
	L4:15-20	3					1		2							3
	L5:20-25	3							3							3
	L6:25-30	10							6	4						10
	L7:30-35	13							13							13
	L8:35-40															0
	L9:40-45															0
	L10:45-50	6							6							6
	L11:50-55	2							2							2
	TU18	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
2/2	L1:0-5															0
	L2:5-10															0
	L3:10-15	2			1				1							2
3/2	L4:15-20															0
	L5:20-25															0
	L6:25-30															0
	TU19	**4**	**0**	**1**	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**4**
2/2	L1:0-5															0
	L2:5-10	1						1								1
	L3:10-15	2		1					1							2
	L4:15-20	1			1											1
3/2	L5:20-25															0
	L6:25-30															0
	L7:30-35															0
	TU20	**9**	**0**	**0**	**0**	**1**	**1**	**0**	**3**	**0**	**0**	**4**	**0**	**0**	**0**	**9**
2/2	L1:0-5	5							3			2				5
	L2:5-10	1					1									1
3/3	L3:10-15	1				1										1
	L4:15-20	2										2				2
	L5:20-25															0
	TU21	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**2**
2/2	L1:0-5															0
	L2:5-10	2								1		1				2
3/3	L3:10-15															0
4/4	L4:15-20															0
	L5:20-25															0

Munsell 10YR	32DI95	Lithic	Point	Biface	Scraper	Tool (fragment)	Retouched flake	Utilized Flake (expedient)	Tertiary	Secondary	Primary	Shatter	Core	Hammerstone	Tested Cobble	Lvl Subtotal
	TU48	20	0	1	0	1	0	0	10	2	1	5	0	0	0	20
3/2	L1:0-5	1							1							1
	L2:5-10	1		1												1
	L3:10-15	4							3		1					4
	L4:15-20	9				1			4	2		2				9
3/2	L5:20-25															0
	L6:25-30	5							2			3				5
3/3-3/4	L7:30-35															0
	L8:35-40															0
	L9:40-45															0
	L10:45-50															0
	TU36	18	0	0	0	0	0	1	11	1	0	5	0	0	0	18
2/2	L1:0-5	1										1				1
	L2:5-10	4							2	1		1				4
3/3	L3:10-15	8							6			2				8
	L4:15-20	4						1	3							4
	L5:20-25															0
	L6:25-30	1										1				1
	L7:30-35															0
	L8:35-40															0
	TU22	17	0	0	0	0	0	2	9	2	0	4	0	0	0	17
2/2	L1:0-5	1							1							1
	L2:5-10	7						1	3	1		2				7
	L3:10-15	3							1	1		1				3
	L4:15-20	5						1	3			1				5
3/3	L5:20-25	1							1							1
	L6:25-30															0
	L7:30-35															0
	TU23	25	0	0	0	0	0	0	14	3	3	5	0	0	0	25
2/2	L1:0-5	1							1							1
	L2:5-10	3							1		2					3
	L3:10-15	10							5	1	1	3				10
3/3	L4:15-20	7							5			2				7
	L5:20-25	4							2	2						4
	L6:25-30															0
	L7:30-35															0
	TU24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	L1:0-5															0
	Construction Monitoring	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15-20	0														0
	Site Total	1798	8	6	12	16	9	37	1214	192	51	238	11	2	2	1798

APPENDIX G: ARTIFACT DATA SHEETS

APPENDIX G1: Projectile Point Data Sheets

Projectile Point Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1265.1, 1265.2**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **3**
Depth: **5 – 10 cmbs**

Morphological Attributes
Point Type: **Duncan**
Blade Form: **Excurvate**
Haft Element Configuration: **Stemmed bifurcated**
Basal Edge Form: **Concave**
Cross-Section: **Lenticular**
Reduction Stage: **III**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Edge-Grinding: **Basal**
Flake Pattern: **Serrated edge**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **46.9 mm**
Maximum Width: **21.2 mm**
Maximum Thickness: **5.9 mm**
Blade Length: **28.7 mm**
Haft Element Length: **7.6 mm**
Weight: **6.3 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Middle Plains Archaic**

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Westwood Professional Services
7699 Anagram Drive
Eden Prairie, MN 55344

PHONE 952-937-5150
FAX 952-937-5822
TOLL FREE 1-888-937-5150

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Projectile Point Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1007.3**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **1**
Depth: **15 – 20 cmbs**

Morphological Attributes
Point Type: **McKean Lanceolate**
Blade Form: **N/A**
Haft Element Configuration: **Basal notched**
Basal Edge Form: **Concave**
Cross-Section: **Lenticular**
Reduction Stage: **III**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Edge-Grinding: **Basal**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **26.6 mm**
Maximum Width: **3.3 mm**
Maximum Thickness: **20.9 mm**
Blade Length: **N/A**
Haft Element Length: **2.8 mm**
Weight: **1.8 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Middle Plains Archaic**

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Projectile Point Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1259.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **2**
Depth: **10 – 15 cmbs**

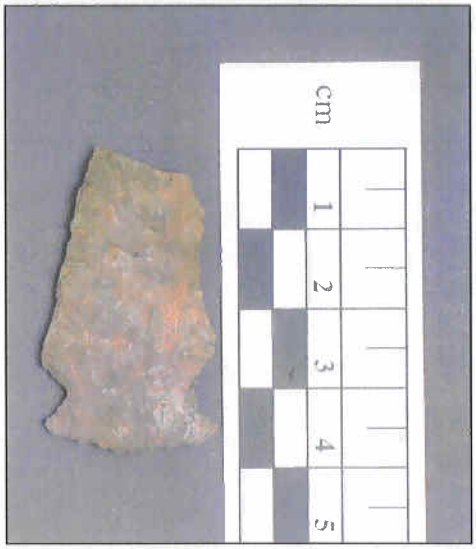
Morphological Attributes
Point Type: **Besant**
Blade Form: **Straight, resharpened to incurvate**
Haft Element Configuration: **Corner notched**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**
Reduction Stage: **III**

Technological Attributes
Raw Material: **Fusilinid Chert**
Heat-Treatment: **No**

Edge-Grinding: **No**
Flake Pattern: **Serrated edge**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **38.2 mm**
Maximum Width: **22.1 mm**
Maximum Thickness: **6.0 mm**
Blade Length: **N/A**
Haft Element Length: **6.7 mm**
Weight: **5.0 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Initial Woodland**

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Projectile Point Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1291.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **III - 33**
Depth: **25 - 30 cmbs**

Morphological Attributes
Point Type: **Hanna**
Blade Form: **Recurvate**
Haft Element Configuration: **Auriculate**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**
Reduction Stage: **III**

Technological Attributes
Raw Material: **Tongue River Silica**
Heat-Treatment: **Yes**
Edge-Grinding: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **27.3 mm**
Maximum Width: **16.4 mm**
Maximum Thickness: **3.1 mm**
Blade Length: **N/A**
Haft Element Length: **4.9 mm**
Weight: **1.8 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Middle Plains Archaic**

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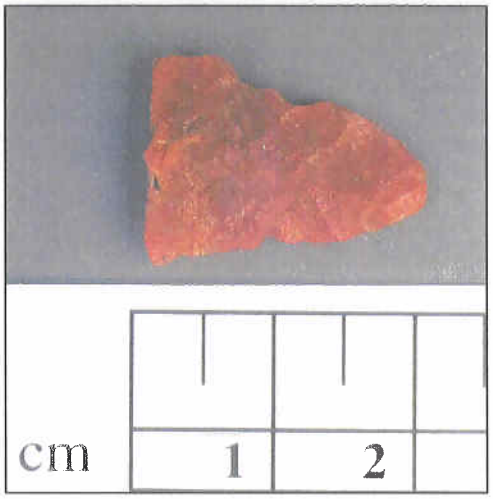
Projectile Point Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1170.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **38**
Depth: **10 – 15 cmbs**

Morphological Attributes
Point Type: **Unidentifiable**
Blade Form: **N/A**
Haft Element Configuration: **N/A**
Basal Edge Form: **N/A**
Cross-Section: **Lenticular**
Reduction Stage: **III**

Technological Attributes
Raw Material: **Hixton Silicified Sandstone**
Heat-Treatment: **Yes**
Edge-Grinding: **N/A**
Flake Pattern: **Serrated edge**



Metric Attributes
Maximum Length: **21.5 mm**
Maximum Width: **14.6 mm**
Maximum Thickness: **3.5 mm**
Blade Length: **N/A**
Haft Element Length: **N/A**
Weight: **1.0 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Unknown**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008

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Projectile Point Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1123.2**

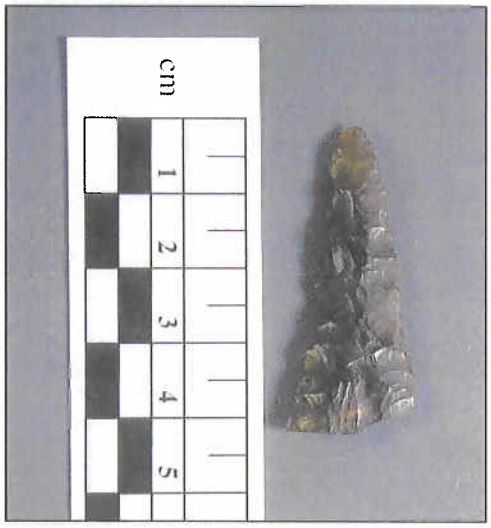
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **27**
Depth: **10 – 15 cmbs**

Morphological Attributes
Point Type: **Unidentified**
Blade Form: **Incurvate**
Haft Element Configuration: **N/A**
Basal Edge Form: **N/A**
Cross-Section: **Lenticular**
Reduction Stage: **III**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Edge-Grinding: **N/A**
Flake Pattern: **Serrated edge**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **4.2 mm**
Maximum Width: **17.5 mm**
Maximum Thickness: **4.8 mm**
Blade Length: **N/A**
Haft Element Length: **N/A**
Weight: **3.1 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Basalt hammerstone, debitage**
Historic Context: **Prehistoric**
Type Designation: **Unknown**

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Projectile Point Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1051.3**

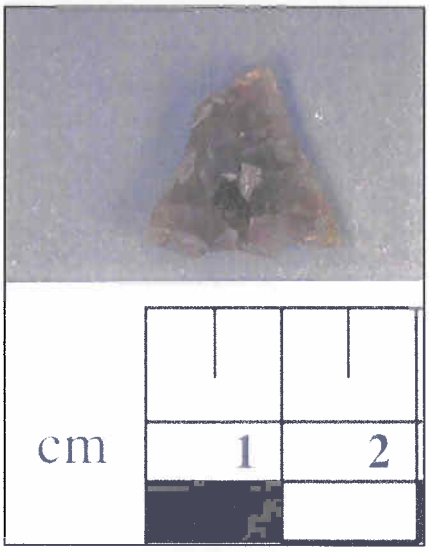
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **11**
Depth: **20 – 25 cmbs**

Morphological Attributes
Point Type: **Unidentifiable**
Blade Form: **N/A**
Haft Element Configuration: **N/A**
Basal Edge Form: **N/A**
Cross-Section: **Lenticular**
Reduction Stage: **III**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Edge-Grinding: **N/A**
Flake Pattern: **Serrated edge**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **14.7 mm**
Maximum Width: **14.6 mm**
Maximum Thickness: **2.5 mm**
Blade Length: **N/A**
Haft Element Length: **N/A**
Weight: **0.6 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint utilized flakes, debitage**
Historic Context: **Prehistoric**
Type Designation: **Unknown**

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Projectile Point Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1029.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **7**
Depth: **5 – 10 cmbs**

Morphological Attributes
Point Type: **Unidentified**
Blade Form: **N/A**
Haft Element Configuration: **Stemmed expanding**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**
Reduction Stage: **III**

Technological Attributes
Raw Material: **Silicified Wood**
Heat-Treatment: **No**
Edge-Grinding: **Basal and notch**
Flake Pattern: **Serrated Edge**

Comments: Certain morphological traits may be consistent with McKean/Duncan/Hanna framework.

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **22.9 mm**
Maximum Width: **4.6 mm**
Maximum Thickness: **18.4 mm**
Blade Length: **N/A**
Haft Element Length: **10.7 mm**
Weight: **1.9 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Possible Plains Archaic**

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APPENDIX G2: Biface Data Sheets

Biface Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1234.1**

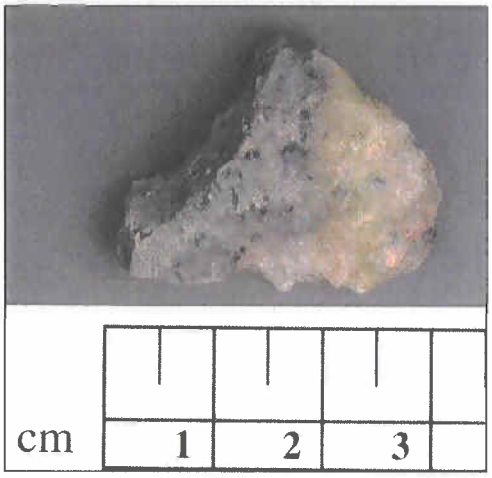
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **48**
Depth: **5 – 10 cmbs**

Morphological Attributes
Type: **Biface tip fragment**
Reduction Stage: **III**
Basal Edge Form: **N/A**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Swan River Chert**
Heat-Treatment: **No**
Edge-Grinding: **N/A**
Flake Pattern: **Serrated edge**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **30.0 mm**
Maximum Width: **22.8 mm**
Maximum Thickness: **8.7 mm**
Length/Width: **1.32**
Width/Length: **0.76**
Weight: **5.2 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Biface Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1086.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **19**
Depth: **10 – 15 cmbs**

Morphological Attributes
Type: **Biface**
Reduction Stage: **III**
Basal Edge Form: **Concave**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Fusilinid Chert**
Heat-Treatment: **No**
Edge-Grinding: **No**
Flake Pattern: **Serrated edge**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **50.8 mm**
Maximum Width: **34.3 mm**
Maximum Thickness: **9.4 mm**
Length/Width: **1.48**
Width/Length: **0.68**
Weight: **17.6 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Biface Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1034.1**

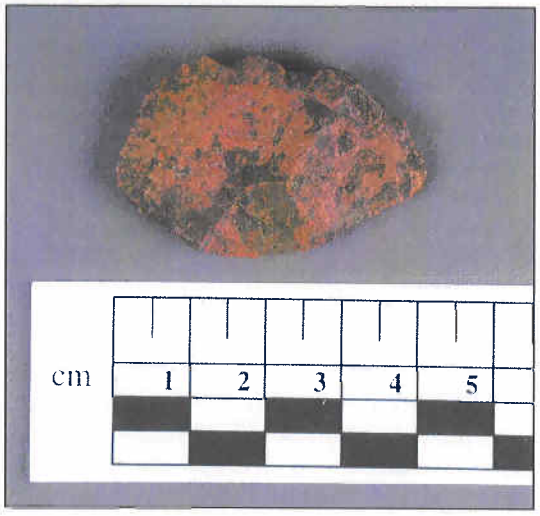
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **8**
Depth: **20 – 25 cmbs**

Morphological Attributes
Type: **Biface**
Reduction Stage: **III**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Tongue River Silica**
Heat-Treatment: **Yes**
Edge-Grinding: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **70.6 mm**
Maximum Width: **25.6 mm**
Maximum Thickness: **7.3 mm**
Length/Width: **2.76**
Width/Length: **0.36**
Weight: **6.9 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Biface Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1248.56**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **None**
Depth: **Surface**

Morphological Attributes
Type: **Biface**
Reduction Stage: **III**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Red River Chert**
Heat-Treatment: **Yes**
Edge-Grinding: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **44.4 mm**
Maximum Width: **31.8 mm**
Maximum Thickness: **12.2 mm**
Length/Width: **2.61**
Width/Length: **0.38**
Weight: **17.2 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Surface find**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Biface Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1248.54**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **None**
Depth: **Surface**

Morphological Attributes
Point Type: **Unidentifiable**
Reduction Stage: **III**
Basal Edge Form: **N/A**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Red River Chert**
Heat-Treatment: **No**
Edge-Grinding: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **16.3 mm**
Maximum Width: **18.1 mm**
Maximum Thickness: **1.6 mm**
Length/Width: **0.9**
Width/Length: **1.1**
Weight: **1.0 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Surface find**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Biface Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1261.1**

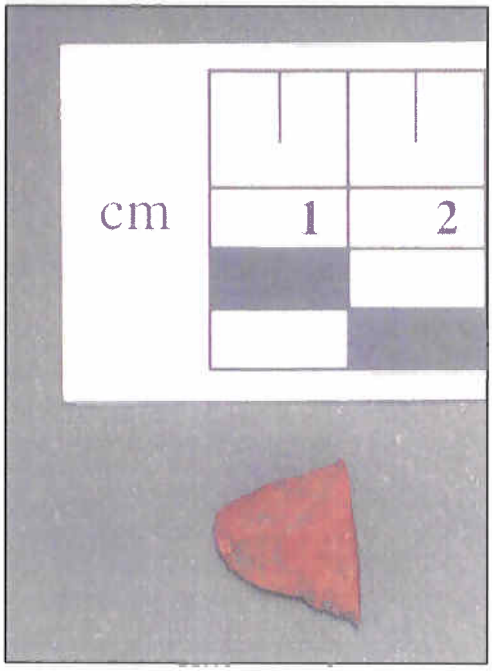
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **2**
Depth: **20 – 25 cmbs**

Morphological Attributes
Type: **Biface**
Reduction Stage: **III**
Basal Edge Form: **N/A**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Porcellanite**
Heat-Treatment: **No**
Edge-Grinding: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **12.8 mm**
Maximum Width: **12.0 mm**
Maximum Thickness: **1.1 mm**
Length/Width: **1.07**
Width/Length: **0.94**
Weight: **0.4 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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APPENDIX G3: Scraper Data Sheets

Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1087.1**

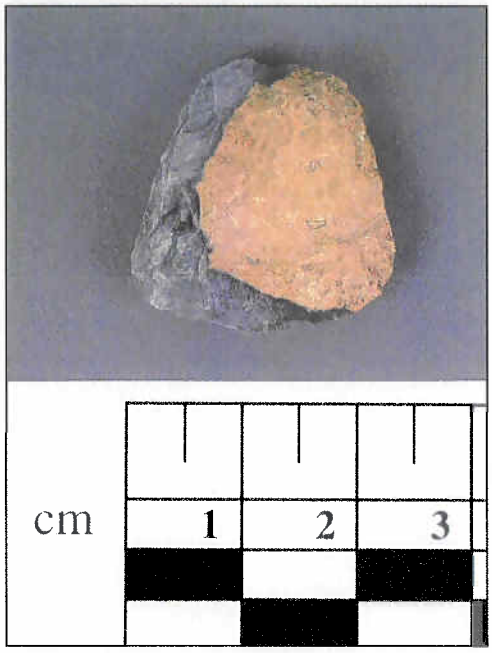
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **19**
Depth: **15 – 20 cmbs**

Morphological Attributes
Type: **Scraper**
Reduction Stage: **III**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Edge-Grinding: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **24.8 mm**
Maximum Width: **22.3 mm**
Maximum Thickness: **6.3 mm**
Length/Width: **1.11**
Width/Length: **9.0**
Weight: **4.0 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1106.1**



Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **25**
Depth: **20 – 25 cmbs**

Metric Attributes
Maximum Length: **27.6 mm**
Maximum Width: **16.1 mm**
Maximum Thickness: **5.2 mm**
Weight: **1.9 g**
Burning/Weathering: **No**

Morphological Attributes
Tool Type: **Side scraper**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Rhomboid**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Cultural Affiliation
Associated Finds: **Jasper scraper, Swan River Chert retouched flake, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1106.2**

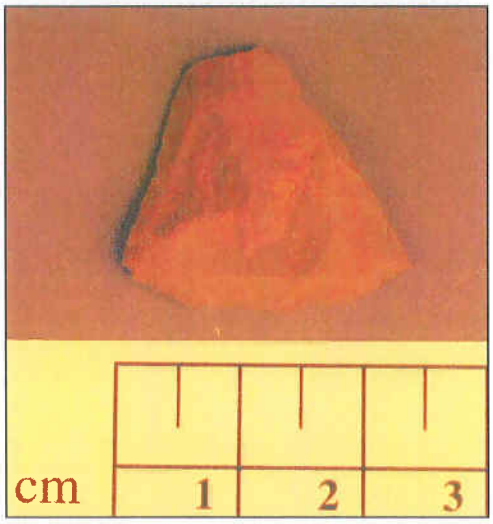
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **25**
Depth: **20 – 25 cmbs**

Morphological Attributes
Tool Type: **Scraper**
Reduction Method: **Chipped**
Basal Edge Form: **Straight**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Jasper**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **22.9 mm**
Maximum Width: **20.1 mm**
Maximum Thickness: **4.7 mm**
Weight: **2.3 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint scraper, Swan River Chert retouched flake, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1178.2**

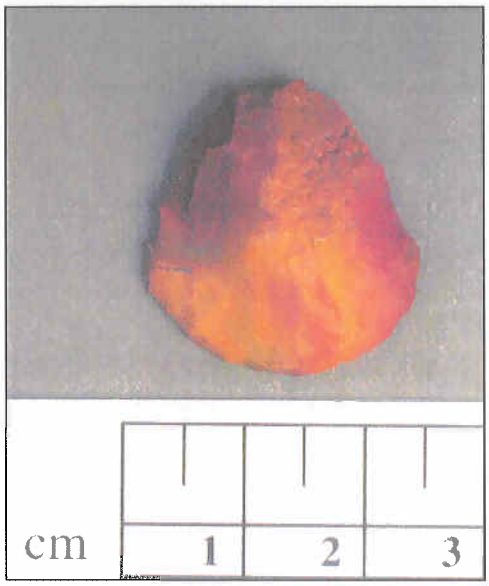
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **40**
Depth: **10 – 15 cmbs**

Morphological Attributes
Tool Type: **Scraper**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Tongue River Silica**
Heat-Treatment: **Yes**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **24.1 mm**
Maximum Width: **22.5 mm**
Maximum Thickness: **5.7 mm**
Weight: **3.3 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint scraper, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1178.1**

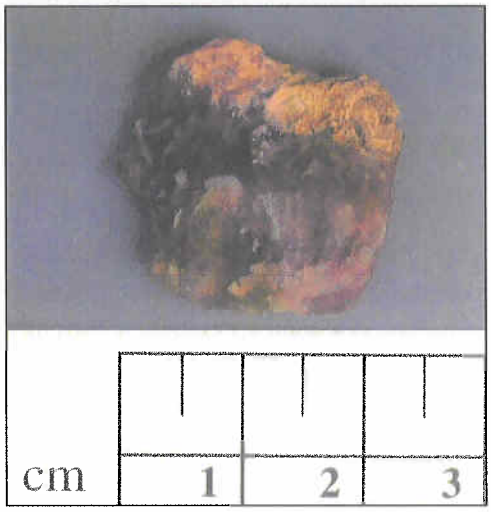
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **40**
Depth: **10 – 15 cmbs**

Morphological Attributes
Tool Type: **Scraper**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **24.9 mm**
Maximum Width: **23.9 mm**
Maximum Thickness: **5.5 mm**
Weight: **3.2 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Tongue River Silica scraper, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1050.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **11**
Depth: **15 – 20 cmbs**

Morphological Attributes
Tool Type: **Scraper**
Reduction Method: **Chipped**
Basal Edge Form: **Straight**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **27.6 mm**
Maximum Width: **19.8 mm**
Maximum Thickness: **4.9 mm**
Weight: **2.9 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Tongue River Silica retouched flake, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1084.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **18**
Depth: **10 - 15 cmbs**

Morphological Attributes
Tool Type: **Concave Scraper**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **37.6 mm**
Maximum Width: **19.2 mm**
Maximum Thickness: **4.7 mm**
Weight: **3.4 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1127.1**

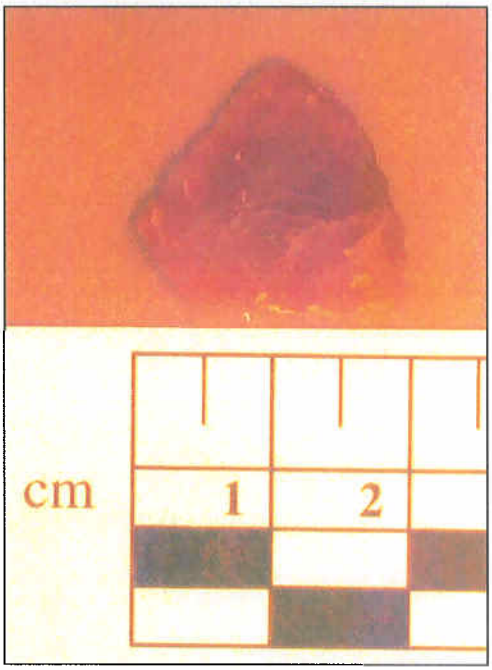
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **27**
Depth: **30 – 35 cmbs**

Morphological Attributes
Tool Type: **Scraper**
Reduction Method: **Chipped**
Basal Edge Form: **Straight**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **19.7 mm**
Maximum Width: **18.9 mm**
Maximum Thickness: **3.6 mm**
Weight: **1.4 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1166.1**

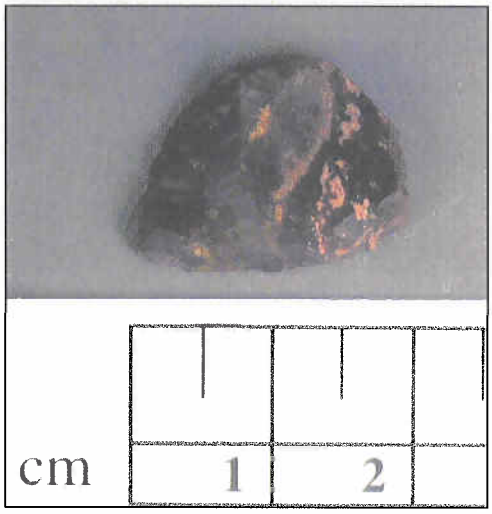
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **37**
Depth: **15 – 20 cmbs**

Morphological Attributes
Tool Type: **Scraper**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Rhomboid**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **20.5 mm**
Maximum Width: **14.5 mm**
Maximum Thickness: **4.2 mm**
Weight: **1.8 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Swan River Chert utilized flake, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1172.1**

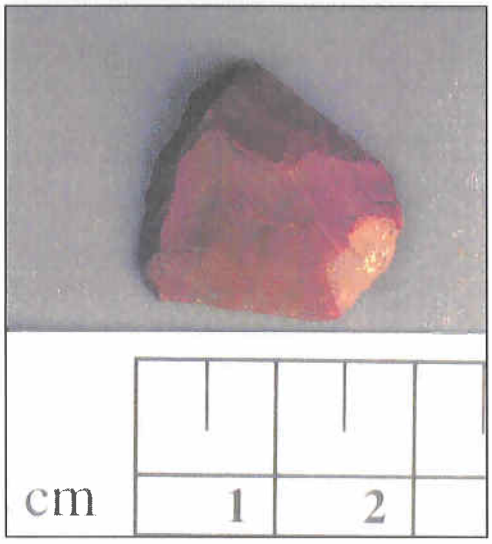
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **38**
Depth: **20 – 25 cmbs**

Morphological Attributes
Tool Type: **Scraper**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Tongue River Silica**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **19.2 mm**
Maximum Width: **18.2 mm**
Maximum Thickness: **4.7 mm**
Weight: **1.7 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1179.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **40**
Depth: **15 – 20 cmbs**

Morphological Attributes
Tool Type: **Scraper**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **22.8 mm**
Maximum Width: **21.0 mm**
Maximum Thickness: **5.9 mm**
Weight: **3.2 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1211.1**

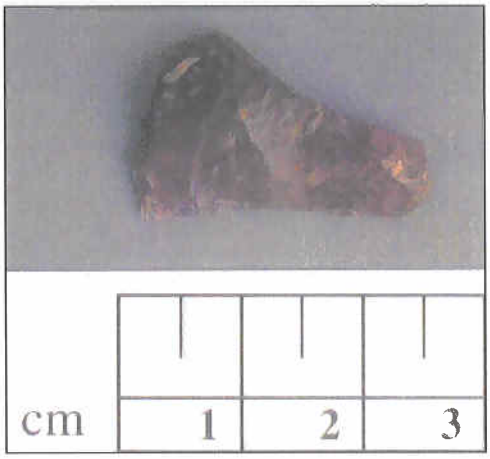
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **45**
Depth: **10 – 15 cmbs**

Morphological Attributes
Tool Type: **Scraper fragment**
Reduction Method: **Chipped**
Basal Edge Form: **Concave**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **24.5 mm**
Maximum Width: **16.0 mm**
Maximum Thickness: **4.7 mm**
Weight: **1.8 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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APPENDIX G4: Tool Data Sheets

Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1255.11**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **1**
Depth: **25 – 30 cmbs**

Morphological Attributes
Tool Type: **Grooved maul**
Reduction Method: **Ground**
Basal Edge Form: **Convex**
Cross-Section: **Round**

Technological Attributes
Raw Material: **Basalt**
Heat-Treatment: **No**
Edge-Grinding: **Surface pecking and grinding**
Flake Pattern: **None**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **114.2 mm**
Maximum Width: **95.0 mm**
Maximum Thickness: **86.7 mm**
Weight: **963.8 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **None**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1241.2**

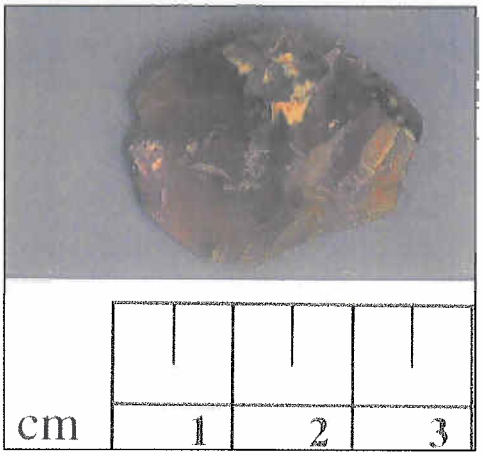
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **49**
Depth: **20 – 25 cmbs**

Morphological Attributes
Tool Type: **Tool fragment**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **24.1 mm**
Maximum Width: **18.6 mm**
Maximum Thickness: **4.1 mm**
Weight: **2.0 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint tool fragment, Knife River Flint utilized flakes, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1241.1**

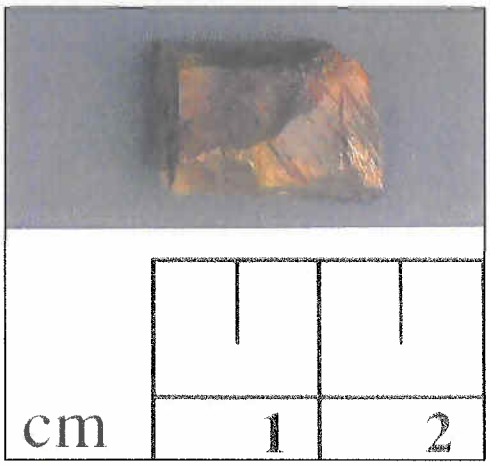
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI95**
Unit: **49**
Depth: **20 – 25 cmbs**

Morphological Attributes
Tool Type: **Tool fragment**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **16.6 mm**
Maximum Width: **10.0 mm**
Maximum Thickness: **3.4 mm**
Weight: **0.8 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint tool fragment, Knife River Flint utilized flakes, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1238.1**

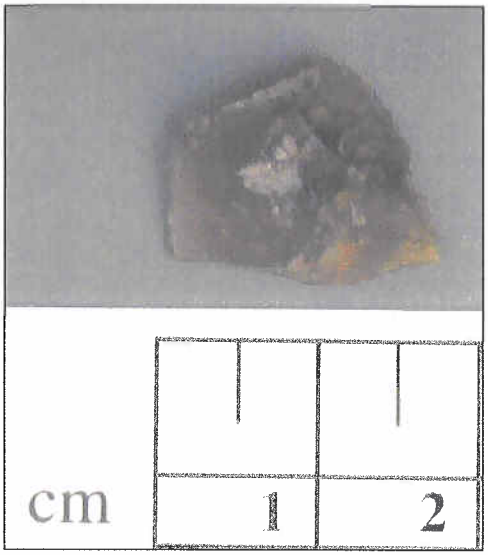
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **49**
Depth: **5 – 10 cmbs**

Morphological Attributes
Tool Type: **Tool fragment**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **17.4 mm**
Maximum Width: **14.1 mm**
Maximum Thickness: **3.4 mm**
Weight: **0.7 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1236.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **48**
Depth: **15 – 20 cmbs**

Morphological Attributes
Tool Type: **Tool fragment**
Reduction Method: **Chipped**
Basal Edge Form: **Straight**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Quartz**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **22.9 mm**
Maximum Width: **16.1 mm**
Maximum Thickness: **5.3 mm**
Weight: **2.0 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1212.1**

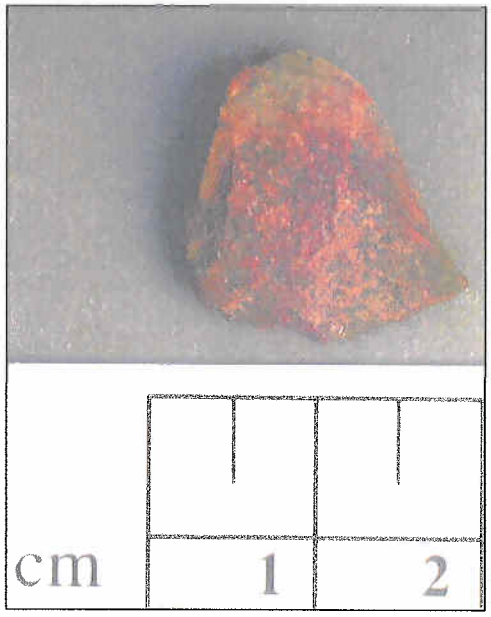
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **45**
Depth: **15 – 20 cmbs**

Morphological Attributes
Tool Type: **Tool fragment**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Tongue River Silica**
Heat-Treatment: **Yes**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **18.5 mm**
Maximum Width: **14.7 mm**
Maximum Thickness: **5.5 mm**
Weight: **1.4 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1196.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **42**
Depth: **0 – 5 cmbs**

Morphological Attributes
Tool Type: **Tool fragment**
Reduction Method: **Chipped**
Basal Edge Form: **Straight**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **25.4 mm**
Maximum Width: **20.2 mm**
Maximum Thickness: **4.2 mm**
Weight: **2.6 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1182.1**

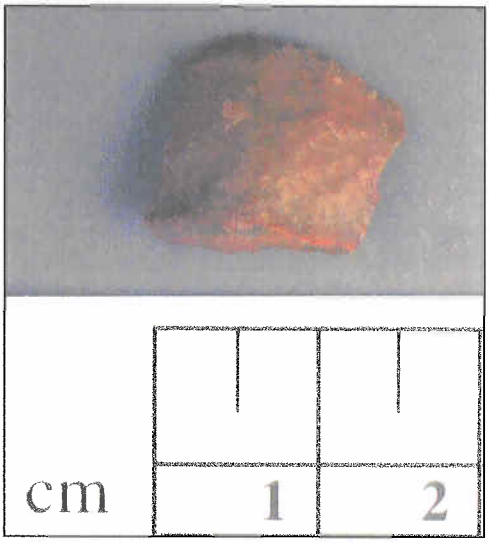
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **41**
Depth: **0 – 5 cmbs**

Morphological Attributes
Tool Type: **Tool fragment**
Reduction Method: **Chipped**
Basal Edge Form: **Straight**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Tongue River Silica**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **17.1 mm**
Maximum Width: **13.5 mm**
Maximum Thickness: **5.9 mm**
Weight: **1.4 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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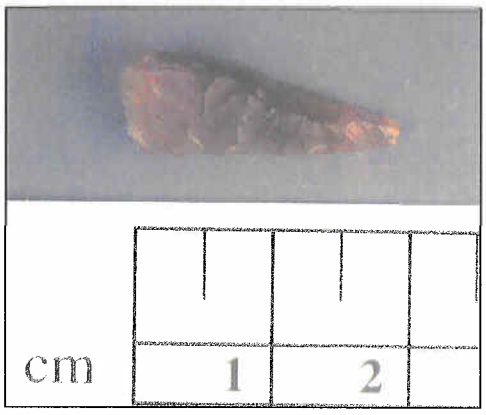
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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1293.1**



Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **35**
Depth: **5 – 10 cmbs**

Morphological Attributes
Tool Type: **Drill tip**
Reduction Method: **Chipped**
Basal Edge Form: **N/A**
Cross-Section: **Round**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Metric Attributes
Maximum Length: **20.8 mm**
Maximum Width: **7.5 mm**
Maximum Thickness: **4.4 mm**
Weight: **0.6 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Quartzite possible hand ax, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1248.57**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **None**
Depth: **Surface**

Morphological Attributes
Tool Type: **Drill fragment**
Reduction Method: **Chipped**
Basal Edge Form: **N/A**
Cross-Section: **Round**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Edge-Grinding: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **23.9 mm**
Maximum Width: **2.4 mm**
Maximum Thickness: **1.9 mm**
Weight: **1.4 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Surface find**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1104.1**

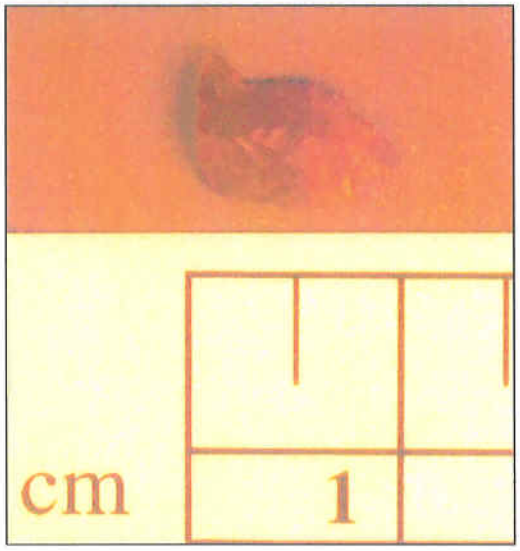
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **25**
Depth: **10 – 15 cmbs**

Morphological Attributes
Tool Type: **Uniface tip**
Reduction Method: **Chipped**
Basal Edge Form: **N/A**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **10.4 mm**
Maximum Width: **6.5 mm**
Maximum Thickness: **2.0 mm**
Weight: **0.1 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint uniface tip, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1025.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **6**
Depth: **5 – 10 cmbs**

Morphological Attributes
Tool Type: **Tool Fragment**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **22.1 mm**
Maximum Width: **8.5 mm**
Maximum Thickness: **3.6 mm**
Weight: **0.8 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1282.1, 1282.2**

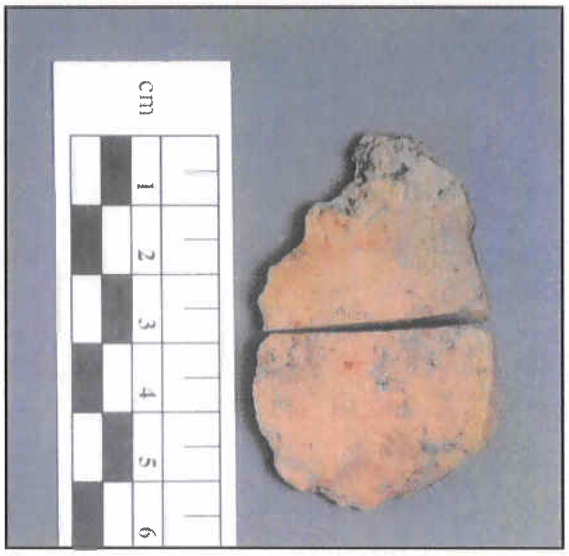
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **ST P2-16**
Depth: **30 cmbs**

Morphological Attributes
Tool Type: **Uniface tool fragments**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Uniface**

Technological Attributes
Raw Material: **Swan River Chert**
Heat-Treatment: **Yes**
Edge-Grinding: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **53.6 mm**
Maximum Width: **35.9 mm**
Maximum Thickness: **5.5 mm**
Weight: **21.8 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage in STP**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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APPENDIX G5: Hammerstone Data Sheets

Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1123.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **27**
Depth: **10 – 15 cmbs**

Morphological Attributes
Tool Type: **Hammerstone**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Round**

Technological Attributes
Raw Material: **Basalt**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **133.6 mm**
Maximum Width: **92.6 mm**
Maximum Thickness: **73.0 mm**
Weight: **1276.0 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint point tip, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1197.1**

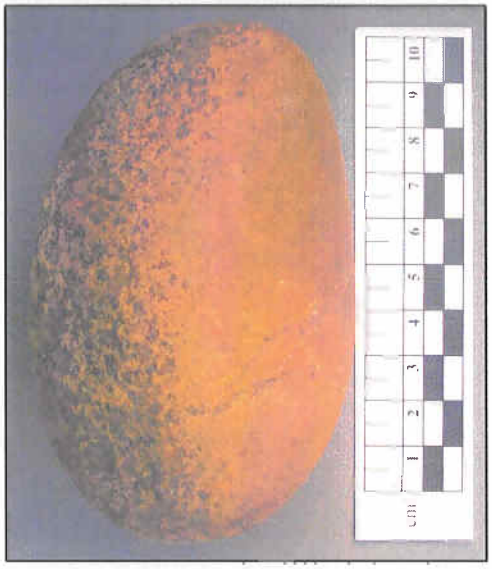
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **43**
Depth: **5 – 10 cmbs**

Morphological Attributes
Tool Type: **Hammerstone**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Round**

Technological Attributes
Raw Material: **Basalt**
Heat-Treatment: **No**
Flake Pattern: **None**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **104 mm**
Maximum Width: **63.5 mm**
Maximum Thickness: **49.7 mm**
Weight: **562.0 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Faunal, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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APPENDIX G6: Selected Retouched Flake Data Sheets

Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1177.2**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **40**
Depth: **5 – 10 cmbs**

Morphological Attributes
Tool Type: **Retouched flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Median Ridge**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **24.7 mm**
Maximum Width: **20.0 mm**
Maximum Thickness: **7.1 mm**
Weight: **2.4 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Red River Chert retouch flake, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1177.1**

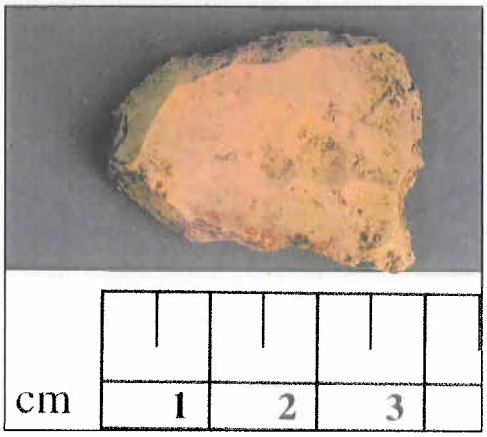
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **40**
Depth: **5 – 10 cmbs**

Morphological Attributes
Tool Type: **Retouched Flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Red River Chert**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **30.8 mm**
Maximum Width: **21.7 mm**
Maximum Thickness: **7.5 mm**
Weight: **5.2 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint retouched flake, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1106.3**

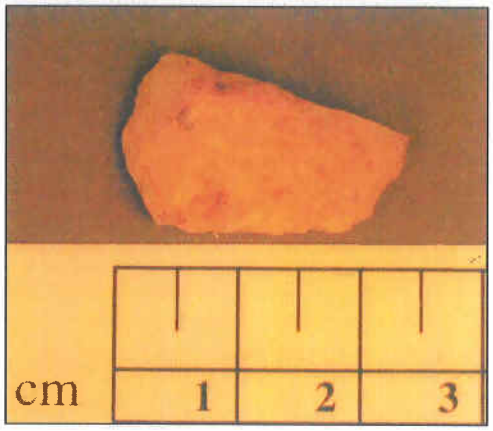
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **25**
Depth: **20 – 25 cmbs**

Morphological Attributes
Tool Type: **Retouched flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Swan River Chert**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **23.3 mm**
Maximum Width: **13.8 mm**
Maximum Thickness: **5.9 mm**
Weight: **2.1 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Jasper scraper, Knife River Flint scraper, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1050.2**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **11**
Depth: **15 – 20 cmbs**

Morphological Attributes
Tool Type: **Retouched Flake**
Reduction Method: **Chipped**
Basal Edge Form: **Concave**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Tongue River Silica**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **45.1 mm**
Maximum Width: **43.8 mm**
Maximum Thickness: **10.5 mm**
Weight: **16.0 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint scraper, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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APPENDIX G7: Selected Utilized Flakes

Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1241.4**

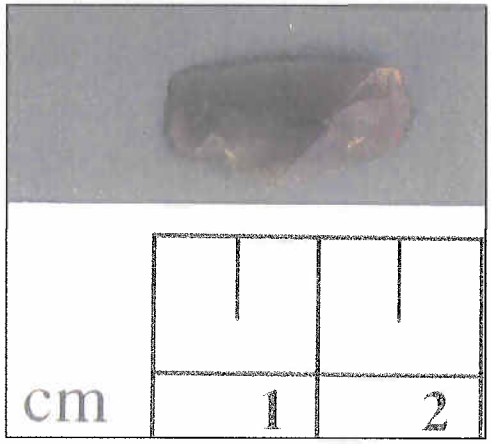
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **49**
Depth: **20 – 25 cmbs**

Morphological Attributes
Tool Type: **Utilized flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **14.8 mm**
Maximum Width: **7.7 mm**
Maximum Thickness: **2.6 mm**
Weight: **0.3 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint tool fragment, Knife River Flint utilized flake, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1241.3**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **49**
Depth: **20 – 25 cmbs**

Morphological Attributes
Tool Type: **Utilized flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **14.3 mm**
Maximum Width: **12.2 mm**
Maximum Thickness: **1.9 mm**
Weight: **0.3 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint tool fragments, Knife River Flint utilized flake, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1239.1**

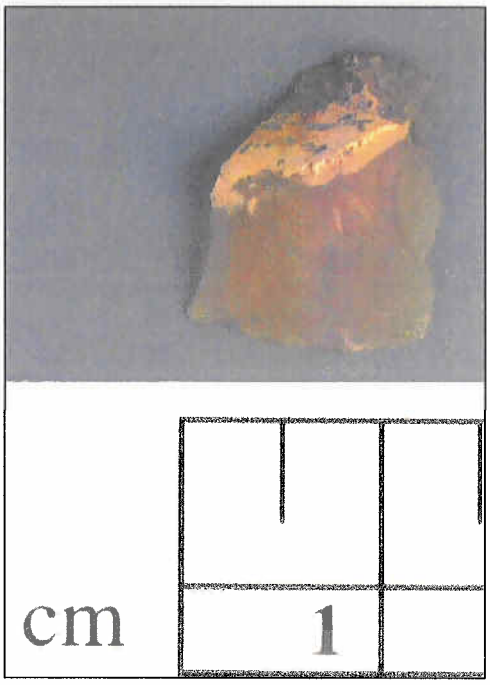
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **49**
Depth: **10 – 15 cmbs**

Morphological Attributes
Tool Type: **Utilized flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **16.9 mm**
Maximum Width: **12.2 mm**
Maximum Thickness: **3.5 mm**
Weight: **0.5 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1221.1**

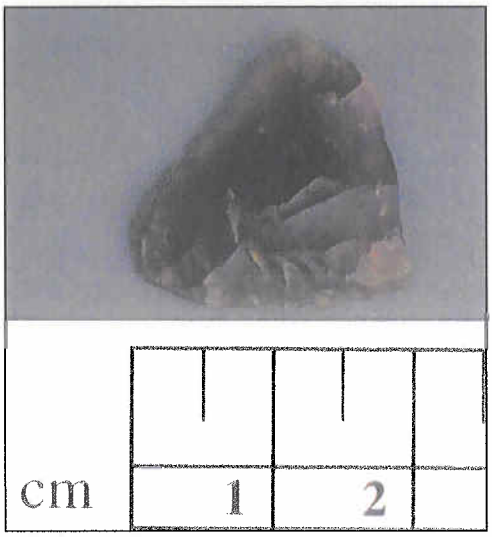
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **46**
Depth: **10 – 15 cmbs**

Morphological Attributes
Tool Type: **Utilized flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **21 mm**
Maximum Width: **17.8 mm**
Maximum Thickness: **2.6 mm**
Weight: **1.3 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1293.2**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **35**
Depth: **5 – 10 cmbs**

Morphological Attributes
Tool Type: **Utilized flake**
Reduction Method: **Chipped, possible pecked groove**
Basal Edge Form: **Convex**
Cross-Section: **Round**

Technological Attributes
Raw Material: **Quartzite**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments: Possible hand axe.

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **100.5 mm**
Maximum Width: **89.5 mm**
Maximum Thickness: **22.3 mm**
Weight: **236.7 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint drill tip, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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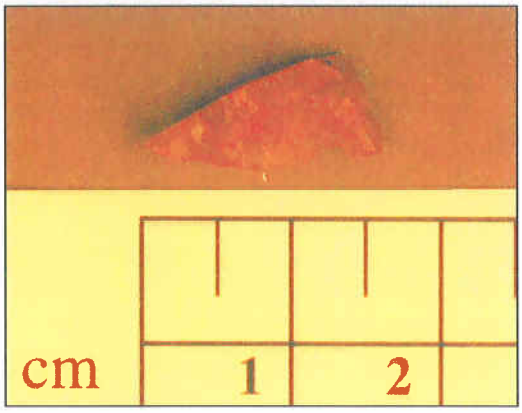
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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1132.1**



Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **28**
Depth: **0 –5 cmbs**

Morphological Attributes
Tool Type: **Utilized flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Metric Attributes
Maximum Length: **15.8 mm**
Maximum Width: **7.1 mm**
Maximum Thickness: **2.9 mm**
Weight: **0.4 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1105.3**

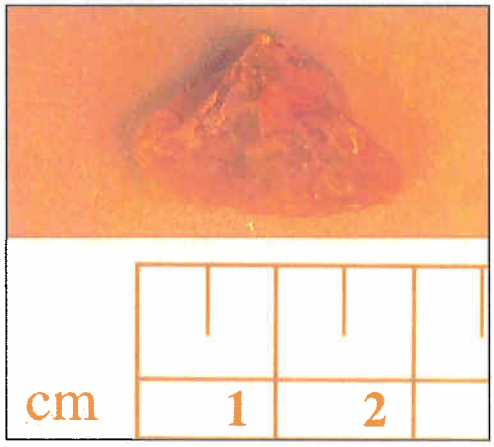
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **25**
Depth: **15 – 20 cmbs**

Morphological Attributes
Tool Type: **Utilized flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **19.5 mm**
Maximum Width: **13.4 mm**
Maximum Thickness: **6.1 mm**
Weight: **1.3 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint uniface tool, Knife River Flint possible tool, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1105.2**

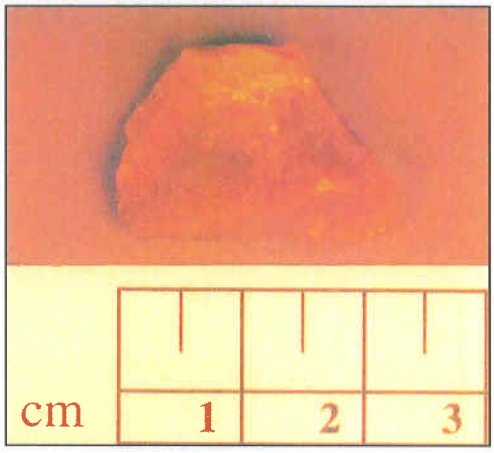
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **25**
Depth: **15 – 20 cmbs**

Morphological Attributes
Tool Type: **Utilized flake**
Reduction Method: **Chipped**
Basal Edge Form: **Slight-concave**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **23.0 mm**
Maximum Width: **13.2 mm**
Maximum Thickness: **6.3 mm**
Weight: **2.7 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint uniface tool, Knife River Flint possible tool, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1105.1**

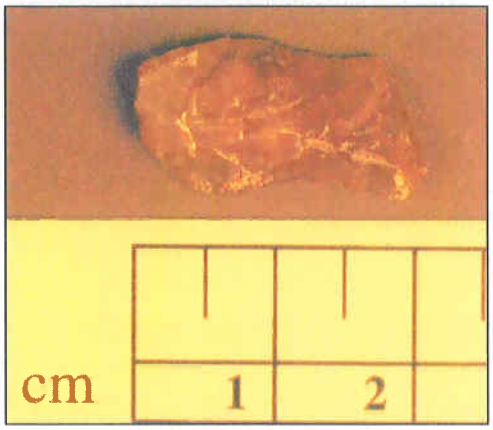
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **25**
Depth: **15 – 20 cmbs**

Morphological Attributes
Tool Type: **Utilized flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **21.6 mm**
Maximum Width: **11.3 mm**
Maximum Thickness: **3.6 mm**
Weight: **0.9 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint possible tools, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1090.1**

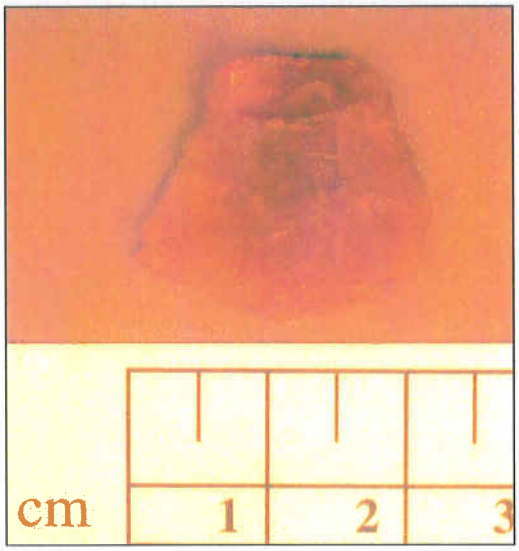
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **20**
Depth: **10 – 15 cmbs**

Morphological Attributes
Tool Type: **Utilized Flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Median Ridged**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **21.7 mm**
Maximum Width: **19.5 mm**
Maximum Thickness: **3.2 mm**
Weight: **1.3 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1085.1**

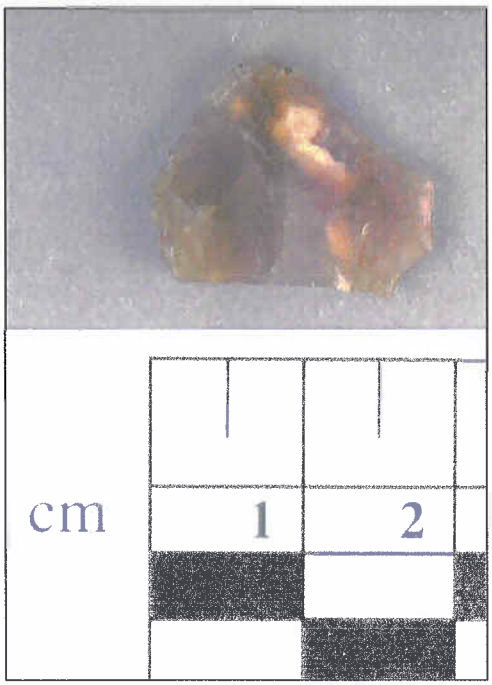
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **19**
Depth: **5 - 10 cmbs**

Morphological Attributes
Tool Type: **Utilized flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **18.4 mm**
Maximum Width: **14.8 mm**
Maximum Thickness: **4.6 mm**
Weight: **1.4 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1067.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **16**
Depth: **10 – 15 cmbs**

Morphological Attributes
Tool Type: **Utilized Flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **15.3 mm**
Maximum Width: **13.7 mm**
Maximum Thickness: **1.7 mm**
Weight: **0.5 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Ceramics, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1063.1**

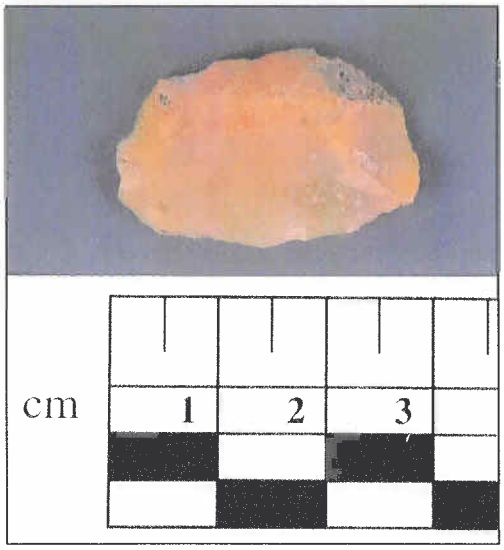
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **15**
Depth: **0 – 5 cmbs**

Morphological Attributes
Tool Type: **Utilized Flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Swan River Chert**
Heat-Treatment: **Yes**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **28 mm**
Maximum Width: **17.8 mm**
Maximum Thickness: **7.1 mm**
Weight: **3.3 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Accession Number: **1052.1**

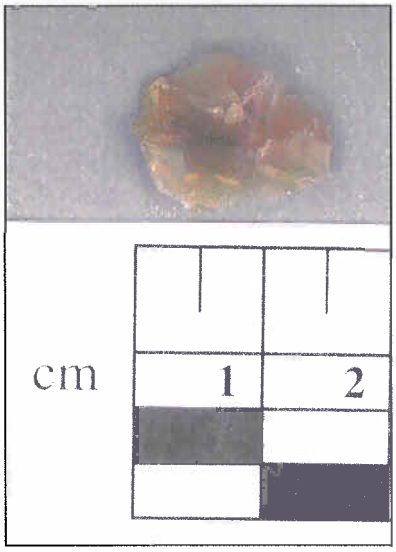
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **11**
Depth: **25 – 30 cmbs**

Morphological Attributes
Tool Type: **Utilized Flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **16.1 mm**
Maximum Width: **12.5 mm**
Maximum Thickness: **2.7 mm**
Weight: **0.5 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Swan River Chert core, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1051.2**

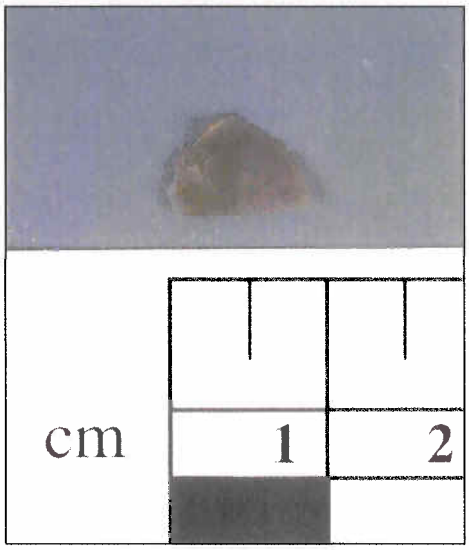
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **11**
Depth: **20 – 25 cmbs**

Morphological Attributes
Tool Type: **Utilized Flake Fragment**
Reduction Method: **Chipped**
Basal Edge Form: **N/A**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **9.2 mm**
Maximum Width: **6.2 mm**
Maximum Thickness: **1.2 mm**
Weight: **0.1 gm**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint point fragment, Knife River Flint utilized flake, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Accession Number: **1051.1**

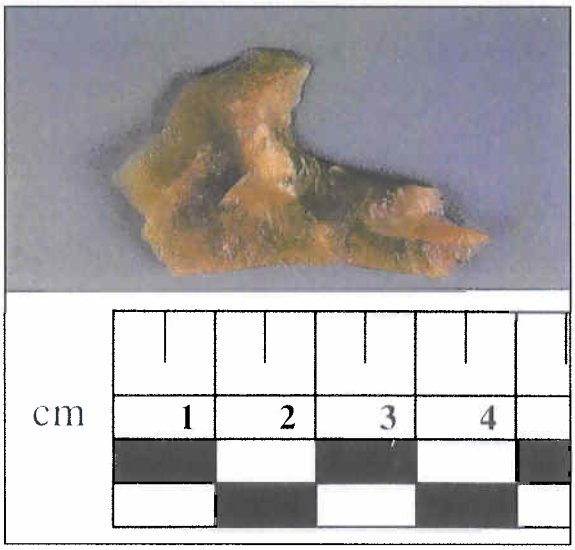
Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **11**
Depth: **20 – 25 cmbs**

Morphological Attributes
Tool Type: **Utilized Flake**
Reduction Method: **Chipped**
Basal Edge Form: **N/A**
Cross-Section: **Lenticular**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **37.6 mm**
Maximum Width: **22.5 mm**
Maximum Thickness: **3.4 mm**
Weight: **1.9 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint point fragment, Knife River Flint utilized flake, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1045.1**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **10**
Depth: **35 – 40 cmbs**

Morphological Attributes
Tool Type: **Utilized Flake**
Reduction Method: **Chipped**
Basal Edge Form: **Convex**
Cross-Section: **Median Ridged**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **22.3 mm**
Maximum Width: **14.0 mm**
Maximum Thickness: **4.6 mm**
Weight: **0.9 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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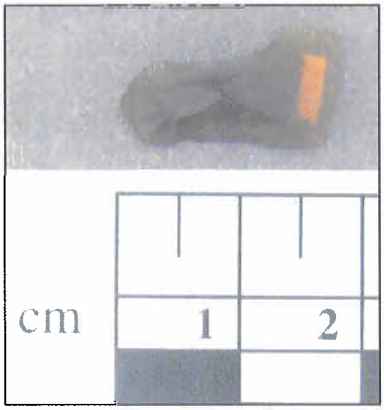
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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1041.1**



Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **10**
Depth: **10 – 15 cmbs**

Metric Attributes
Maximum Length: **18.4 mm**
Maximum Width: **9.9 mm**
Maximum Thickness: **2.0 mm**
Weight: **0.3 g**
Burning/Weathering: **No**

Morphological Attributes
Tool Type: **Utilized Flake**
Reduction Method: **Chipped**
Basal Edge Form: **Concave**
Cross-Section: **Median Ridged**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

Technological Attributes
Raw Material: **Knife River Flint**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008

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TOLL FREE 1-888-937-5150

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APPENDIX G8: Selected Core Data Sheets.

Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1052.7**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **11**
Depth: **25 – 30 cmbs**

Morphological Attributes
Tool Type: **Core**
Reduction Method: **Chipped**
Basal Edge Form: **None**
Cross-Section: **Elliptical**

Technological Attributes
Raw Material: **Swan River Chert**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **111.4 mm**
Maximum Width: **95 mm**
Maximum Thickness: **63.3 mm**
Weight: **708.7 g**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Knife River Flint utilized flake, debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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Eden Prairie, MN 55344

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Lithic Tool Data Sheet

Provenience Information
State: **North Dakota**
County: **Dickey**
City/Twp: **Albertha Twp.**
T/R: **129, 66**
Section: **23**
¼, ¼, ¼: **SE, SE, SE**
Property owner: **Arlena Heinrich**
Collection owner: TBD
Institution: TBD
Catalog Number: **1023.2**

Site Information
Site Name: **Gabriel Site**
Site Number: **32DI0095**
Unit: **5**
Depth: **10 – 15 cmbs**

Morphological Attributes
Tool Type: **Core**
Reduction Method: **Chipped**
Basal Edge Form: **None**
Cross-Section: **Plano-convex**

Technological Attributes
Raw Material: **Unknown gray silica**
Heat-Treatment: **No**
Flake Pattern: **Random flaking**

Comments:

Recorded by: Austin Jenkins
Date: Jan 2008



Metric Attributes
Maximum Length: **20.8 mm**
Maximum Width: **9.5 mm**
Maximum Thickness: **10.0 mm**
Weight: **4.1 gm**
Burning/Weathering: **No**

Cultural Affiliation
Associated Finds: **Debitage**
Historic Context: **Prehistoric**
Type Designation: **Plains Archaic**

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APPENDIX H: FAUNAL REPORT

Tatanka Faunal Assemblage

Report from John Soderberg (1/4/08)

Summary
The Tatanka faunal assemblage consists of a small number of largely undiagnostic fragments. All fragments appear to have been fractured prior to deposition. Several show signs of moderate weathering and battering, suggesting a period of exposure prior to deposition. The assemblage is too small and fragmentary for additional conclusions. All measurements are in millimeters and grams.

Detailed Description

#1
Bag ID:
32DI95
P.III
Unit 42
9 cmts

This bag contains 10 fragments.

Three fragments result from post-excavation breaks and refit into a single fragment with a greatest length of 54.2 mm. The reassembled fragment consists primarily of cancelous bone and has a concave articulation at one end. This morphology is reminiscent of a vertebral drum of a large ungulate, but that identification is speculative. I glued two of the fragments together (before I remembered that dating is a possibility). All three are bagged together.

Two of the other fragments refit into a larger undiagnostic fragment with a greatest length of 30.6 mm. These are bagged together.

The remaining five fragments are undiagnostic cortical bone fragments with the following greatest lengths (mm): 23.0, 30.6, 29.7, 20.6, and 9.1.

Since they are either quite small or mainly cancelous bone, these fragments are not recommended for AMS dating.

#2
Bag ID:
32DI95
TU 47

This bag contains two foil packets.

The writing on the larger is mostly illegible, except for "LV2". It contains one long-bone fragment from a large mammal. The greatest length of the fragment is 49.5 mm. Two possible cut marks appear near one edge of the convex surface. The marks are not recent and appear truncated by the broken edge of the bone. The longer of the two has a remaining length of 3.4 mm.

This fragment is suitable for AMS dating. It weighs 9 g.

The packet contains two other undiagnostic fragments with greatest lengths of 16.8 mm and 13.2 mm.

The smaller packet has the following ID: TV 47, L1: 0-5 cm. The packet contains one undiagnostic bone fragment. Both cancelous and cortical bone are present.

This fragment is not suitable for AMS dating. It weighs 3.6g.

#3
Bag ID:
32DI95
PN III
TV 43
L2: 5-10 cmts

This bag contains one longbone fragment with a greatest length of 84.0 mm. Small transverse scrape marks are apparent on the concave side. The convex side is moderately battered so that little of the exterior surface of the cortical bone remains.

This bone is well suited to AMS dating. It weights 12g.

#4
Bag ID:
32DI95
Const. Monit.
Sect. 24

This bag contains one fragment with some diagnostic morphology. I washed the bone with water in hopes of being able to make a taxonomic identification. It was not possible to do so. My speculative identification is vertebra. The greatest length is 35.2 mm.

The fragment is suitable for AMS dating. It weighs 13g.

#5
Bag ID:
32DI95
Ph III
TV 25
LG: 25-30 cmts

This bag contains a fragment of tooth enamel from a large ungulate. It is unlikely to be from a cervid and is probably from *Bos* or *Bison.*

I don't know the requirements for dating enamel, but I suspect this fragment is too small. It weighs 1.2 g.

APPENDIX I: AMS REPORT

BETA

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MR. DARDEN HOOD
Director

Mr. Ronald Hatfield
Mr. Christopher Patrick
Deputy Directors

January 25, 2008

Mr. Ryan Grohnke
Westwood Professional Services
7699 Anagram Dr.
Eden Prairie, MN 55344
USA

RE: Radiocarbon Dating Results For Samples 200625694702, 200625694302

Dear Mr. Grohnke:

Enclosed are the radiocarbon dating results for two samples recently sent to us. They each provided plenty of carbon for accurate measurements and all the analyses proceeded normally. The report sheet contains the dating result, method used, material type, applied pretreatment and two-sigma calendar calibration result (where applicable) for each sample.

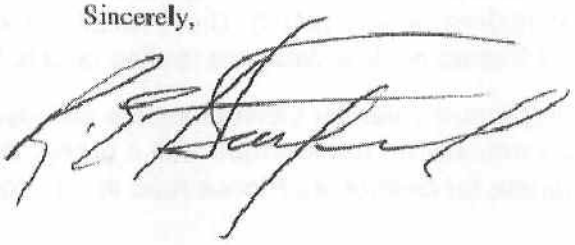
This report has been both mailed and sent electronically, along with a separate publication quality calendar calibration page. This is useful for incorporating directly into your reports. It is also digitally available in Windows metafile (.wmf) format upon request. Calibrations are calculated using the newest (2004) calibration database. References are quoted on the bottom of each calibration page. Multiple probability ranges may appear in some cases, due to short-term variations in the atmospheric 14C contents at certain time periods. Examining the calibration graphs will help you understand this phenomenon. Calibrations may not be included with all analyses. The upper limit is about 20,000 years, the lower limit is about 250 years and some material types are not suitable for calibration (e.g. water).

We analyzed these samples on a sole priority basis. No students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analyses. We analyzed them with the combined attention of our entire professional staff.

Information pages are enclosed with the mailed copy of this report. They should answer most of questions you may have. If they do not, or if you have specific questions about the analyses, please do not hesitate to contact us. Someone is always available to answer your questions.

The cost of the analysis was charged to the MASTERCARD card provided. A receipt is enclosed. Thank you. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,



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Miami, Florida 33155 USA
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Fax: 305 663 0/97
Beta@radiocarbon.com
Www.radiocarbon.com

Mr. Darden Hood
Director

Mr. Ronald Hatfield
Mr. Christopher Patrick
Deputy Directors

Final Report

The final report package includes the final date report, a statement outlining our analytical procedures, a glossary of pretreatment terms, calendar calibration information, billing documents (containing balance/credit information and the number of samples submitted within the yearly discount period), and peripheral items to use with future submittals. The final report includes the individual analysis method, the delivery basis, the material type and the individual pretreatments applied. The final report has been sent by mail and e-mail (where available).

Pretreatment

Pretreatment methods are reported along with each result. All necessary chemical and mechanical pretreatments of the submitted material were applied at the laboratory to isolate the carbon which may best represent the time event of interest. When interpreting the results, it is important to consider the pretreatments. Some samples cannot be fully pretreated, making their ^{14}C ages more subjective than samples which can be fully pretreated. Some materials receive no pretreatments. Please look at the pretreatment indicated for each sample and read the pretreatment glossary to understand the implications.

Analysis

Materials measured by the radiometric technique were analyzed by synthesizing sample carbon to benzene (92% C), measuring for ^{14}C content in one of 53 scintillation spectrometers, and then calculating for radiocarbon age. If the Extended Counting Service was used, the ^{14}C content was measured for a greatly extended period of time. AMS results were derived from reduction of sample carbon to graphite (100% C), along with standards and backgrounds. The graphite was then detected for ^{14}C content in one of 9 accelerator-mass-spectrometers (AMS) .

The Radiocarbon Age and Calendar Calibration

The "Conventional ^{14}C Age (*)" is the result after applying $^{13}C/^{12}C$ corrections to the measured age and is the most appropriate radiocarbon age. If an "*" is attached to this date, it means the $^{13}C/^{12}C$ was estimated rather than measured (The ratio is an option for radiometric analysis, but included on all AMS analyses.) Ages are reported with the units "BP" (Before Present). "Present" is defined as AD 1950 for the purposes of radiocarbon dating.

Results for samples containing more ^{14}C than the modern reference standard are reported as "percent modern carbon" (pMC). These results indicate the material was respiring carbon after the advent of thermo-nuclear weapons testing (and is less than ~ 50 years old).

Applicable calendar calibrations are included for materials between about 100 and 19,000 BP. If calibrations are not included with a report, those results were either too young, too old, or inappropriate for calibration. Please read the enclosed page discussing calibration.

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Miami, Florida 33155 USA
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Mr. Darden Hood
Director

Mr. Ronald Hatfield
Mr. Christopher Patrick
Deputy Directors

Calendar Calibration at Beta Analytic

Calibrations of radiocarbon age determinations are applied to convert BP results to calendar years. The short-term difference between the two is caused by fluctuations in the heliomagnetic modulation of the galactic cosmic radiation and, recently, large scale burning of fossil fuels and nuclear devices testing. Geomagnetic variations are the probable cause of longer-term differences.

The parameters used for the corrections have been obtained through precise analyses of hundreds of samples taken from known-age tree rings of oak, sequoia, and fir up to about 10,000 BP. Calibration using tree-rings to about 12,000 BP is still being researched and provides somewhat less precise correlation. Beyond that, up to about 20,000 BP, correlation using a modeled curve determined from U/Th measurements on corals is used. This data is still highly subjective. Calibrations are provided up to about 19,000 years BP using the most recent calibration data available.

The Pretoria Calibration Procedure (Radiocarbon, Vol 35, No.1, 1993, pg 317) program has been chosen for these calendar calibrations. It uses splines through the tree-ring data as calibration curves, which eliminates a large part of the statistical scatter of the actual data points. The spline calibration allows adjustment of the average curve by a quantified closeness-of-fit parameter to the measured data points. A single spline is used for the precise correlation data available back to 9900 BP for terrestrial samples and about 6900 BP for marine samples. Beyond that, splines are taken on the error limits of the correlation curve to account for the lack of precision in the data points.

In describing our calibration curves, the solid bars represent one sigma statistics (68% probability) and the hollow bars represent two sigma statistics (95% probability). Marine carbonate samples that have been corrected for $^{13}C/^{12}C$, have also been corrected for both global and local geographic reservoir effects (as published in Radiocarbon, Volume 35, Number 1, 1993) prior to the calibration. Marine carbonates that have not been corrected for $^{13}C/^{12}C$ are adjusted by an assumed value of 0 %0 in addition to the reservoir corrections. Reservoir corrections for fresh water carbonates are usually unknown and are generally not accounted for in those calibrations. In the absence of measured $^{13}C/^{12}C$ ratios, a typical value of -5 %0 is assumed for freshwater carbonates.

(Caveat: the correlation curve for organic materials assume that the material dated was living for exactly ten years (e.g. a collection of 10 individual tree rings taken from the outer portion of a tree that was cut down to produce the sample in the feature dated). For other materials, the maximum and minimum calibrated age ranges given by the computer program are uncertain. The possibility of an "old wood effect" must also be considered, as well as the potential inclusion of younger or older material in matrix samples. Since these factors are indeterminant error in most cases, these calendar calibration results should be used only for illustrative purposes. In the case of carbonates, reservoir correction is theoretical and the local variations are real, highly variable and dependent on provenience. Since imprecision in the correlation data beyond 10,000 years is high, calibrations in this range are likely to change in the future with refinement in the correlation curve. The age ranges and especially the intercept ages generated by the program must be considered as approximations.)

BETA ANALYYTIC INC. - 4985 SW 74 Court, Miami, Florida 33155 USA - Tel: 305-667-5167 - Fax 305-663-0964 - beta@radiocarbon.com

PRETREATMENT GLOSSARY
Standard Pretreatment Protocols at Beta Analytic
(Continued)

"collagen extraction: with alkali or collagen extraction: without alkali

The material was first tested for friability ("softness"). Very soft bone material is an indication of the potential absence of the collagen fraction (basal bone protein acting as a "reinforcing agent" within the crystalline apatite structure). It was then washed in de-ionized water, the surface scraped free of the outer most layers and then gently crushed. Dilute, cold HCl acid was repeatedly applied and replenished until the mineral fraction (bone apatite) was eliminated. The collagen was then dissected and inspected for rootlets. Any rootlets present were also removed when replenishing the acid solutions. "With alkali" refers to additional pretreatment with sodium hydroxide (NaOH) to ensure the absence of secondary organic acids. "Without alkali" refers to the NaOH step being skipped due to poor preservation conditions, which could result in removal of all available organics if performed.

Typically applied to: bones

"acid etch"

The calcareous material was first washed in de-ionized water, removing associated organic sediments and debris (where present). The material was then crushed/dispersed and repeatedly subjected to HCl etches to eliminate secondary carbonate components. In the case of thick shells, the surfaces were physically abraded prior to etching down to a hard, primary core remained. In the case of porous carbonate nodules and caliches, very long exposure times were applied to allow infiltration of the acid. Acid exposure times, concentrations, and number of repetitions, were applied accordingly with the uniqueness of the sample.

Typically applied to: shells, caliches, and calcareous nodules

"neutralized"

Carbonates precipitated from ground water are usually submitted in an alkaline condition (ammonium Hydroxide or sodium hydroxide solution). Typically this solution is neutralized in the original sample container, using deionized water. If larger volume dilution was required, the precipitate and solution were transferred to a sealed separatory flask and rinsed to neutrality. Exposure to atmosphere was minimal.

Typically applied to: Strontium carbonate, Barium carbonate
(i.e. precipitated ground water samples)

"carbonate precipitation"

Dissolved carbon dioxide and carbonate species are precipitated from submitted water by complexing them as ammonium carbonate. Strontium chloride is added to the ammonium carbonate solution and strontium carbonate is precipitated for the analysis. The result is representative of the dissolved inorganic carbon within the water. Results are reported as "water DIC".

Applied to: water

"solvent extraction"

The sample was subjected to a series of solvent baths typically consisting of benzene, toluene, hexane, pentane, and/or acetone. This is usually performed prior to acid/alkali/acid pretreatments.

Applied to: textiles, prevalent or suspected cases of pitch/tar contamination, conserved materials.

"none"

No laboratory pretreatments were applied. Special requests and pre-laboratory pretreatment usually accounts for this.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-19.5:lab. mult=1)

Laboratory number: **Beta-239658**

Conventional radiocarbon age: **30±40 BP**

2 Sigma calibrated results[2]: (95% probability) **Cal AD 1700 to 1720 (Cal BP 250 to 230) and Cal AD 1820 to 1840 (Cal BP 130 to 110) and Cal AD 1880 to 1920 (Cal BP 70 to 40) and Cal AD 1950 to beyond 1960 (Cal BP 0 to 0)**

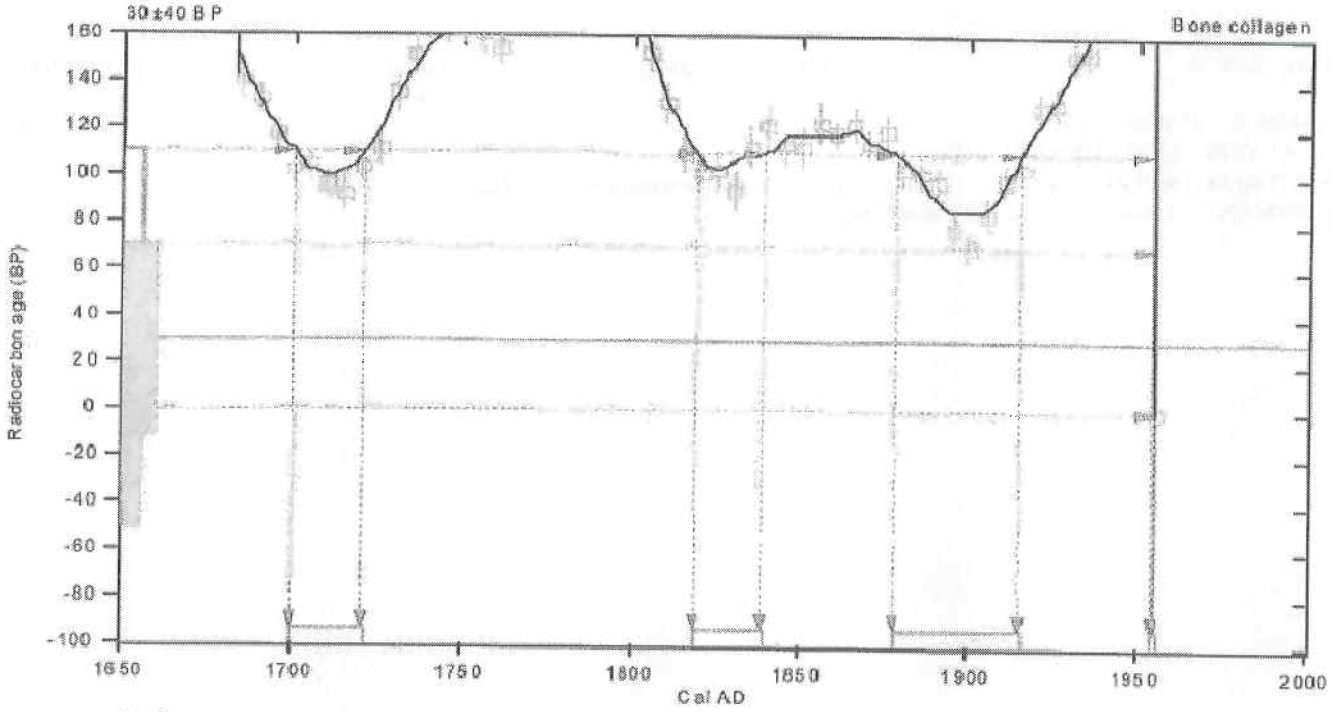
[2] 2 Sigma range being quoted is the maximum antiquity based on the minus 2 Sigma range

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1960 (Cal BP 0)

1 Sigma calibrated result[3]: (68% probability) Cal AD 1960 to beyond 1960 (Cal BP 0 to 0)

[3] 1 Sigma range being quoted is the maximum antiquity based on the minus 1 Sigma range



References:

Data base used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Radiocarbon Dating Laboratory

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BETA ANALYTIC INC.
DR. M.A. TAMERS and MR. D.G. HOOD
UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964
E-MAIL: beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Mr. Ryan Grohnke

Report Date: 1/25/2008

Westwood Professional Services

Material Received: 1/8/2008

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 239658	100.7 +/- 0.5 pMC	-19.5 o/oo 15N/14N = + 4.6 o/oo	30 +/- 40 BP

SAMPLE : 200625694702
ANALYSIS : AMS-ADVANCE delivery
MATERIAL/PRETREATMENT : (bone collagen): collagen extraction: with alkali
2 SIGMA CALIBRATION : Cal AD 1700 to 1720 (Cal BP 250 to 230) AND Cal AD 1820 to 1840 (Cal BP 130 to 110)
Cal AD 1880 to 1920 (Cal BP 70 to 40) AND Cal AD 1950 to beyond 1960 (Cal BP 0 to 0)

Beta - 239659	101.5 +/- 0.5 pMC	-17.7 o/oo 15N/14N = + 3.2 o/oo	0 +/- 40 BP

SAMPLE : 200625694302
ANALYSIS : AMS-ADVANCE delivery
MATERIAL/PRETREATMENT : (bone collagen): collagen extraction: with alkali
COMMENT: Result outside of calibration range

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

APPENDIX J: CORRESPONDENCE

STATE HISTORICAL SOCIETY OF NORTH DAKOTA

FEB 07 2007

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Governor of North Dakota

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Gereld Gerntholz
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Douglass Prchal
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Francis Ziegler
Director
Department of Transportation

Merlan E. Paaverud, Jr.
Director

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February 5, 2007

Steven J. Blondo
Cultural Resource Specialist
Westwood Professional Services, Inc.
7699 Anagram Dr.
Eden Prairie, MN 55344

RE: 2007 North Dakota Permit

Dear Mr. Blondo:

Congratulations for receiving a 2007 permit to conduct cultural resource investigations in North Dakota. Amanda Gronhovd is qualified as principal investigator in archaeology. She is also qualified in history and architectural history. Steven Blondo has been granted a provisional permit to act as a principal investigator to conduct surveys and text excavations in archaeology in North Dakota has been granted.

Please remember to include a $50.00 filing fee for each report your firm produces in North Dakota in compliance with Section 106 of the National Historic Preservation Act. Multiple copies of one original report are considered one report in terms of filing fees. If you have any questions regarding this permit, please feel free to contact me directly at (701)328-3574, or in writing.

Sincerely,

Paul R. Picha
Chief Archaeologist

Enclosure

STATE HISTORICAL SOCIETY OF NORTH DAKOTA

ANNUAL PERMIT - CULTURAL RESOURCE INVESTIGATION
STATE HISTORICAL SOCIETY OF NORTH DAKOTA

WESTWOOD PROFESSIONAL SERVICES, INC., having filed application and fee in proper and complete form as prescribed by law and regulation, is hereby granted a permit pursuant to North Dakota Century Code 55-03. The permit holder, or employees thereof, may investigate, evaluate, or mitigate adverse effects on, cultural resources, historic buildings, structures, or objects in North Dakota to satisfy laws and regulations listed in North Dakota Century Code 55-03-01. This permit is subject to regulations found at North Dakota Administrative Code 40-02-02, "Permit for Cultural Resource Investigation," and is issued for calendar year: 2007.

STATE OF NORTH DAKOTA
STATE HISTORICAL SOCIETY
OF NORTH DAKOTA

By: Merlan E. Paaverud, Jr.
Merlan E. Paaverud, Jr., Director

STATE OF NORTH DAKOTA)
) ss.
COUNTY OF BURLEIGH)

On this 2 day of February, in the year of 2007 before me personally appeared Merlan E. Paaverud, Jr., know to me to be the person who is described in and who executed the written instrument and acknowledged to me that the State Historical Society of North Dakota executed the same.

(SEAL)

DAVID C SKALSKY
Notary Public
State of North Dakota
My Commission Expires Dec. 29, 2011

David C Skalsky
Notary Public

My Commission Expires: 12-29-2011

STATE HISTORICAL SOCIETY OF NORTH DAKOTA

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Douglass Prchal
Director
Parks and Recreation Department

Francis Ziegler
Director
Department of Transportation

Merlan E. Paaverud, Jr.
Director

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June 18, 2007

Margaret Van Ness
Regional Federal Preservation Officer
US Fish and Wildlife Service
Denver Federal Center
PO Box 25486
Denver, CO 80225

Steven Blondo
Cultural Resource Specialist
Westwood Professional Services
7699 Anagram Drive
Eden Prairie, MN 55344

NDSHPO REF. : 07-0003f USFWS Tatanka Windfarm, Dickey and McIntosh Counties, North Dakota–Data Recovery Plan and Research Design for Site 32DI95

Dear Meg and Steve:

We have received and reviewed your correspondence of today, June 18, and accompanying document for project: 07-0003f "Draft Research Design and Data Recovery Plan for 32DI95," by Ryan P. Grohnke, Kent Bakken, and Amanda M. Gronhovd (June 18, 2007) and offer the following comment. As indicated in prior correspondence, we concur that site 32DI95 is significant and is eligible for listing in the National Register of Historic Places.

A section needs to be added that states: "In the event that human remains are encountered all work shall immediately cease, and protocols established in NDCC 23-06-27 and NDAC 40-02-03 will be implemented and followed."

Thank you for the opportunity to review the project and we look forward to the final document and to further consultation regarding it. If you have questions please contact either Paul Picha at (701) 328-3574 or Susan Quinnell at (701) 328-3576.

Sincerely,

Merlan E. Paaverud, Jr.
State Historic Preservation Officer (North Dakota)
and
Director, State Historical Society of North Dakota

c: Tony Clark, Commissioner-Chair, ND PSC

STATE HISTORICAL SOCIETY OF NORTH DAKOTA

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Secretary of State

Douglass Prchal
Director
Parks and Recreation Department

Francis Ziegler
Director
Department of Transportation

Merlan E. Paaverud, Jr.
Director

Accredited by the American Association of Museums

June 18, 2007

Margaret Van Ness
Regional Federal Preservation Officer
US Fish and Wildlife Service
Denver Federal Center
PO Box 25486
Denver, CO 80225

Steven Blondo
Cultural Resource Specialist
Westwood Professional Services
7699 Anagram Drive
Eden Prairie, MN 55344

NDSHPO REF. : 07-0003d USFWS Tatanka Windfarm, Dickey and McIntosh Counties, North Dakota–Evaluation of Site 32DI95

Dear Meg and Steve:

We have received and reviewed today your correspondence of June 6 and accompanying report for project: 07-0003d "An Archaeological Evaluation of 32DI95: The Gabriel Site, Albertha Township, Dickey County, North Dakota," by Ryan P. Grohnke, and Amanda M. Gronhovd (June 5, 2007) and find it acceptable. We concur that site 32DI95 is significant and is eligible for listing in the National Register of Historic Places.

We look forward to reviewing the research design for 32DI95 outlining the proposed investigations to mitigate effects to this site. As we have discussed, impacts to 32DI95 should be minimized by judicious project design and thereby avoiding stone features and significant deposits to the extent possible.

Thank you for the opportunity to review the project and we look forward to further consultation regarding it. If you have questions please contact either Paul Picha at (701) 328-3574 or Susan Quinnell at (701) 328-3576.

Sincerely,

for Merlan E. Paaverud, Jr.
State Historic Preservation Officer (North Dakota)
and
Director, State Historical Society of North Dakota

c: Tony Clark, Commissioner-Chair, ND PSC

STATE HISTORICAL SOCIETY OF NORTH DAKOTA

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PROFESSIONAL SERVICES

John Hoeven
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North Dakota State Historical Board

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Francis Ziegler
Director
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Merlan E. Paaverud, Jr.
Director

Accredited by the American Association of Museums

July 18, 2007

Steven Blondo
Cultural Resource Specialist
Westwood Professional Services Denver Federal Center
7699 Anagram Drive
Eden Prairie, MN 55344

NDSHPO REF. : 07-0003f USFWS Tatanka Windfarm, Dickey and McIntosh Counties, North Dakota–Data Recovery Plan and Research Design for Site 32DI95Update

Dear Steve:

We have received and reviewed your correspondence of yesterday and today, July 18. We offer the following comment. As indicated in prior correspondence, we concur that site 32DI95 is significant and is eligible for listing in the National Register of Historic Places. The field investigation project updates and photographs are acceptable and are most useful. The stone feature you investigated and supplied information about is likely a petrofrom–and zoomorphic in nature. Avoidance of the feature is recommended. Additional information about graphic depictions of various forms may be found in:

Greene, C. S., and R. Thorton (eds.)
2007 *The Year the Stars Fell: Lakota Winter Counts at the Smithsonian.*
Smithsonian Institution Press, Washington, DC.

Thank you for the opportunity to review the project and we look forward to the final document covering the investigations. If you have questions please contact either Paul Picha at (701) 328-3574 or Susan Quinnell at (701) 328-3576.

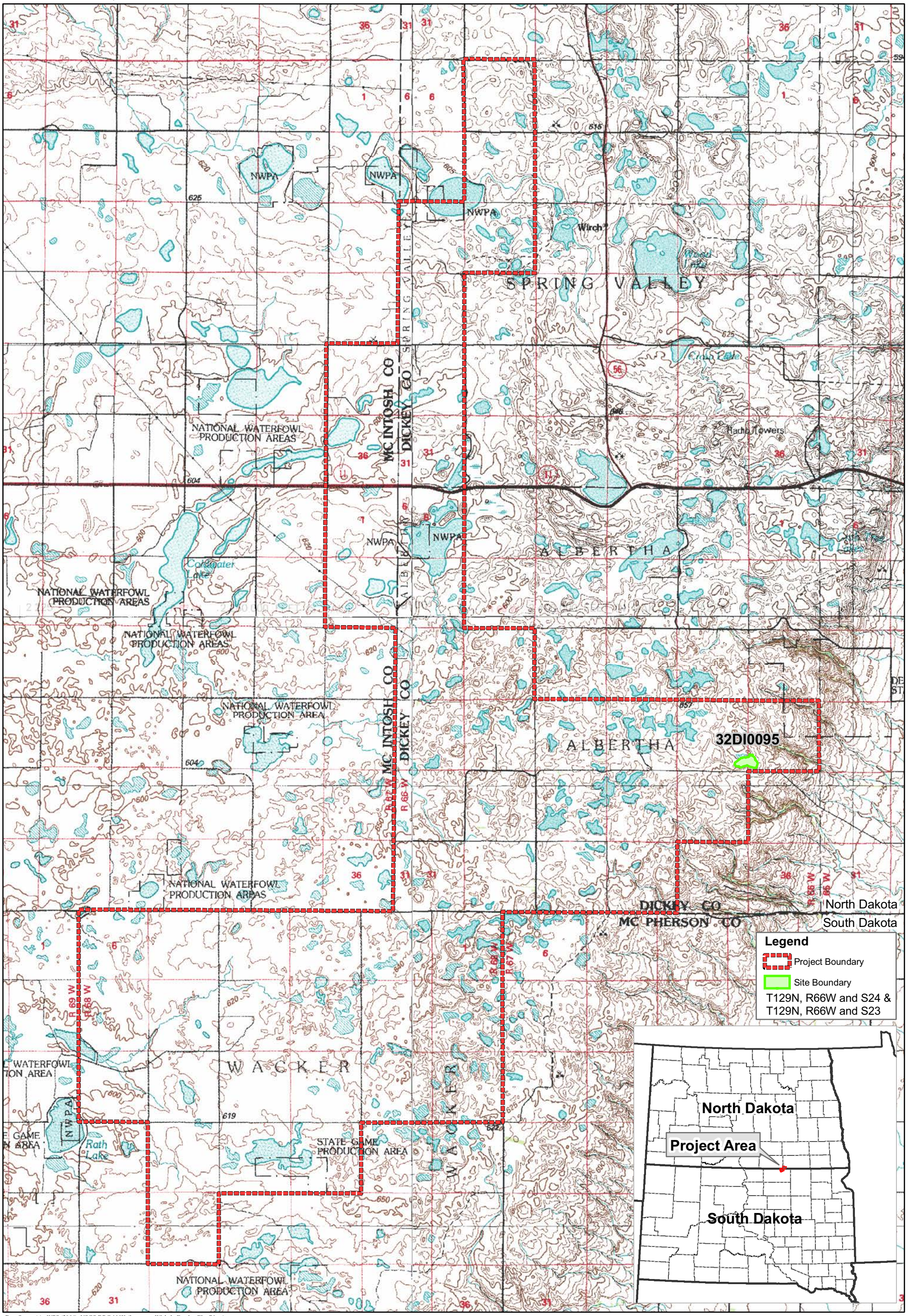
Sincerely,

Merlan E. Paaverud, Jr.
State Historic Preservation Officer (North Dakota)
and
Director, State Historical Society of North Dakota
c: Meg VanNess, FPO, USFWS
c: Susan Wefald, Commissioner, ND PSC

EXHIBITS

Map Document: (P:\20062569\gis\crm\2007\20062569loc03B_0605.mxd)
2/14/2008 -- 3:00:52 PM

© 2006 Westwood Professional Services, Inc.



Data Source(s): WPS (2006); USGS DRG 100K (Lamoure, Wishek, Eureka, Elm River).

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N

0 Miles 1.25

Tatanka Wind Farm

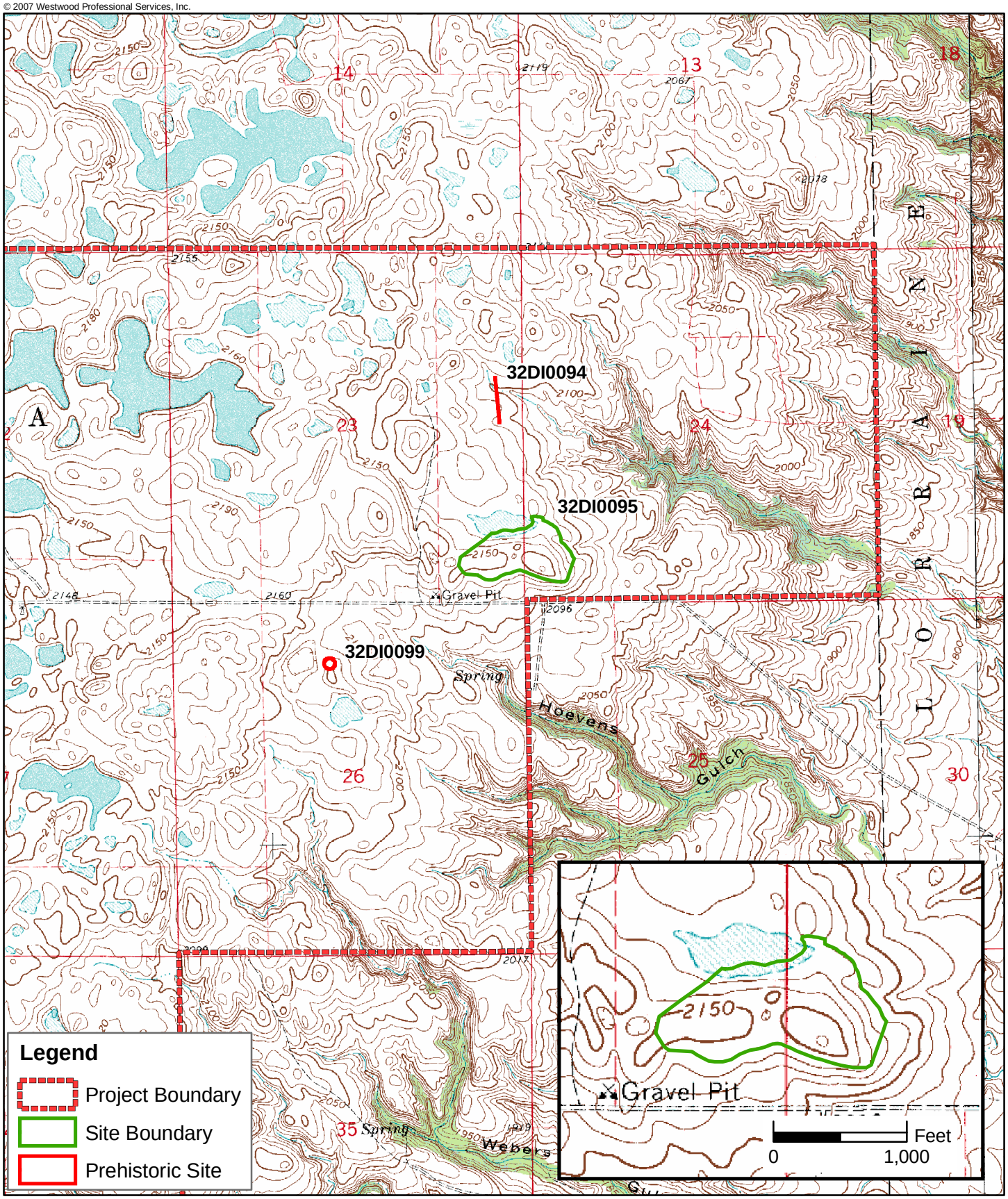
Tatanka Wind Power, LLC

Dickey and McIntosh Counties, North Dakota & McPherson County, South Dakota

Site Location Map

EXHIBIT 1

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Data Source(s): USGS DRG (Coldwater Lake NE, Merricourt NW, Coldwater Lake, Merricourt SW, Long Lake NE, Forbes NW, Long Lake SE, Forbes SW).

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Dickey and McIntosh Counties, North Dakota &
McPherson County, South Dakota

Prehistoric sites near 32DI0095

EXHIBIT 2

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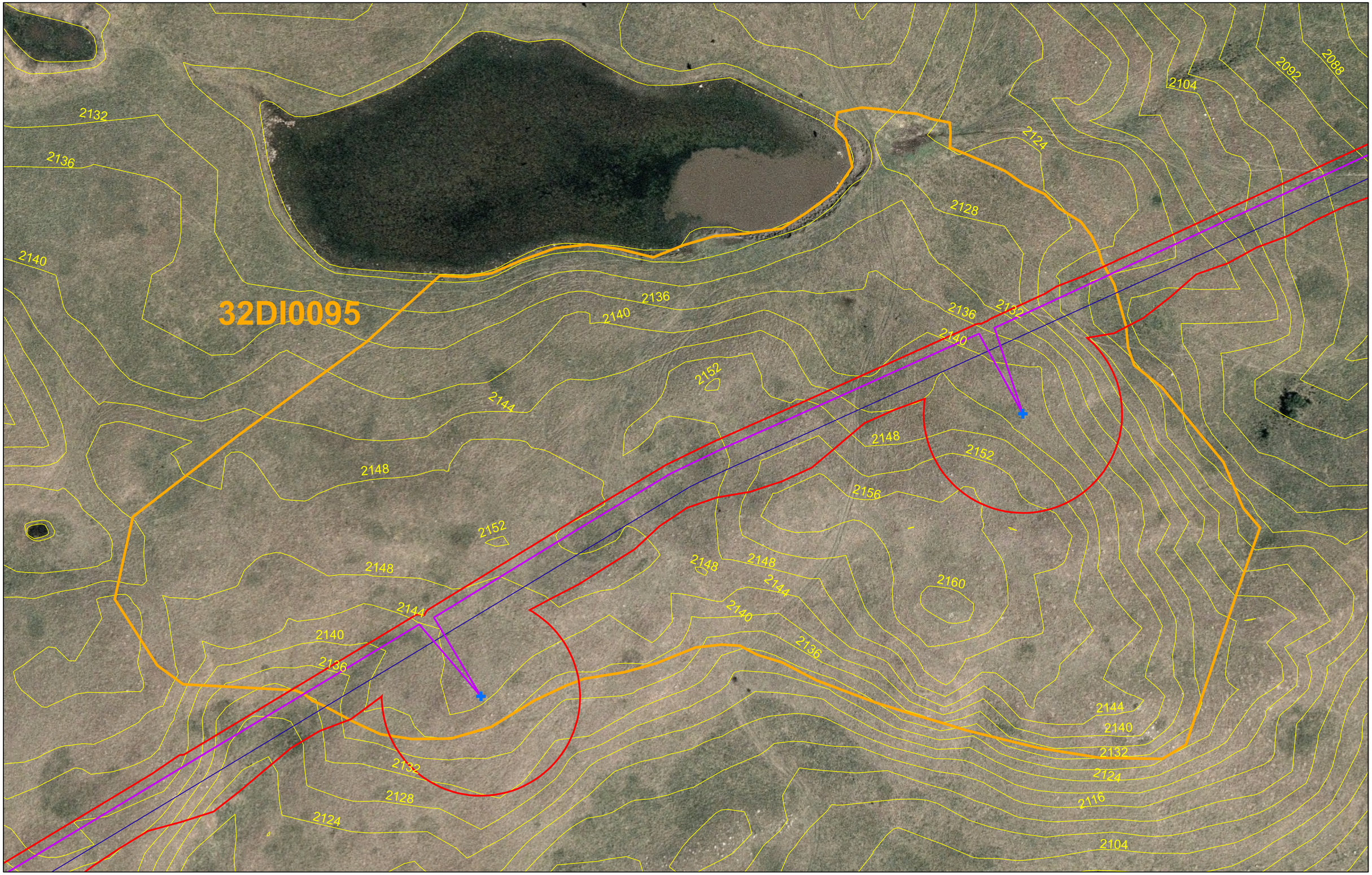
www.westwoodps.com

N

Feet
0
2,000

Map Document: (P:\20062569\gis\crm\2007\20062569crm03A_8.mxd)
2/14/2008 -- 3:14:35 PM

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Data Source(s): Horizons Aerial (2006); WPS (2008).

Legend

- Site Boundary
- Proposed Construction Limits
- 4 Foot Contour
- Proposed Cable
- Proposed Road
- Proposed Turbine

N

0 30 Meters

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Tatanka Wind Farm

Tatanka Wind Power, LLC

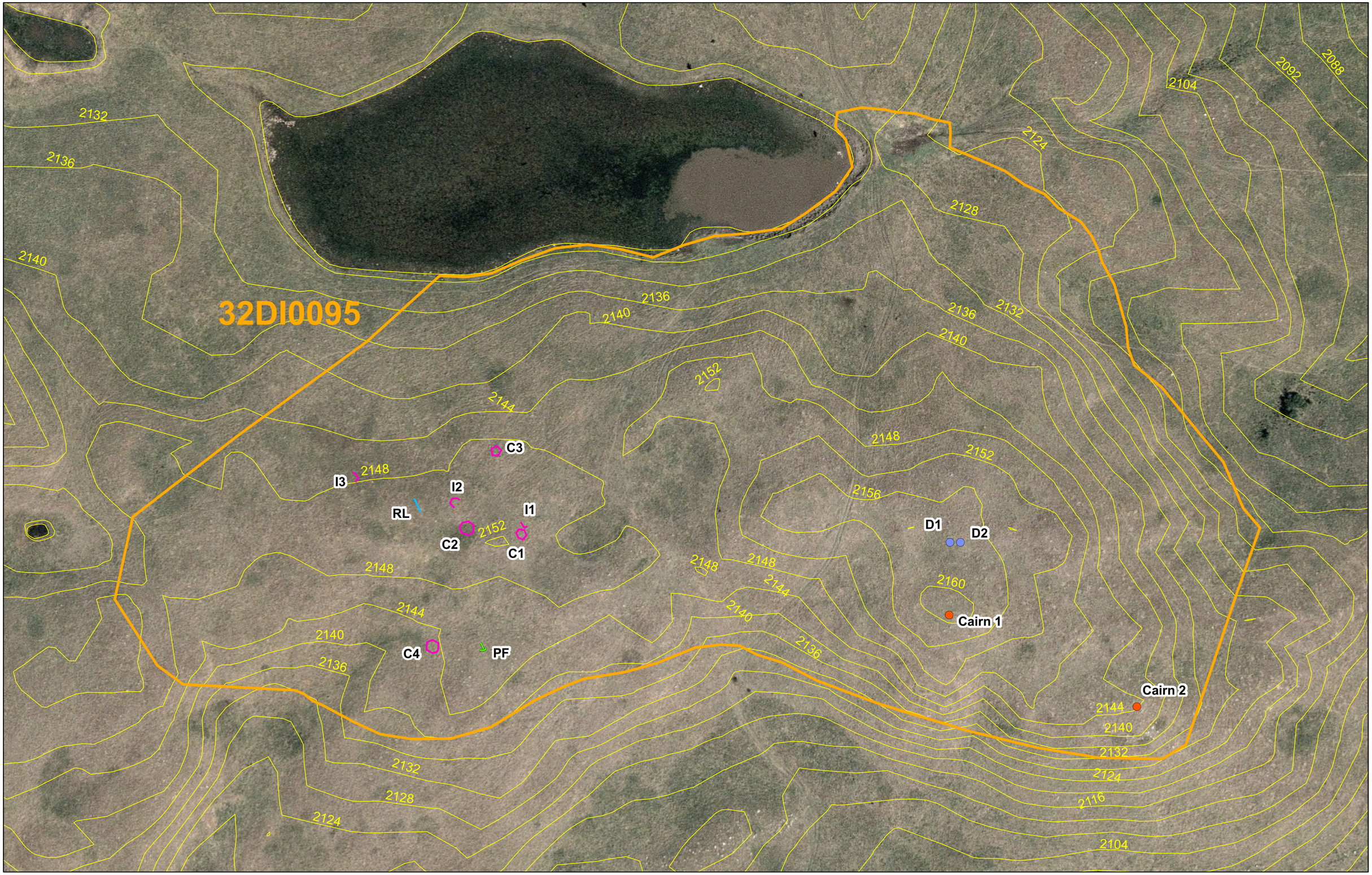
Dickey and McIntosh Counties, North Dakota &
McPherson County, South Dakota

Area of Potential Effects

EXHIBIT 3

Map Document: (P:\20062569\gis\crm\2007\20062569crm03A_6.mxd)
2/14/2008 -- 3:29:10 PM

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Data Source(s): Horizons Aerial (2006); WPS (2008).

Legend

- Site Boundary
- Stone Circles
- 4 Foot Contour
- Rock Alignment
- Petroform
- Cairn
- Depression

N

0 30 Meters

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Tatanka Wind Farm

Tatanka Wind Power, LLC

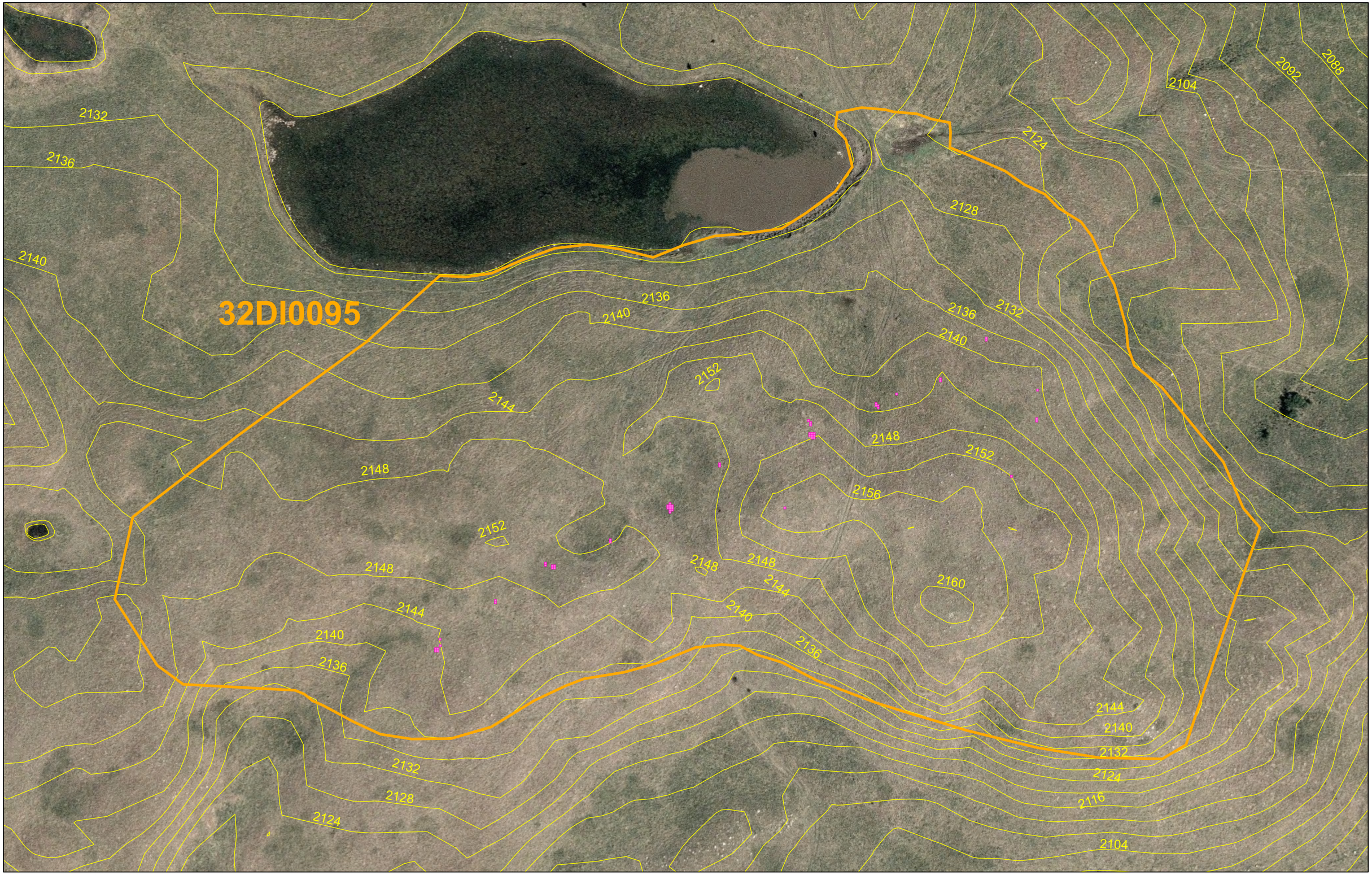
Dickey and McIntosh Counties, North Dakota &
McPherson County, South Dakota

Surface Features

EXHIBIT 4

Map Document: (P:\20062569\gis\crm\2007\20062569crm03A_5.mxd)
2/14/2008 – 3:40:05 PM

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Data Source(s): Horizons Aerial (2006); WPS (2008).

Tatanka Wind Farm

Tatanka Wind Power, LLC

Dickey and McIntosh Counties, North Dakota &
McPherson County, South Dakota

Data Recovery Test Units Overview

EXHIBIT 5

Legend

- Site Boundary
- Test Unit
- 4 Foot Contour

N

0 30 Meters

Westwood

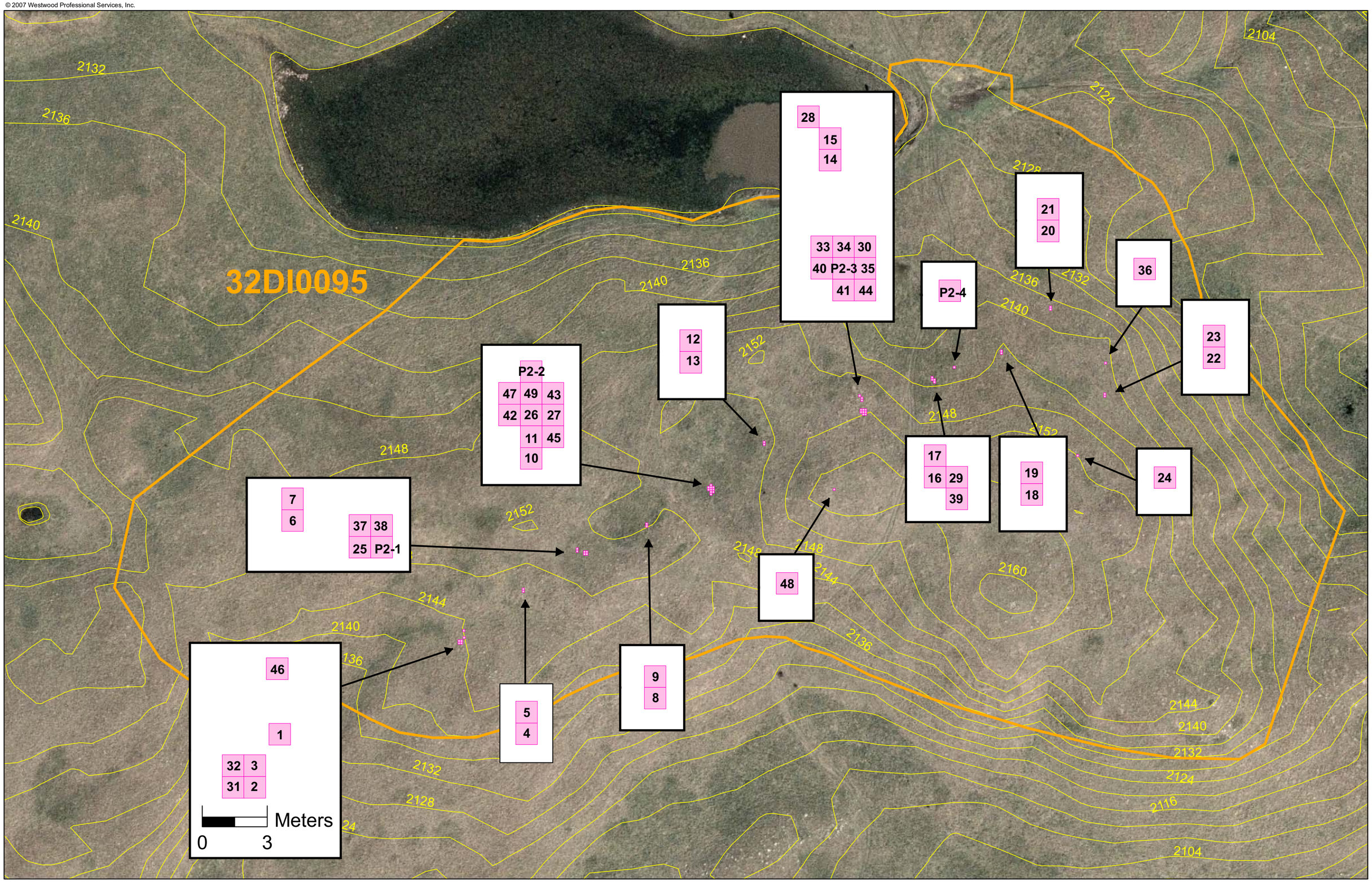
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2/14/2008 -- 4:21:48 PM

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Data Source(s): Horizons Aerial (2006); WPS (2008).

Legend

- Site Boundary
- Test Unit
- 4 Foot Contour

N

Meters
0 30

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Tatanka Wind Farm

Tatanka Wind Power, LLC

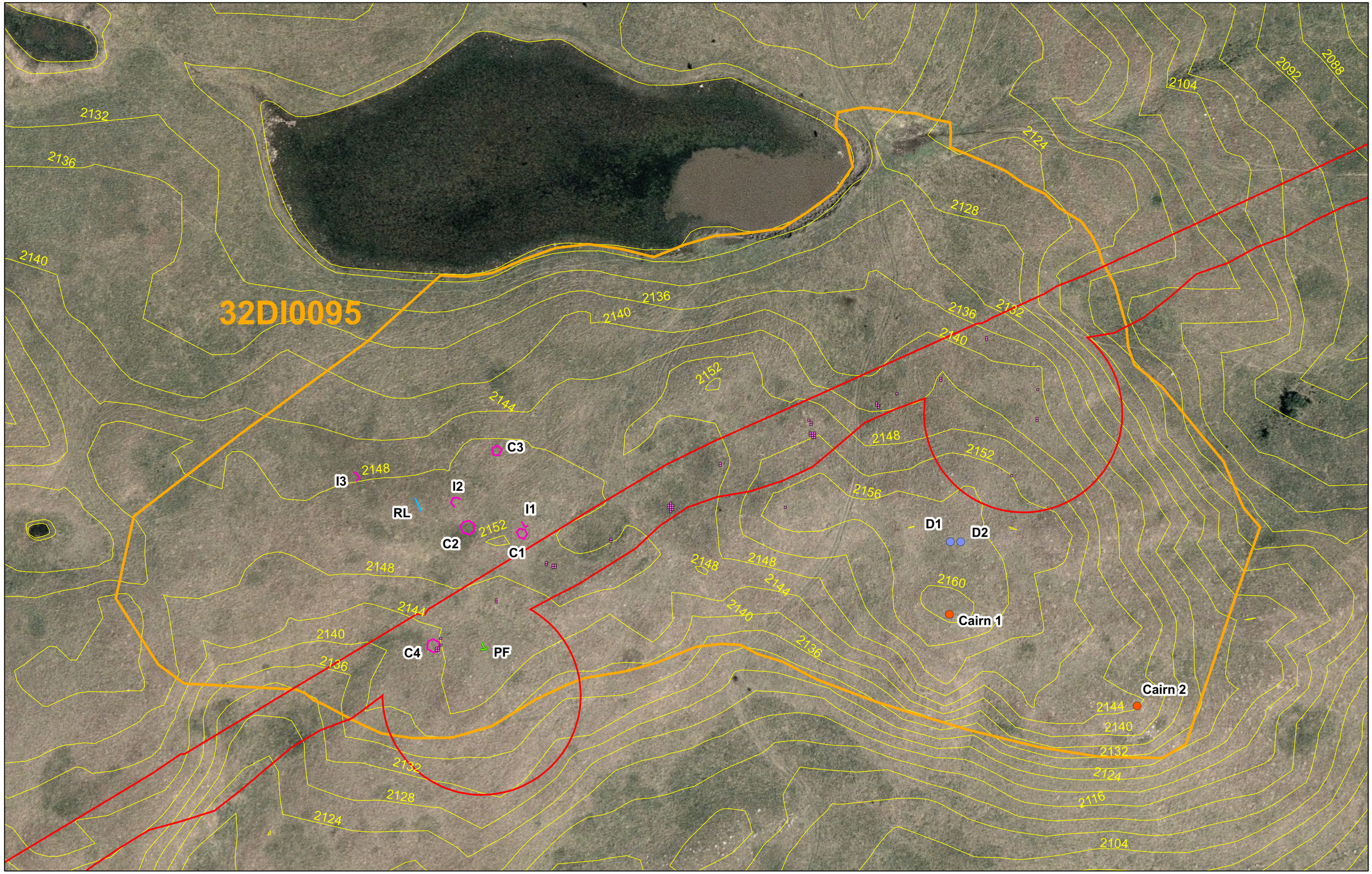
Dickey and McIntosh Counties, North Dakota &
McPherson County, South Dakota

Data Recovery Test Units Detail

EXHIBIT 6

Map Document: (P:\20062569\gis\crm\2007\20062569crm03A_2.mxd)
2/14/2008 -- 4:02:06 PM

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Data Source(s): Horizons Aerial (2006); WPS (2008).

Legend

- Site Boundary
- Construction Limits
- Test Unit
- 4 Foot Contour
- Stone Circles
- Rock Alignment
- Petroform
- Depression
- Cairn

N

0 30 Meters

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Tatanka Wind Farm

Tatanka Wind Power, LLC

Dickey and McIntosh Counties, North Dakota &
McPherson County, South Dakota

Surface Features, Test Units and
Area of Potential Effects

EXHIBIT 7

Map Document: (P:\20062569\gis\crm\20070\20062569crm03A_9.mxd)
2/14/2008 -- 4:13:58 PM

Shermco industries

One Line.One Company.

Customer: Acciona Wind Energy USA, LLC

Location: Tatanka Wind Farm

Shermco Project No.: C100303

Description: 230 kV Transmission Line Tension Measurement

Date: November 15, 2011

Work Performed and Report Prepared By:
Shermco Industries
Cedar Rapids, Iowa



Cedar Rapids Service Center
777 10th St.
Marion, Iowa 52302
p. 319.377.3377
f. 319.377.3399
CedarRapids@shermco.com

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f. 979.848.0012
Houston@shermco.com

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Sweetwater, Texas 79556
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f. 325.236.8192
Sweetwater@shermco.com

Tulsa Service Center
4510 South 86th East Ave.
Tulsa, Oklahoma 74145
p. 918.234.2300
f. 918.234.2306
Tulsa@shermco.com

November 28, 2011

Mr. Tony Edwards
Acciona Wind Energy USA, LLC
333 W Wacker Drive
Suite 1500
Chicago, IL 60606

Subject: **230 kV Transmission Line Tension Measurement**
Shermco Project No.: C100303

Location: **Tatanka Wind Farm**
Ashley, North Dakota

Dear Mr. Edwards:

On November 15, 2011, Shermco Industries performed testing for Acciona Wind Energy USA, LLC at the Tatanka Wind Farm located in Ashley, North Dakota.

Included are a spreadsheet showing the tensions on the 3/8 steel and the opgw at the four locations where the measurements were requested, a picture of the dyno's of each conductor at each site, a copy of the dyno test and a picture from the dyno showing the test date and a picture taken inline at structure 21 showing the insulator being pulled.

Thank you for the opportunity to be of service. Should you have any questions or require additional information or services, please do not hesitate to contact us. We are available 24 hours a day, seven days a week.

Respectfully submitted,
Shermco Industries
Cedar Rapids Service Center

J. W. Wickham

Jay Wickham
Engineering Services Division

EU Sales Office
Boulevard Saint-Michel 47
1040 Brussels, Belgium
p. +32 (0) 2 400.00.54
f. +32 (0) 2 400.00.32
Brussels@shermco.com

Tension Data Report



TENSION DATA REPORT

PROJECT NAME:	**Tatanka T-line**	**CONDUCTOR TYPE**	**795-t2**
CONTRACTOR:	**Michels Power**	**STATIC TYPE**	**3/8 shieldwire**
VOLTAGE:	**230kv**	**FIBER TYPE**	**opgw**
DATE:	**11/15/2011**		

STRUCTURE #	**5 to 6**	**SPAN LENGTH**	**725'**
CONDUCTOR	**static**	**opgw**	
TENSION (lbs)	**1460lbs**	**1490lbs**	
TEMP (°F)	**20**	**20**	
PICTURE #	**1**	**2**	

STRUCTURE #	**21 to 22**	**SPAN LENGTH**	**686'**
CONDUCTOR	**static**	**opgw**	
TENSION (lbs)	**1080**	**1420**	
TEMP (°F)	**20**	**20**	
PICTURE #	**3**	**4**	

STRUCTURE #	**31 to 32**	**SPAN LENGTH**	**681'**
CONDUCTOR	**static**	**opgw**	
TENSION (lbs)	**1400**	**1780**	
TEMP (°F)	**20**	**20**	
PICTURE #	**5**	**6**	

STRUCTURE #	**55 to 56**	**TO STRUCTURE #**	**566'**
CONDUCTOR	**static**	**opgw**	
TENSION (lbs)	**1480**	**1740**	
TEMP (°F)	**20**	**20**	
PICTURE #	**7**	**8**	

SUBCONTRACTOR REPRESENTATIVE:

STEVE STEDER-MARK WEEMS **DATE:** **11/15/2011**

All Sections of This Document Need to be Filled Out, Signed and Dated During Stinging Operations

Dyno Test



Fox Valley Metrology
3125 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 • Fax (920) 426-8120
http://FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ilac-MRA ACLASS ACCREDITED TESTING AND CALIBRATION

Certificate No. AC-1272

Certification Number CB283-51649-245

For Michels Power
1775 East Shady Lane
Neenah, WI 54956

Test Instrument	Dynamometer
Make	Dillon
Model	EDjunior (10000 lb)
Serial Number	DEDJ501312
Identification	MP12467
Purchase Order #	Call Jay
Customer Location	
Condition Received	Out Of Tolerance
Condition Returned	In Tolerance
Calibrated By	Danny Scherr
Form Reviewed By	M.T.
Calibration Location	FVM
Calibration Conditions	69.5°F, 42.5%RH
Calibration Date	10/27/2011
Recalibration Due	10/27/2012

Procedures Followed
FVE-017 rev. 2

This certificate shall not be altered in any form or reproduced, except in full, without prior written approval from originating lab. These results relate only to the item(s) calibrated.

Standards Used

Instrument	Serial Number	Trace Number	Next Cal
FVS-275	05122103_20R	CA362-40168-176	12/28/2011
FVS-378	323930	CB104-53873-141	04/28/2012

Total expanded measurement uncertainty based on two standard deviations (k=2) is 0.05% of reading (up to 200 lb), 0.073% of reading (200 lb to 10000 lb), 0.1% of reading (10000 lb to 50000 lb)

All instruments have been calibrated against standards traceable to NIST. Calibration was completed in accordance with ISO/IEC 17025 and ANSI Z540-1-1994.

Calibration Results

* - denotes out of tolerance

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left
Tension	(lb)	(lb)	(lb)	(lb)	(lb)
	500	485	515	924*	502
	1000	985	1015	1418*	998
	2000	1985	2015	2441*	2000
	3000	2985	3015	3433*	2998
	5000	4985	5015	5481*	4990
	7000	6985	7015	7455*	6990
	9000	8985	9015	9428*	8988

COPY

Project Photos




Working Load Limit
10,000 lbf / 5000 kgf
see users manual for details
DILLON
ED junior
Michels Power
MP12467
ZERO


Fox Valley Metrology
(920) 426-5894
ID: MP12467
Cal By: DS
CB283-51649-2
Date: 10/27/2011
Due: 10/27/2012
Working Load Limit
10,000 lbf / 5000 kgf
see users manual for details
DILLON ED junior
Michels Power
MP12467
I/⏻
Force lbf
1590
ZERO
ESC
→


Working Load Limit
10,000 lbf / 5000 kgf
see users manual for details
DILLON ED junior
Michels Power
MP12466
Force lbf
1080
Units
Mode
Clear
I/⏻
ZERO
ESC
→


Working Load Limit
10,000 lbf / 5000 kgf
see users manual for details
DILLON ED junio
Michels Power
MP12466
Force lbf
1420
Units
Mode
Clear
I/O
ESC


Working Load Limit
10,000 lbf / 5000 kgf
DILLON
ESC


Working Load Limit
10,000 lbf / 5000 kgf
see users manual for details
DILLON ED junior
Michels Power
MP12466
I/⏻
Force lbf
1780
ZERO
ESC


Working Load Limit
10,000 lbf / 5000 kgf
see users manual for details
DILLON ED junior
Michels Power
MP12466
I/O
Force lbf
1480
ZERO
ESC


Work
10,000 lb
000 kgf
see users manual for details
DILLON ED junior
Michels Power
MP12466
I/
Force lbf
ZERO
ESC



Struct. No.	Stake Description	Station	Ahead Span	X	Y	Z	Line Angle				Comments
		(ft)	(ft)	(ft)	(ft)	(ft)	DEG	MIN	SEC	DEFL	
1	C/L Hub	0+00	188	2347606.491	102925.797	2107.000					Sub DE
1	Structure Hub			2347606.491	102925.797	2107.000					
1	bpP			2347600.739	102907.717	2106.999					
1	bpX			2347600.242	102943.711	2106.999					
1	bpXY			2347612.243	102943.877	2106.999					
1	bpY			2347612.739	102907.883	2106.999					
2	C/L Hub	1+88	655	2347794.32	102928.39	2106.186					
2	Structure Hub			2347794.32	102928.39	2106.186					
2	poll			2347794.589	102908.89	2106.186					
2	polc			2347794.32	102928.39	2106.186					
2	polr			2347794.05	102947.889	2106.186					
2	g2			2347759.871	102888.202	2106.186					
2	g3			2347828.988	102889.659	2106.186					
2	g4			2347751.86	102908.3	2106.186					
2	g5			2347837.318	102909.48	2106.186					
2	g6			2347751.591	102927.8	2106.186					
2	g7			2347837.048	102928.98	2106.186					
2	g8			2347758.775	102967.611	2106.186					
2	g9			2347827.906	102968.063	2106.186					
2	g10			2347751.322	102947.299	2106.186					
2	g11			2347836.779	102948.479	2106.186					
3	C/L Hub	8+42	305	2348448.42	102937.42	2102.000	26°	22'	45''	LT	
3	Structure Hub			2348449.628	102932.568	2102.000					
3	poll			2348455.91	102907.338	2102.001					
3	polc			2348449.628	102932.568	2102.001					
3	polr			2348443.346	102957.799	2102.001					
3	guy2			2348470.034	102850.605	2102.001					
3	guy3			2348459.377	102857.493	2102.001					
3	guy4			2348476.218	102861.686	2102.001					
3	guy5			2348453.095	102882.723	2102.001					
3	guy6			2348469.937	102886.916	2102.001					
3	guy7			2348446.814	102907.95	2102.001					
3	guy8			2348463.656	102912.143	2102.001					
4	C/L Hub	11+68	748	2348719.13	103076.37	2098.092	63°	21'	46''	LT	
4	Structure Hub			2348719.13	103076.37	2098.092					
4	poll			2348743.949	103061.37	2098.092					
4	polc			2348719.13	103076.37	2098.092					
4	polr			2348694.311	103091.37	2098.092					
4	g2			2348751.1	103015.439	2098.092					
4	g3			2348786.99	103076.064	2098.092					
4	g4			2348745.665	103008.343	2098.092					
4	g5			2348792.591	103084.939	2098.092					
4	g6			2348720.787	103025.084	2099.838					
4	g7			2348767.881	103099.992	2097.968					
4	g8			2348691.757	103044.957	2098.092					
4	g9			2348731.868	103113.803	2100.658					
4	g10			2348696.025	103038.344	2098.092					
4	g11			2348742.951	103114.94	2098.092					
5	C/L Hub	19+16	725	2348712.165	103824.838	2100.228					
5	Structure Hub			2348709.865	103824.816	2100.228					
5	poll			2348700.115	103824.725	2100.229					
5	polr			2348719.615	103824.907	2100.229					
6	C/L Hub	26+42	646	2348705.416	104550.096	2119.063					
6	Structure Hub			2348708.416	104550.124	2119.063					
6	poll			2348698.666	104550.033	2119.062					
6	polr			2348718.166	104550.215	2119.062					
7	C/L Hub	32+88	540	2348699.404	105196.198	2112.000					
7	Structure Hub			2348699.404	105196.198	2112.000					
7	poll			2348689.653	105196.107	2112.001					
7	polr			2348709.154	105196.289	2112.001					
8	C/L Hub	38+28	726	2348694.382	105735.865	2111.055					
8	Structure Hub			2348694.382	105735.865	2111.055					
8	poll			2348684.631	105735.774	2111.056					
8	polr			2348704.132	105735.956	2111.056					
9	C/L Hub	45+54	749	2348687.622	106462.254	2111.858	4°	58'	19''	RT	
9	Structure Hub			2348692.619	106462.084	2111.858					
9	poll			2348702.364	106461.751	2111.857					
9	polr			2348682.874	106462.416	2111.857					

Struct. No.	Stake Description	Station	Ahead Span	X	Y	Z	Line Angle				Comments
		(ft)	(ft)	(ft)	(ft)	(ft)	DEG	MIN	SEC	DEFL	
9	guy1			2348674.57	106465.141	2111.857					
9	g3			2348674.404	106460.262	2111.857					
10	C/L Hub	53+04	560	2348745.668	107209.993	2122.279	39°	46'	11''	RT	
10	Structure Hub			2348748.402	107208.757	2122.279					
10	poll			2348724.709	107219.466	2122.280					
10	polc			2348748.402	107208.757	2122.280					
10	polr			2348772.095	107198.047	2122.280					
10	guy2			2348671.435	107243.548	2122.280					
10	guy3			2348683.446	107247.642	2122.280					
10	guy4			2348676.297	107231.827	2122.280					
10	guy5			2348707.138	107236.932	2122.280					
10	guy6			2348699.99	107221.117	2122.280					
10	guy7			2348730.828	107226.224	2122.280					
10	guy8			2348723.679	107210.409	2122.280					
11	C/L Hub	58+66	559	2349137.161	107612.45	2124.878					
11	Structure Hub			2349137.161	107612.45	2124.878					
11	poll			2349130.171	107619.249	2124.877					
11	polr			2349144.15	107605.652	2124.877					
12	C/L Hub	64+24	579	2349526.888	108013.094	2122.553					
12	Structure Hub			2349526.888	108013.094	2122.553					
12	poll			2349519.899	108019.893	2122.555					
12	polr			2349533.878	108006.295	2122.555					
13	C/L Hub	70+04	678	2349930.743	108428.26	2131.124	45°	00'	00''	LT	
13	Structure Hub			2349936.782	108425.856	2131.124					
13	poll			2349960.938	108416.238	2131.125					
13	polc			2349936.782	108425.856	2131.125					
13	polr			2349912.625	108435.473	2131.125					
13	guy2			2350015.256	108394.613	2131.125					
13	guy3			2350003.445	108389.975	2131.125					
13	guy4			2350009.864	108406.1	2131.125					
13	guy5			2349979.288	108399.593	2131.125					
13	guy6			2349985.708	108415.717	2131.125					
13	guy7			2349955.134	108409.209	2131.125					
13	guy8			2349961.554	108425.334	2131.125					
14	C/L Hub	76+79	742	2349921.413	109103.655	2135.444					
14	Structure Hub			2349921.413	109103.655	2135.444					
14	poll			2349931.163	109103.79	2135.444					
14	polr			2349911.663	109103.521	2135.444					
15	C/L Hub	84+21	655	2349911.163	109845.665	2128.620					
15	Structure Hub			2349911.163	109845.665	2128.620					
15	poll			2349920.913	109845.799	2128.620					
15	polr			2349901.414	109845.53	2128.620					
16	C/L Hub	90+76	647	2349902.121	110500.272	2112.477					
16	Structure Hub			2349902.121	110500.272	2112.477					
16	poll			2349911.871	110500.407	2112.477					
16	polr			2349892.371	110500.138	2112.477					
17	C/L Hub	97+20	732	2349893.225	111144.297	2097.716	44°	59'	55''	LT	
17	Structure Hub			2349899.195	111146.867	2097.716					
17	poll			2349923.077	111157.147	2097.717					
17	polc			2349899.195	111146.867	2097.717					
17	polr			2349875.313	111136.586	2097.717					
17	guy2			2349976.777	111180.264	2097.717					
17	guy3			2349971.705	111168.632	2097.717					
17	guy4			2349964.842	111184.574	2097.717					
17	guy5			2349947.823	111158.352	2097.717					
17	guy6			2349940.96	111174.293	2097.717					
17	guy7			2349923.944	111148.073	2097.717					
17	guy8			2349917.081	111164.014	2097.717					
18	C/L Hub	104+49	457	2349370.382	111652.917	2107.911					
18	Structure Hub			2349370.382	111652.917	2107.911					
18	poll			2349377.181	111659.906	2107.913					
18	polr			2349363.583	111645.928	2107.913					
19	C/L Hub	109+07	483	2349042.637	111971.746	2124.997					
19	Structure Hub			2349042.637	111971.746	2124.997					
19	poll			2349049.436	111978.735	2124.998					
19	polr			2349035.838	111964.757	2124.998					
20	C/L Hub	113+89	750	2348696.643	112308.327	2107.392	40°	15'	44''	RT	
20	Structure Hub			2348696.643	112308.327	2107.392					

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
4	4–17–08	AS–BUILT
3	9–14–07	RE–ISSUED FOR CONSTRUCTION
2	8–17–07	RE–ISSUED FOR CONSTRUCTION
1	7–16–07	RE–ISSUED FOR CONSTRUCTION
0	4–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

MORTENSON

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TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE COORDINATE LIST

0 1" 2"

FILENAME	CL–01.dwg
SCALE	NONE

SHEET **CL-01**

Struct. No.	Stake Description	Station	Ahead Span	X	Y	Z	Line Angle				Comments
		(ft)	(ft)	(ft)	(ft)	(ft)	DEG	MIN	SEC	DEFL	
20	poll			2348673.207	112297.069	2107.394					
20	polc			2348696.643	112308.327	2107.394					
20	polr			2348720.08	112319.586	2107.394					
20	guy2			2348632.147	112277.344	2107.394					
20	guy3			2348631.326	112285.328	2107.394					
20	guy4			2348637.866	112271.713	2107.394					
20	guy5			2348648.532	112294.843	2107.394					
20	guy6			2348656.047	112279.198	2107.394					
20	guy7			2348671.966	112306.1	2107.394					
20	guy8			2348679.481	112290.456	2107.394					
21	C/L Hub	121+39	686	2348624.41	113054.693	2097.465	4°	55'	48"	RT	
21	Structure Hub			2348632.398	113055.121	2097.465					
21	poll			2348642.135	113055.642	2097.464					
21	polr			2348622.662	113054.6	2097.464					
21	guy1			2348618.669	113062.787	2097.464					
21	g3			2348619.565	113046.033	2097.464					
22	C/L Hub	128+26	857	2348617.249	113740.973	2071.474					
22	Structure Hub			2348615.249	113740.952	2071.474					
22	poll			2348605.499	113740.851	2071.474					
22	polr			2348625	113741.054	2071.474					
23	C/L Hub	136+82	633	2348608.313	114597.497	2079.064					
23	Structure Hub			2348613.312	114597.549	2079.064					
23	poll			2348603.562	114597.447	2079.064					
23	polr			2348623.062	114597.651	2079.064					
24	C/L Hub	143+15	625	2348601.712	115230.132	2073.397					
24	Structure Hub			2348603.212	115230.148	2073.397					
24	poll			2348593.462	115230.046	2073.397					
24	polr			2348612.962	115230.25	2073.397					
25	C/L Hub	149+39	734	2348595.195	115854.678	2080.671					
25	Structure Hub			2348601.195	115854.741	2080.671					
25	poll			2348591.445	115854.639	2080.670					
25	polr			2348610.945	115854.843	2080.670					
26	C/L Hub	156+74	675	2348587.534	116588.928	2065.015					
26	Structure Hub			2348584.534	116588.897	2065.015					
26	poll			2348574.784	116588.795	2065.014					
26	polr			2348594.285	116588.999	2065.014					
27	C/L Hub	163+49	687	2348580.491	117263.982	2047.000					
27	Structure Hub			2348580.491	117263.982	2047.000					
27	poll			2348570.741	117263.88	2046.999					
27	polr			2348590.241	117264.083	2046.999					
28	C/L Hub	170+36	375	2348573.321	117951.164	2053.000					
28	Structure Hub			2348574.821	117951.18	2053.000					
28	poll			2348565.071	117951.078	2052.999					
28	polr			2348584.571	117951.282	2052.999					
29	C/L Hub	174+11	751	2348569.408	118326.163	2060.001	3°	49'	23"	RT	
29	Structure Hub			2348570.908	118326.129	2060.001					
29	poll			2348580.656	118325.905	2060.000					
29	polr			2348561.16	118326.352	2060.000					
29	guy1			2348552.825	118328.985	2060.000					
29	g3			2348552.714	118324.105	2060.000					
30	C/L Hub	181+62	893	2348611.662	119076.001	2042.057	3°	45'	20"	LT	
30	Structure Hub			2348611.662	119076.001	2042.057					
30	poll			2348601.914	119076.23	2042.058					
30	polr			2348621.41	119075.771	2042.058					
30	guy1			2348634.551	119072.601	2042.058					
30	g4			2348654.239	119074.999	2042.058					
31	C/L Hub	190+55	681	2348603.397	119968.996	2043.105					
31	Structure Hub			2348603.397	119968.996	2043.105					
31	poll			2348613.147	119969.086	2043.107					
31	polr			2348593.647	119968.906	2043.107					
32	C/L Hub	197+36	765	2348597.09	120650.457	2028.915					
32	Structure Hub			2348597.09	120650.457	2028.915					
32	poll			2348606.84	120650.547	2028.913					
32	polr			2348587.34	120650.366	2028.913					
33	C/L Hub	205+01	720	2348590.013	121415.024	2024.000					
33	Structure Hub			2348590.013	121415.024	2024.000					
33	poll			2348599.764	121415.114	2024.000					
33	polr			2348580.263	121414.934	2024.000					
34	C/L Hub	212+21	945	2348583.353	122134.599	2022.239	3°	21'	59"	LT	

Struct. No.	Stake Description	Station	Ahead Span	X	Y	Z	Line Angle				Comments
		(ft)	(ft)	(ft)	(ft)	(ft)	DEG	MIN	SEC	DEFL	
34	Structure Hub			2348583.353	122134.599	2022.239					
34	poll			2348573.61	122134.222	2022.240					
34	polr			2348593.097	122134.975	2022.240					
34	guy1			2348603.867	122132.749	2022.240					
34	g3			2348623.363	122136.145	2022.240					
35	C/L Hub	221+66	524	2348519.104	123077.825	2019.669	3°	13'	58"	RT	
35	Structure Hub			2348519.684	123077.848	2019.669					
35	poll			2348529.427	123078.236	2019.670					
35	polr			2348509.941	123077.46	2019.670					
35	guy1			2348496.626	123079.793	2019.670					
35	g4			2348496.853	123074.076	2019.670					
36	C/L Hub	226+90	337	2348513.03	123602.004	2022.000					
36	Structure Hub			2348514.219	123602.018	2022.000					
36	poll			2348504.469	123601.905	2022.000					
36	polr			2348523.969	123602.131	2022.000					
37	C/L Hub	230+27	182	2348509.127	123938.71	2016.275					
37	Structure Hub			2348510.707	123938.728	2016.275					
37	poll			2348494.708	123938.543	2016.274					
37	polc			2348510.707	123938.728	2016.274					
37	polr			2348526.707	123938.914	2016.274					
37	g4			2348494.34	123970.286	2016.274					
37	g5			2348495.076	123906.8	2016.274					
37	g6			2348510.339	123970.472	2016.274					
37	g7			2348511.075	123906.985	2016.274					
37	g8			2348543.533	123968.855	2016.274					
37	g9			2348543.71	123910.234	2016.274					
37	g10			2348526.339	123970.657	2016.274					
37	g11			2348527.075	123907.171	2016.274					
37	g1			2348500.979	123955.133	2016.274					
38	C/L Hub	232+09	359	2348507.013	124121.195	2017.536	3°	12'	37"	RT	
38	Structure Hub			2348508.812	124121.166	2017.536					
38	poll			2348524.811	124120.903	2017.535					
38	polc			2348508.812	124121.166	2017.535					
38	polr			2348492.814	124121.428	2017.535					
38	g2			2348541.492	124090.881	2017.535					
38	g3			2348541.953	124149.5	2017.535					
38	g4			2348524.289	124089.162	2017.535					
38	g5			2348525.332	124152.644	2017.535					
38	g6			2348508.291	124089.424	2017.535					
38	g7			2348509.334	124152.907	2017.535					
38	g10			2348492.292	124089.687	2017.535					
38	g11			2348493.335	124153.169	2017.535					
38	g1			2348499.19	124105.114	2017.535					
39	C/L Hub	235+68	399	2348522.96	124479.789	2014.784					
39	Structure Hub			2348522.96	124479.789	2014.784					
39	wp			2348522.96	124479.789	2014.783					
40	C/L Hub	239+67	313	2348540.69	124878.47	2020.000	3°	05'	40"	LT	
40	Structure Hub			2348540.69	124878.47	2020.000					
40	wp			2348540.69	124878.47	2019.999					
41	C/L Hub	242+80	328	2348537.697	125191.331	2009.010					
41	Structure Hub			2348537.697	125191.331	2009.010					
41	wp			2348537.697	125191.331	2009.011					
42	C/L Hub	246+08	322	2348534.562	125518.996	2007.000					
42	Structure Hub			2348534.562	125518.996	2007.000					
42	wp			2348534.562	125518.996	2007.001					
43	C/L Hub	249+30	507	2348531.48	125841.16	2001.583	0°	37'	18"	RT	
43	Structure Hub			2348531.48	125841.16	2001.583					
43	wp			2348531.48	125841.16	2001.585					
44	C/L Hub	254+37	655	2348532.13	126348.141	1979.000					
44	Structure Hub			2348532.13	126348.141	1979.000					
44	wp			2348532.13	126348.141	1978.999					
45	C/L Hub	260+92	784	2348532.97	127003.57	1979.000	5°	04'	46"	LT	
45	Structure Hub			2348529.973	127003.441	1979.000					
45	poll			2348520.231	127003.021	1979.001					
45	polr			2348539.714	127003.86	1979.001					
45	guy1			2348553.037	127001.571	1979.001					
45	g4			2348572.522	127005.274	1979.001					
46	C/L Hub	268+76	751	2348464.556	127784.602	1982.871	9°	12'	52"	LT	
46	Structure Hub			2348469.486	127785.437	1982.871					

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
4	4-17-08	AS-BUILT
3	9-14-07	RE-ISSUED FOR CONSTRUCTION
2	8-17-07	RE-ISSUED FOR CONSTRUCTION
0	4-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

MORTENSON

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TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE COORDINATE LIST

0 1" 2"

FILENAME	CL-02.dwg
SCALE	NONE

SHEET
CL-02

Struct. No.	Stake Description	Station (ft)	Ahead Span (ft)	X (ft)	Y (ft)	Z (ft)	Line Angle DEG	MIN	SEC	DEFL	Comments
46	poll			2348495.122	127789.779	1982.869					
46	polc			2348469.486	127785.437	1982.869					
46	polr			2348443.85	127781.095	1982.869					
46	guy2			2348560.755	127800.896	1982.869					
46	guy3			2348554.084	127789.38	1982.869					
46	guy4			2348550.664	127809.572	1982.869					
46	guy5			2348528.448	127785.038	1982.869					
46	guy6			2348525.028	127805.23	1982.869					
46	guy7			2348502.813	127780.696	1982.869					
46	guy8			2348499.393	127800.888	1982.869					
47	C/L Hub	276+26	439	2348280.35	128511.494	1986.398	13°	03'	57"	RT	
47	Structure Hub			2348275.394	128510.825	1986.398					
47	poll			2348249.627	128507.347	1986.399					
47	polc			2348275.394	128510.825	1986.399					
47	polr			2348301.161	128514.303	1986.399					
47	guy2			2348179.642	128497.9	1986.399					
47	guy3			2348186.218	128509.908	1986.399					
47	guy4			2348189.167	128488.065	1986.399					
47	guy5			2348211.985	128513.386	1986.399					
47	guy6			2348214.934	128491.543	1986.399					
47	guy7			2348237.752	128516.864	1986.399					
47	guy8			2348240.701	128495.021	1986.399					
48	C/L Hub	280+65	1008	2348271.509	128950.201	1977.140					
48	Structure Hub			2348271.509	128950.201	1977.140					
48	poll			2348261.76	128950.005	1977.140					
48	polr			2348281.257	128950.398	1977.140					
49	C/L Hub	290+73	909	2348251.191	129958.433	1968.183					
49	Structure Hub			2348251.191	129958.433	1968.183					
49	poll			2348241.442	129958.236	1968.184					
49	polr			2348260.939	129958.629	1968.184					
50	C/L Hub	299+82	675	2348232.879	130867.109	1967.000					
50	Structure Hub			2348232.879	130867.109	1967.000					
50	poll			2348223.13	130866.913	1967.001					
50	polr			2348242.627	130867.306	1967.001					
51	C/L Hub	306+57	830	2348219.286	131541.593	1986.904					
51	Structure Hub			2348219.286	131541.593	1986.904					
51	poll			2348209.538	131541.397	1986.902					
51	polr			2348229.035	131541.79	1986.902					
52	C/L Hub	314+86	758	2348202.581	132370.575	1972.886	16°	16'	40"	RT	
52	Structure Hub			2348197.618	132371.183	1972.886					
52	poll			2348171.81	132374.345	1972.884					
52	polc			2348197.618	132371.183	1972.884					
52	polr			2348223.425	132368.022	1972.884					
52	guy2			2348105.736	132382.44	1972.884					
52	guy3			2348115.418	132391.569	1972.884					
52	guy4			2348112.928	132371.242	1972.884					
52	guy5			2348141.226	132388.408	1972.884					
52	guy6			2348138.736	132368.081	1972.884					
52	guy7			2348167.034	132385.246	1972.884					
52	guy8			2348164.544	132364.919	1972.884					
53	C/L Hub	322+42	747	2348399.89	133100.649	1990.909	15°	45'	22"	LT	
53	Structure Hub			2348404.85	133100.018	1990.909					
53	poll			2348430.643	133096.739	1990.908					
53	polc			2348404.85	133100.018	1990.908					
53	polr			2348379.057	133103.298	1990.908					
53	guy2			2348496.68	133088.344	1990.908					
53	guy3			2348486.955	133079.258	1990.908					
53	guy4			2348489.538	133099.574	1990.908					
53	guy5			2348461.162	133082.537	1990.908					
53	guy6			2348463.745	133102.853	1990.908					
53	guy7			2348435.369	133085.816	1990.908					
53	guy8			2348437.952	133106.132	1990.908					
54	C/L Hub	329+89	835	2348391.649	133846.799	1993.000					
54	Structure Hub			2348391.649	133846.799	1993.000					
54	poll			2348401.399	133846.907	1993.000					
54	polr			2348381.899	133846.692	1993.000					
55	C/L Hub	338+23	566	2348382.43	134681.496	1980.528					
55	Structure Hub			2348381.36	134681.484	1980.528					
55	poll			2348391.11	134681.592	1980.529					
55	polr			2348371.61	134681.377	1980.529					
56	C/L Hub	343+89	850	2348376.178	135247.615	1981.001					
56	Structure Hub			2348375.048	135247.602	1981.001					
56	poll			2348384.798	135247.71	1981.001					
56	polr			2348365.298	135247.495	1981.001					
57	C/L Hub	352+40	657	2348366.787	136097.933	1981.900					
57	Structure Hub			2348366.087	136097.925	1981.900					
57	poll			2348375.837	136098.033	1981.899					
57	polr			2348356.337	136097.817	1981.899					
58	C/L Hub	358+97	620	2348359.526	136755.336	1982.204					
58	Structure Hub			2348359.526	136755.336	1982.204					
58	poll			2348369.276	136755.444	1982.203					
58	polr			2348349.776	136755.229	1982.203					
59	C/L Hub	365+17	730	2348352.68	137375.22	1968.002	9°	16'	02"	LT	
59	Structure Hub			2348354.672	137375.404	1968.002					
59	poll			2348374.091	137377.194	1968.001					
59	polc			2348354.672	137375.404	1968.001					
59	polr			2348335.253	137373.614	1968.001					
59	guy3			2348439.215	137383.196	1968.001					
59	guy1			2348447.64	137383.973	1968.001					
60	C/L Hub	372+47	749	2348227.25	138093.91	1965.000	9°	17'	02"	RT	
60	Structure Hub			2348219.533	138093.2	1965.000					
60	poll			2348200.113	138091.413	1965.001					
60	polc			2348219.533	138093.2	1965.001					
60	polr			2348238.952	138094.987	1965.001					
60	guy3			2348130.506	138085.007	1965.001					
60	guy1			2348122.08	138084.232	1965.001					
61	C/L Hub	379+95	489	2348219.203	138842.415	1989.753					
61	Structure Hub			2348219.203	138842.415	1989.753					
61	poll			2348209.453	138842.31	1989.752					
61	polr			2348228.953	138842.519	1989.752					
62	C/L Hub	384+84	645	2348213.945	139331.466	1982.966					
62	Structure Hub			2348213.945	139331.466	1982.966					
62	poll			2348204.195	139331.361	1982.965					
62	polr			2348223.695	139331.57	1982.965					
63	C/L Hub	391+29	750	2348207.019	139975.648	1975.699	8°	53'	07"	RT	
63	Structure Hub			2348199.286	139976.165	1975.699					
63	poll			2348180.016	139979.158	1975.697					
63	polc			2348199.286	139976.165	1975.697					
63	polr			2348218.557	139973.173	1975.697					
63	guy3			2348115.39	139989.193	1975.697					
63	guy1			2348107.029	139990.492	1975.697					
64	C/L Hub	398+77	898	2348314.728	140716.747	1970.441	7°	23'	27"	LT	
64	Structure Hub			2348322.453	140716.129	1970.441					
64	poll			2348341.683	140712.885	1970.441					
64	polc			2348322.453	140716.129	1970.441					
64	polr			2348303.223	140719.372	1970.441					
64	guy3			2348401.736	140702.756	1970.441					
64	guy1			2348410.077	140701.349	1970.441					
65	C/L Hub	407+75	748	2348328.487	141614.036	1970.642					
65	Structure Hub			2348328.487	141614.036	1970.642					
65	poll			2348338.237	141613.887	1970.640					
65	polr			2348318.738	141614.186	1970.640					
66	C/L Hub	415+23	632	2348339.952	142361.668	1971.158					
66	Structure Hub			2348339.952	142361.668	1971.158					
66	poll			2348349.701	142361.519	1971.158					
66	polr			2348330.202	142361.818	1971.158					
67	C/L Hub	421+54	485	2348349.639	142993.404	1975.500					
67	Structure Hub			2348349.639	142993.404	1975.500					
67	poll			2348359.389	142993.254	1975.500					
67	polr			2348339.89	142993.553	1975.500					
68	C/L Hub	426+39	781	2348357.071	143478.075	1995.000					
68	Structure Hub			2348357.071	143478.075	1995.000					
68	poll			2348366.821	143477.925	1995.001					
68	polr			2348347.322	143478.224	1995.001					
69	C/L Hub	434+20	853	2348369.048	144259.125	2001.355					
69	Structure Hub			2348369.048	144259.125	2001.355					
69	poll			2348378.798	144258.976	2001.354					
69	polr			2348359.299	144259.275	2001.354					

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ISSUE	DATE	DESCRIPTION
4	4-17-08	AS-BUILT
3	9-14-07	RE-ISSUED FOR CONSTRUCTION
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1	7-16-07	RE-ISSUED FOR CONSTRUCTION
0	4-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

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TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE COORDINATE LIST

0 1" 2"

FILENAME	CL-03.dwg
SCALE	NONE

SHEET **CL-03**

Struct. No.	Stake Description	Station	Ahead Span	X	Y	Z	Line Angle				Comments
		(ft)	(ft)	(ft)	(ft)	(ft)	DEG	MIN	SEC	DEFL	
70	C/L Hub	442+73	831	2348382.121	145111.625	1999.000					
70	Structure Hub			2348382.121	145111.625	1999.000					
70	poll			2348391.871	145111.475	1998.999					
70	polr			2348372.372	145111.774	1998.999					
71	C/L Hub	451+04	707	2348394.87	145943	2004.000	1°	58'	55"	LT	
71	Structure Hub			2348394.87	145943	2004.000					
71	poll			2348385.119	145942.981	2004.001					
71	polr			2348404.621	145943.019	2004.001					
71	guy1			2348417.805	145940.187	2004.001					
71	g3			2348417.794	145945.903	2004.001					
72	C/L Hub	458+12	715	2348381.251	146650.136	2013.563					
72	Structure Hub			2348383.89	146650.187	2013.563					
72	poll			2348393.639	146650.375	2013.563					
72	polr			2348374.141	146649.999	2013.563					
73	C/L Hub	465+26	715	2348367.489	147364.674	2025.260					
73	Structure Hub			2348368.859	147364.7	2025.260					
73	poll			2348378.608	147364.888	2025.260					
73	polr			2348359.11	147364.512	2025.260					
74	C/L Hub	472+41	793	2348353.727	148079.201	2027.000					
74	Structure Hub			2348353.727	148079.201	2027.000					
74	poll			2348363.476	148079.389	2027.000					
74	polr			2348343.979	148079.013	2027.000					
75	C/L Hub	480+34	881	2348338.455	148872.154	2035.000					
75	Structure Hub			2348337.666	148872.139	2035.000					
75	poll			2348347.414	148872.327	2034.999					
75	polr			2348327.917	148871.951	2034.999					
76	C/L Hub	489+15	776	2348321.488	149753.121	2027.258					
76	Structure Hub			2348320.319	149753.098	2027.258					
76	poll			2348330.067	149753.286	2027.257					
76	polr			2348310.57	149752.91	2027.257					
77	C/L Hub	496+91	715	2348306.552	150528.647	2037.340					
77	Structure Hub			2348303.522	150528.588	2037.340					
77	poll			2348313.271	150528.776	2037.338					
77	polr			2348293.774	150528.401	2037.338					
78	C/L Hub	504+05	740	2348292.79	151243.184	2042.000					
78	Structure Hub			2348288.571	151243.103	2042.000					
78	poll			2348298.32	151243.291	2042.000					
78	polr			2348278.822	151242.915	2042.000					
79	C/L Hub	511+45	919	2348278.542	151982.987	2020.438					
79	Structure Hub			2348276.362	151982.945	2020.438					
79	poll			2348286.111	151983.133	2020.439					
79	polr			2348266.613	151982.757	2020.439					
80	C/L Hub	520+65	924	2348260.836	152902.287	2012.739					
80	Structure Hub			2348259.877	152902.268	2012.739					
80	poll			2348269.625	152902.456	2012.737					
80	polr			2348250.128	152902.08	2012.737					
81	C/L Hub	529+89	805	2348243.047	153825.955	2016.000					
81	Structure Hub			2348238.048	153825.859	2016.000					
81	poll			2348228.299	153825.671	2015.999					
81	polr			2348247.797	153826.047	2015.999					
82	C/L Hub	537+95	720	2348227.552	154630.481	1995.370	84°	27'	44"	RT	
82	Structure Hub			2348227.552	154630.481	1995.370					
82	poll			2348205.697	154649.542	1995.369					
82	polc			2348227.552	154630.481	1995.369					
82	polr			2348249.407	154611.42	1995.369					
82	g2			2348205.781	154701.021	1992.469					
82	g3			2348154.758	154642.469	1991.051					
82	g4			2348205.799	154711.114	1992.350					
82	g5			2348144.692	154641.07	1991.327					
82	g6			2348227.654	154691.779	1992.629					
82	g7			2348166.577	154622.013	1991.356					
82	g8			2348249.48	154654.964	1993.896					
82	g9			2348201.156	154604.719	1993.427					
82	g10			2348249.506	154671.362	1993.984					
82	g11			2348190.874	154603.291	1993.820					
83	C/L Hub	545+07	951	2348942.73	154713.75	1977.00	5°	58'	09"	RT	
83	Structure Hub			2348942.73	154713.75	1977.00					
83	poll			2348943.68	154699.03	1977.00					
83	polr			2348942.43	154718.49	1977.00					
83	guy1, guy2			2348934.80	154736.04	1977.00					

Struct. No.	Stake Description	Station	Ahead Span	X	Y	Z	Line Angle				Comments
		(ft)	(ft)	(ft)	(ft)	(ft)	DEG	MIN	SEC	DEFL	
83	g6, g7			2348947.77	154736.87	1977.00					
84	C/L Hub	554+67	963	2349894.079	154724.911	1974.504					
84	Structure Hub			2349894.079	154724.911	1974.504					
84	poll			2349893.965	154734.661	1974.505					
84	polr			2349894.194	154715.161	1974.505					
85	C/L Hub	564+29	653	2350856.616	154736.202	1978.356					
85	Structure Hub			2350856.616	154736.202	1978.356					
85	poll			2350856.502	154745.952	1978.355					
85	polr			2350856.731	154726.452	1978.355					
86	C/L Hub	570+83	792	2351510.026	154743.866	2005.485					
86	Structure Hub			2351510.026	154743.866	2005.485					
86	poll			2351509.912	154753.616	2005.484					
86	polr			2351510.14	154734.116	2005.484					
87	C/L Hub	578+75	856	2352302.061	154753.156	1977.509					
87	Structure Hub			2352302.061	154753.156	1977.509					
87	poll			2352301.947	154762.906	1977.510					
87	polr			2352302.176	154743.406	1977.510					
88	C/L Hub	587+31	796	2353157.993	154763.196	1984.042					
88	Structure Hub			2353157.993	154763.196	1984.042					
88	poll			2353157.878	154772.946	1984.043					
88	polr			2353158.107	154753.446	1984.043					
89	C/L Hub	595+27	594	2353953.999	154772.532	2012.000					
89	Structure Hub			2353953.999	154772.532	2012.000					
89	poll			2353953.885	154782.282	2012.001					
89	polr			2353954.113	154762.782	2012.001					
90	C/L Hub	601+20	642	2354547.682	154779.496	2000.929	89°	48'	40"	LT	
90	Structure Hub			2354547.682	154779.496	2000.929					
90	poll			2354568.393	154759.198	2000.929					
90	polc			2354547.682	154779.496	2000.929					
90	polr			2354526.971	154799.794	2000.929					
90	g2			2354564.808	154712.852	2000.929					
90	g3			2354613.659	154763.617	2000.929					
90	g4			2354568.928	154706.145	2000.929					
90	g5			2354622.44	154759.743	2000.929					
90	g6			2354548.217	154726.442	2000.929					
90	g7			2354601.728	154780.041	2000.929					
90	g8			2354523.385	154753.448	2000.929					
90	g9			2354572.234	154804.215	2000.929					
90	g10			2354527.506	154746.74	2000.929					
90	g11			2354581.017	154800.339	2000.929					
91	C/L Hub	607+63	699	2354542.267	155421.523	2000.996					
91	Structure Hub			2354542.267	155421.523	2000.996					
91	poll			2354532.516	155421.441	2000.998					
91	polr			2354552.017	155421.605	2000.998					
92	C/L Hub	614+62	787	2354536.367	156120.963	1985.000					
92	Structure Hub			2354536.367	156120.963	1985.000					
92	poll			2354526.617	156120.881	1984.999					
92	polr			2354546.117	156121.045	1984.999					
93	C/L Hub	622+49	797	2354529.73	156907.862	1987.640					
93	Structure Hub			2354529.73	156907.862	1987.640					
93	poll			2354519.979	156907.78	1987.640					
93	polr			2354539.48	156907.945	1987.640					
94	C/L Hub	630+46	885	2354523.006	157704.981	1985.000					
94	Structure Hub			2354523.006	157704.981	1985.000					
94	poll			2354513.256	157704.899	1985.000					
94	polr			2354532.756	157705.063	1985.000					
95	C/L Hub	639+31	500	2354515.544	158589.64	1980.973					
95	Structure Hub			2354515.544	158589.64	1980.973					
95	poll			2354505.794	158589.558	1980.974					
95	polr			2354525.294	158589.723	1980.974					
96	C/L Hub	644+31	821	2354511.324	159089.977	1994.000					
96	Structure Hub			2354511.324	159089.977	1994.000					
96	poll			2354501.573	159089.894	1994.000					
96	polr			2354521.074	159090.059	1994.000					
97	C/L Hub	652+52	1016	2354504.397	159911.146	1998.731					
97	Structure Hub			2354504.397	159911.146	1998.731					
97	poll			2354494.647	159911.064	1998.731					
97	polr			2354514.148	159911.229	1998.731					
98	C/L Hub	662+69	772	2354495.826	160927.348	2005.186					
98	Structure Hub			2354495.826	160927.348	2005.186					

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
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2	8-17-07	RE-ISSUED FOR CONSTRUCTION
0	4-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

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TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE COORDINATE LIST

0 1" 2"

FILENAME	CL-04.dwg
SCALE	NONE

SHEET **CL-04**

Struct. No.	Stake Description	Station	Ahead Span	X	Y	Z	Line Angle				Comments
		(ft)	(ft)	(ft)	(ft)	(ft)	DEG	MIN	SEC	DEFL	
98	poll			2354486.076	160927.266	2005.184					
98	polr			2354505.576	160927.431	2005.184					
99	C/L Hub	670+41	943	2354489.312	161699.626	2018.808					
99	Structure Hub			2354489.312	161699.626	2018.808					
99	poll			2354479.561	161699.544	2018.807					
99	polr			2354499.062	161699.708	2018.807					
100	C/L Hub	679+83	633	2354481.361	162642.181	2049.912					
100	Structure Hub			2354481.361	162642.181	2049.912					
100	poll			2354471.611	162642.099	2049.911					
100	polr			2354491.112	162642.263	2049.911					
101	C/L Hub	686+17	207	2354476.02	163275.464	2035.882					
101	Structure Hub			2354476.02	163275.464	2035.882					
101	poll			2354456.519	163275.299	2035.881					
101	polc			2354476.02	163275.464	2035.881					
101	polr			2354495.52	163275.628	2035.881					
101	g2			2354436.018	163310.128	2035.881					
101	g3			2354437.103	163241.004	2035.881					
101	g4			2354456.159	163318.031	2035.881					
101	g5			2354456.88	163232.568	2035.881					
101	g6			2354475.659	163318.195	2035.881					
101	g7			2354476.38	163232.732	2035.881					
101	g8			2354515.431	163310.797	2035.881					
101	g9			2354515.512	163241.665	2035.881					
101	g10			2354495.16	163318.36	2035.881					
101	g11			2354495.881	163232.897	2035.881					
102	C/L Hub	688+24		2354474.272	163482.694	2030.585					
102	Structure Hub			2354474.272	163482.694	2030.585					
102	bpP			2354492.325	163476.859	2030.584					
102	bpX			2354456.329	163476.528	2030.584					
102	bpXY			2354456.219	163488.529	2030.584					
102	bpY			2354492.215	163488.86	2030.584					

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0	4–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

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TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE COORDINATE LIST

0 1" 2"

FILENAME	CL–05.dwg
SCALE	NONE

SHEET
CL-05

TATANKA WIND FARM
230 KV TRANSMISSION LINE

DRAWING LIST

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1	4–30–07	RE–ISSUED FOR CONSTRUCTION
0	4–20–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

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TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
DRAWING LIST

0 1" 2"

FILENAME	DL–01.dwg
SCALE	NONE

SHEET
DL-01

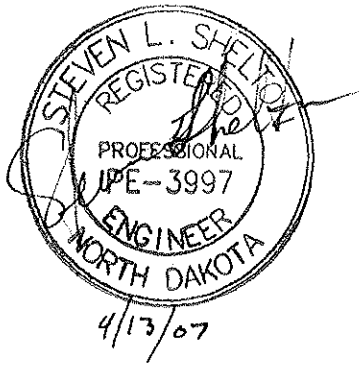
Tatanka Wind Energy

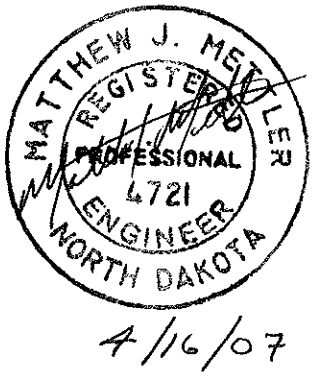
Interconnect Substation

Erection Specification

REV 0: ISSUE FOR CONSTRUCTION

April 13, 2007





TATANKA WIND ENERGY
INTERCONNECT SUBSTATION

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SECTION 02200
EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Earthwork.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
      c. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m)).
      d. D2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   2. Certifications.
   3. Test reports:
      a. Soils inspection and testing results.

B. Samples:
   1. Submit samples and source of fill and backfill materials proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fill and Backfill: Selected material approved by Engineer from site excavation or from off site borrow.

PART 3 - EXECUTION

3.1 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES

A. General:
   1. In general, work includes, but is not necessarily limited to, excavation for structures, removal of underground obstructions and undesirable material, backfilling, filling, and fill, backfill, and subgrade compaction.

2. In this Section of the Specifications, the word "foundations" includes footings, base slabs, foundation walls, mat foundations, grade beams, piers and any other support placed directly on soil.
3. In the paragraphs of this Section of the Specifications, the word "soil" also includes any type of rock subgrade that may be present at or below existing subgrade levels.

B. Excavation Requirements for Structures:
1. Dimensions:
   a. Excavate to elevations and dimensions indicated or specified.
   b. Allow additional space as required for construction operations and inspection of foundations.
2. Level off bottoms of excavations to receive foundations, or equipment support pads.
   a. Remove loose materials and bring excavations into approved condition to receive concrete or fill material.
   b. Do not carry excavations lower than shown for foundations except as directed by Engineer.
   c. If any part of excavations is carried below required depth without authorization, maintain excavation and start foundation from excavated level with concrete of same strength as required for superimposed foundation, and no extra compensation will be made to Contractor therefore.
3. Notify Engineer as soon as excavation is completed in order that subgrades may be inspected.
   a. Do not commence further construction until subgrade under foundations and under equipment support pads has been inspected and approved by the Engineer as being free of undesirable material, being of compaction density required by this specification, and being capable of supporting the allowable foundation design bearing pressures and superimposed foundation, fill, and equipment loads to be placed thereon.
   b. Engineer shall be given the opportunity to inspect subgrade below fill material both prior to and after subgrade compaction.
   c. Place foundations and equipment support pads as soon as weather conditions permit after excavation is completed, inspected, and approved and after forms and reinforcing are inspected and approved.
   d. Before concrete or fill material is placed, protect approved subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.
4. Do not place equipment support pads on grade until subgrade below has been approved, reinforcement placement has been approved, and Contractor receives approval to commence slab construction.
   a. Do not place equipment support pads when temperature of air surrounding the slab and pads is or is expected to be below 40 DegF before structure is completed and heated to a temperature of at least 50 DegF.
5. Protection of structures:
   a. Prevent new structures from becoming damaged due to construction operations or other reasons.
   b. Prevent subgrade under new foundations from becoming wet and undermined during construction due to presence of surface or subsurface water or due to construction operations.
6. Frost protection:
   a. Do not place foundations or equipment support pads on frozen ground.
   b. When freezing temperatures may be expected, do not excavate to full depth indicated, unless foundations or equipment support pads can be placed immediately after excavation has been completed and approved.
   c. Protect excavation from frost if placing of concrete is delayed.
   d. Protect subgrade under foundations of a structure from becoming frozen until structure is completed and heated to a temperature of at least 50 DegF.

C. Filling and Backfilling Outside of Structures.
   1. This paragraph of this Specification applies to fill and backfill placed outside of structures above bottom level of both foundations but not under paving.
   2. Provide material as approved by Soils Engineer for filling and backfilling outside of structures.
   3. Fill and backfill placement:
      a. Prior to placing fill and backfill material, obtain optimum moisture and maximum density properties for proposed material from Soils Engineer.
      b. Place fill and backfill material in thin lifts as necessary to obtain required compaction density.
      c. Compact material with equipment of proper type and size to obtain density specified.
      d. Use only hand operated equipment for filling and backfilling next to walls and retaining walls.
      e. Do not place fill or backfill material when temperature is less than 40 DegF and when subgrade to receive material is frozen, wet, loose, or soft.
      f. Use vibratory equipment for compacting granular material; do not use water.

END OF SECTION

SECTION 02221
TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavation, trenching, backfilling and compacting for all underground utilities.

B. Related Sections include but are not necessarily limited to:
   1. Section 02200 - Earthwork.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
      c. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
      d. D2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
      e. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      f. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

1.3 DEFINITIONS

A. Excavation: All excavation will be defined as unclassified.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

1.5 PROJECT CONDITIONS

A. Protect and maintain bench marks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of Owner and controlling agency.

B. Verify location of existing underground utilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill Material:
   1. As approved by Engineer.
      a. Free of rock cobbles, roots, sod or other organic matter, and frozen material.

b. Moisture content at time of placement: 3 percent plus/minus of optimum moisture content as specified in accordance with ASTM D698 and/or ASTM D1557.

B. Bedding Materials:
1. As approved by the Engineer.
2. Granular bedding materials:
a. ASTM C33, gradation 67 (3/4 IN to No. 4 sieve) defined below:

Sieve Size	1 IN	3/4 IN	3/8 IN	No. 4	No. 20
Percent Passing by Weight	100	90-100	20-55	0-10	0

PART 3 - EXECUTION

3.1 GENERAL

A. Remove and dispose of unsuitable materials as directed by Soils Engineer to site provided by Owner.

3.2 EXCAVATION

A. Unclassified Excavation: Remove rock excavation, clay, silt, gravel, hard pan, loose shale, and loose stone as directed by Soils Engineer.

B. Trenching for Electrical Installations:
1. Modify for electrical installations as follows:
a. Open no more than 600 LF of trench in exterior locations for trenches more than 12 IN but not more than 30 IN wide.
b. Any length of trench may be opened in exterior locations for trenches which are 12 IN wide or less.
c. Do not over excavate trench.
d. Cut trenches for electrical runs with minimum 30 IN cover, unless otherwise specified or shown on Drawings.
e. See Division 16 for additional requirements.

3.3 BACKFILLING METHODS

A. Do not backfill until tests to be performed on system show system is in full compliance to specified requirements.

B. Backfilling for Electrical Installations:
a. Observe notes and details on electrical drawings for fill in immediate vicinity of direct burial cables.

3.4 COMPACTION

A. General:
1. Place and assure bedding, backfill, and fill materials achieve an equal or "higher" degree of compaction than undisturbed materials adjacent to the work.
2. In no case shall degree of compaction below "Minimum Compaction" specified be accepted.

B. Compaction Requirements:
1. Unless noted otherwise on Drawings or more stringently by other sections of these Specifications, comply with following trench compaction criteria:

MINIMUM COMPACTIONS

LOCATION	SOIL TYPE	DENSITY
2. Bedding material:		
All locations	Cohesionless soils	75 percent of max relative density by ASTM D4253 and D4254
3. Carefully compacted backfill:		
All applicable areas	Cohesive soils	95 percent of max dry density by ASTM D698 and ASTM D1557
	Cohesionless soils	75 percent of max relative density by ASTM D4253 and D4254

END OF SECTION

SECTION 02260
FINISHED GRADING (GRAVEL/CRUSHED ROCK)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Finished grading.

B. Related Sections include but are not necessarily limited to:
   1. Section 02200 - Earthwork.

C. Location of Work: All areas within limits of grading and all areas outside limits of grading which are disturbed in the course of the work.

1.2 SUBMITTALS

A. Shop Drawings:
   1. Project Data: Test reports for furnished topsoil.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Gravel Surfacing:
   1. Material shall consist of crushed stone or crushed gravel conforming to the following gradation:

SIEVE SIZE	PERCENTAGE BY WEIGHT
1 inch (sq. mesh)	100
¾ inch (sq. mesh)	50
3/8 inch (sq. mesh)	5 to 10
No. 4 (sq. mesh)	4 to 9
No. 8 (sq. mesh)	0 to 2

2.2 TOLERANCES

A. Finish Grading Tolerance: 0.1 FT plus/minus from required elevations.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall provide labor, material, and heavy equipment necessary to provide a finished gravel surface as shown on "Site Contour and Details".

B. This material is intended to provide the necessary drain field to minimize fire hazard due to failure of oil-filled equipment, control earth potentials under fault conditions, control vegetation, and provide a neat and dust-free finish surface.

C. Contractor shall provide, at least two weeks prior to placement, a sample of intended surfacing material for Engineer's approval.

D. Material proposed for use as finish gravel should match the texture and appearance of the existing finish as closely as practical.

E. Furnish and place gravel surfacing over the entire fenced area of the substation to a distance of four feet outside the fence lines as shown on the Drawings.

F. Gravel shall be placed in a smooth layer and compacted to a depth of six inches.

END OF SECTION

SECTION 03108
FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Formwork requirements for concrete construction.

B. Related Sections include but are not necessarily limited to:
   1. Section 03311 - Concrete Mixing, Placing, Jointing, and Curing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
      b. 347R, Guide to Formwork for Concrete.
   2. Building code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2003 Edition including all amendments, referred to herein as Building Code.

B. Miscellaneous:
   1. Design and engineering of formwork, as well as its construction is the responsibility of the Contractor.
   2. Design requirements:
      a. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code.
         1) Where conflicts occur between the above two standards, the more stringent requirements shall govern.
      b. Design formwork to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.
   3. For slabs not cast on the ground, develop a procedure and schedule for removal of shores and for calculating the loads transferred to the structure during this process.
      a. Perform structural calculations as required to prove that all portions of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus the loads placed thereon.
      b. When developing procedure, schedule and structural calculations, consider the following at each stage of construction:
         1) The structural system that exists.
         2) Effects of all loads during construction.
         3) Strength of concrete.
         4) The influence of deformations of the structure and shoring system on the distribution of dead loads and construction loads.
         5) The strength and spacing of shores or shoring systems used, as well as the method of shoring, bracing, shore removal, and reshoring including the minimum time intervals between the various operations.
         6) Any other loading or condition that affects the safety or serviceability of the structure during construction.

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer and type of proposed form materials.
      d. Manufacturer and type of proposed form ties.
      e. Manufacturer and type of proposed form coating material.

B. Samples:
   1. A 12 IN SQ sample of each of the following form finishes:

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Stay-in-place forms:
      a. Alabama Metal Industries Corporation.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Forms for Surfaces Exposed to View:
   1. Wood forms:
      a. New 5/8 or 3/4 IN 5-ply structural plywood of concrete form grade.
      b. Built-in-place or prefabricated type panel.
      c. 4 x 8 FT sheets for built-in-place type except where smaller pieces will cover entire area.
      d. When approved, plywood may be reused.
   2. Metal forms:
      a. Metal forms excluding aluminum may be used.
      b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.

2.3 ACCESSORIES

A. Form Ties:
   1. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
   2. 3/4 IN minimum to 1 IN maximum diameter cones on both ends.
   3. Embedded portion of ties to be not less than 1-1/2 IN from face of concrete after ends have been removed.

B. Stay-In-Place Forms:
   1. Ribbed expanded metal leave-in-place concrete forms commercially fabricated to provide an intentionally rougher surface.
   2. Hot-dipped galvanized.
   3. Similar to "Stay-Form" by Alabama Metal Industries Corporation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Form Surface Treatment:
   1. Before placing of either reinforcing steel or concrete, cover surfaces of forms with an approved coating material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
      a. A field applied form release agent or sealer of approved type or a factory applied nonabsorptive liner may be used.
   2. Do not allow excess form coating material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

B. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.
   1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 5 FT apart.

C. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.2 ERECTION

A. Install products in accordance with manufacturer's instructions.

B. Tolerances:
   1. Variation from plumb:
      a. In lines and surfaces of columns, piers, walls, and in risers.
         1) Maximum in any 10 FT of height: 1/4 IN.
         2) Maximum for entire height: 1/2 IN.
      b. For control-joint grooves, and other exposed to view lines:
         1) Maximum in any 20 FT length: 1/4 IN.
         2) Maximum for entire length: 1/2 IN.
   2. Variation from level or from grades specified:
      a. In slab, measured before removal of supporting shores.
         1) Maximum in any 10 FT of length: 1/4 IN.
         2) Maximum in any bay or in any 20 FT length: 3/8 IN.
         3) Maximum for entire length: 3/4 IN.
      b. In exposed horizontal grooves, and other exposed to view lines:
         1) Maximum in any bay or in 20 FT length: 1/4 IN.
         2) Maximum for entire length: 1/2 IN.
   3. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 IN.
   4. Variation in thickness of slabs: Maximum of -1/4 IN, +1/2 IN.
   5. Footings and foundations:
      a. Variations in concrete dimensions in plan: -1/2 IN, +2 IN.
      b. Misplacement or eccentricity:
         1) 2 percent of footing width in direction of misplacement but not more than 2 IN.
      c. Thickness:
         1) Decrease in specified thickness: 5 percent.
         2) Increase in specified thickness: No limit except that which may interfere with other construction.

6. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and bench marks to be used for reference purposes to check tolerances.
7. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.
8. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.

C. Make forms sufficiently tight to prevent loss of mortar from concrete.

D. Place 3/4 IN chamfer strips in exposed to view corners of forms to produce 3/4 IN wide beveled edges.

E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 IN.
1. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
2. Where possible, locate juncture of built-in-place wood or metal forms at control joints or at construction joints.

F. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.

G. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.

H. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.

I. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.
1. Securely brace forms against lateral deflection.
2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

J. Stay-In-Place Forms:
1. Support stay-in-place forms as required to maintain the formwork in proper position.
2. Hold the edge of stay-in-place forms back a minimum of 2 IN from all smooth formed concrete surfaces.
3. Stay-in-place forms may be used at the Contractor's option at:
   a. Surfaces that will be backfilled with soil. Maintain a minimum of 3 IN of concrete cover over all reinforcing.
   b. Roughened construction joints.
   c. Other locations approved by Engineer.

3.3 REMOVAL OF FORMS

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads places thereon.

B. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.

1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Section 03311.

D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.

E. Formwork for parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

F. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28-day compressive strength.
1. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

3.4 RESHORING

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.

B. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.

C. During reshoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs.

E. Tighten reshores to carry their required loads without overstressing.

F. Shoring, reshoring and supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. For floors supporting shores under newly placed concrete leave original supporting shores in place or reshore.
1. Reshoring system shall have a capacity sufficient to resist anticipated loads.
2. Locate reshores directly under a shore position above.

H. In multi-story buildings, extend reshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads in such a manner that design superimposed loads of floors supporting shores are not exceeded.

END OF SECTION

SECTION 03208
REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforcing bar requirements for concrete construction.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. SP-66, ACI Detailing Manual.
      b. 318, Building Code Requirements for Structural Concrete.
   2. ASTM International (ASTM):
      a. A185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
      b. A497, Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
      c. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement (Including Supplementary Requirements S1).
      d. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
      e. A775, Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
   3. American Welding Society (AWS):
      a. D1.4, Structural Welding Code - Reinforcing Steel.
   4. Concrete Reinforcing Steel Institute (CRSI):
      a. Manual of Standard Practice.

B. Qualifications:
   1. Welding operators, processes and procedures to be qualified in accordance with AWS D1.4.
   2. Welding operators to have been qualified during the previous 12 months prior to commencement of welding.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Mill certificates for all reinforcing.
      d. Manufacture and type of proprietary rebar mechanical splices.
      e. Manufacturer and type of rebar adhesive anchor including installation instructions.
   2. Qualifications of welding operators, welding processes and procedures.
   3. Rebar number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and rebar supports.
   4. Sufficient rebar details to permit installation of reinforcing.
   5. Rebar details in accordance with ACI SP-66.
   6. Locations where proprietary rebar mechanical splices are required or proposed for use.
   7. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.

a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Support and store all reinforcing above ground.

B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

C. Handling of Epoxy-Coated Rebar:
   1. Use padded or nonmetallic slings and padded straps to protect coated reinforcement from damage.
   2. Handle bundled bars to prevent sagging that could damage the coating.
   3. Do not drop or drag rebars.
   4. Store on wooden cribbing.
   5. Coated rebars subject to rejection by Engineer if rebar coating has been damaged.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

A. Subject to compliance with Contract Documents, the following Manufacturers are acceptable:
   1. Rebar adhesive anchors:
      a. HIT-HY150 System by HILTI FASTENING SYSTEMS, INC.
      b. Epcon Adhesive Anchoring System by ITW Ramset/Red Head.
      c. Power-Fast by Powers Fastening, Inc.
   2. Rebar mechanical splices:
      a. Lenton Rebar Splicing by Erico, Inc.
      b. Richmond dowel bar splicer system by Richmond Screw and Anchor Co., Inc.
      c. Bar-Grip Systems by Barsplice Products, Inc.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Reinforcing Bars: ASTM A615, grade 60, deformed.

B. Reinforcing Bars to be Welded: ASTM A706.

C. Welded Wire Fabric: ASTM A185 or ASTM A497.

D. Smooth Dowel Bars: ASTM A615, grade 60 with metal end cap to allow longitudinal movement equal to joint width plus 1 IN.

E. Epoxy-Coated Rebars: ASTM A775 and A615, Grade 60, meeting Annex A1 for epoxy coating.

F. Epoxy-Coated Rebar Patching Material:
   1. Compatible with the coating material.
   2. Inert in concrete.
   3. Meet requirements of Annex A1 of ASTM A775.
   4. Obtained from the manufacturer of the epoxy resin that was used to originally coat the rebars.

G. Proprietary Rebar Mechanical Splices: To develop in tension and compression a minimum of 125 percent of the yield strength of the rebars being spliced.

H. Welding Electrodes:
1. E90 meeting requirements of AWS D1.4.

I. Rebar Adhesive Anchors:
1. Manufactured for the specific purpose of embedding and developing the yield strength of rebars in hardened concrete.

2.3 ACCESSORIES

A. Metal Chairs, Runners, Bolsters, Spacers, Hangers, and Other Rebar Supports:
1. Plastic-coated tips in contact with forms.
2. Plastic coating meeting requirements of CRSI Manual of Standard Practice.

B. Protective plastic caps at mechanical splices.

2.4 FABRICATION

A. Tolerances:
1. Sheared lengths: +1 IN.
2. Overall dimensions of stirrups, ties and spirals: +1/2 IN.
3. All other bends: +0 IN, -1/2 IN.

B. Minimum diameter of bends measured on the inside of the rebar to be as indicated in ACI 318 Paragraph 7.2.

C. Ship rebars to jobsite with attached plastic or metal tags.
1. Place on each tag the mark number of the rebar corresponding to the mark number indicated on the Shop Drawing.
2. Mark numbers on tags to be so placed that the numbers cannot be removed.
3. For epoxy-coated rebars, use only plastic tags secured to rebars by nylon or plastic ties.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Tolerances:
1. Rebar placement:
a. Clear distance to formed surfaces: +1/4 IN.
b. Minimum spacing between bars: -1/4 IN.
c. Top bars in slabs:
1) Members 8 IN deep or less: +1/4 IN.
2) Members between 8 IN and 2 FT deep: -1/4 IN, +1/2 IN.
3) Members more than 2 FT deep: -1/4 IN, +1 IN.
d. Crosswise of members: Spaced evenly within +1 IN.
e. Lengthwise of members: +2 IN.
2. Minimum clear distances between rebars:
a. Slabs: Distance equal to rebar diameter, maxiumum aggragate size or 1 IN, whichever is greater.
b. Slab rebars shall be threaded through the slab vertical rebars without displacing the slab vertical rebars and still maintaining the clear distances required for the slab rebars.

B. Minimum concrete protective covering for reinforcement: As shown on Drawings.

C. Unless indicated otherwise on Drawings, provide splice lengths for reinforcing as follows:
1. For rebars: Class B splice meeting the requirements of Paragraph 12.15 of ACI 318.

2. For welded wire fabric: Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than 1 spacing of cross wires plus 2 IN, nor less than 1.5 x development length nor less than 6 IN. Development length shall be as required for the yield strength of the welded wire fabric in accordance with Paragraph 12.8 of ACI 318.
3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Drawings.

D. Welding:
1. Obtain approval by the Engineer prior to welding reinforcing.
2. Perform welding of rebars in accordance with requirements of AWS D1.4.
3. Have each welder place an approved identifying mark near each completed weld.

E. Placing Rebars:
1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.
2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM specification that governs for the rebar supplied.
3. Rebar support:
    a. Uncoated rebar:
        1) Support rebars and fasten together to prevent displacement by construction loads or placing of concrete.
        2) On ground, provide supporting concrete blocks or metal bar supports with bottom plate.
            a) Do not use concrete blocks to support slab-on-grade reinforcing.
        3) Over formwork, provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other rebar support. Only tips in contact with the forms need to be plastic coated.
    b. Coated rebar:
        1) Support coated rebars and fasten together to prevent displacement.
        2) Use plastic or nylon ties to hold rebars rigidly in place.
        3) Support rebars by use of plastic or plastic-coated chairs, runners, bolsters, spacers, hangers and rebar supports as required.
4. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, rebars in the upper layers shall be placed directly above rebars in the bottom layer with clear distance between layers to be 1 IN. Place spacer rebars at 3 FT maximum centers to maintain the required 1 IN clear distance between layers.
5. Extend reinforcement to within 2 IN of concrete perimeter edges. If perimeter edge is formed by earth or stay-in-place forms, extend reinforcement to within 3 IN of the edge.
6. To assure proper placement, furnish templates for all column vertical bars and dowels.
7. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer. Do not bend reinforcing by means of heat.
8. Do not tack weld reinforcing.
9. Embed rebars into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:
    a. Drill hole in concrete with diameter and depth as required to develop 125 percent of the yield strength of the bar according to manufacturer's requirements.
    b. Place adhesive in drilled hole.
    c. Insert rebar into hole and adhesive in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. Reinforcement Congestion and Interferences:
   1. Notify Engineer whenever the specified clearances between rebars cannot be met.
   2. Do not place any concrete until the Engineer submits a solution to rebar congestion problem.
   3. Rebars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
   4. If rebars are moved more than one bar diameter, obtain Engineer's approval of resulting arrangement of rebars.
   5. No cutting of rebars shall be done without written approval of Engineer.

B. Inspection of Epoxy-Coated Rebars:
   1. Coated rebars will be inspected on the jobsite for handling defects, coating abrasion, coating thickness and continuity of coating.
   2. Engineer may defer final inspection of rebar coating integrity and repairs until the rebars have been erected and all handling is completed.
   3. Repair coated areas as directed by Engineer. Do not place concrete until all repairs to coatings have been completed.

C. Patching of Epoxy-Coated Rebar:
   1. Patching and repair to be performed in accordance with the instructions of patching material manufacturer.
   2. Patching material to provide a minimum film thickness of 5 mils over the bare area. Thickness of area adjacent to patched area not to exceed 15 mils.
   3. Areas to be patched to be clean and free of surface contaminants. Treat areas in accordance with patching material manufacturer's instructions before oxidation occurs.
   4. Total surface area covered by patching material not to exceed 2 percent of total surface area of the rebar.
   5. Rebar welds and adjacent bare rebar areas to also be patched after welding is completed.

D. Employ a testing laboratory to perform and report following:
   1. Review and approve Contractor proposed welding procedures and processes for conformance with AWS D1.4.
   2. Qualify welders in accord with AWS D1.4.
   3. Test three samples of each bar size and each type of weld in accord with AWS D1.4. The tensile strength of each test shall be not less than 125 percent of the required yield strength of the rebar tested.
   4. Conduct nondestructive field tests (radiographic or magnetic particle) on not less than one random sample for each 10 welds. In addition if any welds are found defective, test five previous welds performed by same welder.
   5. Visually inspect each weld for presence of cracks, undercuts, inadequate size and other visible defects.

END OF SECTION

SECTION 03308
CONCRETE, MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete materials, strengths and proportioning for concrete work.
   2. Grouting:
      a. Base plates for columns and equipment.
      b. Dowels and anchors into concrete.
      c. Patching cavities in concrete.
      d. As specified and indicated in the Contract Document.

B. Related Sections include but are not necessarily limited to:
   1. Section 03350 - Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
      b. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
      c. 212.3R, Chemical Admixtures for Concrete.
      d. 318, Building Code Requirements for Structural Concrete.
      e. 350, Code Requirements for Environmental Engineering Concrete Structures.
   2. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
      c. C94, Standard Specification for Ready-Mixed Concrete.
      d. C150, Standard Specification for Portland Cement.
      e. C157, Standard Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete.
      f. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
      g. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
      h. C494, Standard Specification for Chemical Admixtures for Concrete.
      i. C595, Standard Specification for Blended Hydraulic Cements.
      j. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
   3. Corps of Engineers(COE):
      a. CRD-C621, Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (NonShrink).

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's instructions.
      c. Concrete mix designs as required by Section 03350.
      d. Manufacture and type of proposed admixtures.
      e. Manufacturer and type of proposed non-shrink grout and grout cure/seal compound.
   2. Certifications:
      a. Certification of standard deviation value in psi for ready mix plant supplying the concrete.
      b. Certification that the fly ash meets the quality requirements stated in this Section, and fly ash supplier's certified test reports for each shipment of fly ash delivered to concrete supplier.
      c. Certification that the class of coarse aggregate meets the requirements of ASTM C33 for type and location of concrete construction.
      d. Certification of aggregate gradation.
   3. Test reports: Cement mill reports for all cement to be supplied.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:
   1. Store cement and pozzolan in weathertight buildings, bins, or silos which will exclude moisture and contaminants.
   2. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
   3. Allow natural sand to drain until it has reached a relatively uniform moisture content before use.
   4. Store admixtures in such a manner as to avoid contamination, evaporation, or damage.
      a. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure thorough distribution of ingredients.
      b. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics and performance.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Non-shrink grout:
      a. BASF Admixtures, Inc.
      b. Euclid Chemical Company.
      c. U. S. Grout.
      d. Upco.
      e. Set Products, Inc.
      f. L & M Construction Chemicals, Inc.
      g. Sika Corporation
   2. Epoxy grout:
      a. Ceilcote.
      b. Exxon Chemical Company.
      c. Sika Corporation.
      d. U. S. Grout.

e. Euclid Chemical Company.

2.2 MATERIALS

A. Cement:
1. ASTM C150, Type II modified or Type V.
2. Cement type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

B. Fly Ash:
1. ASTM C618, Class F or Class C.
2. Non-staining.
3. Suited to provide hardened concrete of uniform light gray color.
4. Maximum loss on ignition: 4 percent.
5. Compatible with other concrete ingredients and having no deleterious effects on the hardened concrete.
6. Produced by source approved by the State Highway Department in the state where the project is located for use in concrete for bridges.
7. Cement and fly ash type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

C. Admixtures:
1. Air entraining: ASTM C260.
2. Water reducing, retarding, and accelerating: Conform to ASTM C494, Types A through E, and provisions of ACI 212.3R.
3. High range water reducers (superplasticizers): Conform to ASTM C494, Types F or G.
4. Admixtures to be chloride free.
   a. Do not use calcium chloride.
5. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.

D. Water:
1. Potable.
2. Clean and free from deleterious substances.
3. Free of oils, acids and organic matter.

E. Aggregates for Normal Weight Concrete:
1. ASTM C33.
2. Fine and coarse aggregates to be regarded as separate ingredients.
3. Fine aggregates to be natural, not manufactured.
4. Coarse aggregate sieve analysis:
   a. For lean concrete, concrete topping, and integral wearing course: ASTM C33, size number 7 (maximum 1/2 IN).
   b. For all other concrete: ASTM C33, size number 57 (maximum 1 IN).
5. Provide aggregates approved for bridge construction by the State Highway Department in the State where the Project is located.
6. Pozzolan or other additives shall not be used to compensate for alkali reactivity of aggregates.

F. Maximum total chloride ion content for concrete mix including all ingredients measured as a weight percent of cement:
1. 0.06 for prestressed concrete.
2. 0.10 for all other concrete.

G. Sand Cement Grout:
1. Approximately 3 parts sand, 1 part Portland cement, 6 ±1 percent entrained air and water to produce a slump which allows grout to completely fill required areas and surround adjacent reinforcing.
a. Provide sand in accordance with requirements for fine aggregate for concrete.
2. Minimum 28-day compressive strength: 4000 psi.

H. Non-shrink Grout:
1. Non-shrink, non-metallic, non-corrosive, and non-staining.
2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.
3. Grout to produce a positive but controlled expansion.
a. Mass expansion shall not be created by gas liberation or by other means.
4. Minimum 28-day compressive strength: 6500 psi.
5. BASF Admixtures, Inc. "Masterflow, 713 Plus"; Euclid Chemical "NS Grout"; Sauereisen Cements "F-100 Level Fill Grout"; U. S. Grout "Five Star Grout"; Set Products, Inc. "Set Non-Shrink Grout"; The Upco Corp "Upcon"; L & M "Crystex"; Sika Corporation "Sika Grout 212"; or equal.
6. In accordance with COE CRD-C621.

I. Epoxy Grout:
1. Three-component epoxy resin system:
a. Two (2) liquid epoxy components.
b. One (1) inert aggregate filler component.
2. Adhesive:
a. BASF "Masterflow 648 CP".
b. Exxon Chemical Company "Escoweld 2505."
c. Sika "Sikadur Hi-Mod."
d. U. S. Grout "Five Start Epoxy Grout."
e. Euclid Chemical "E3-G."
f. Or equal.
3. Aggregate:
a. BASF "Masterflow 648 CP".
b. Exxon Chemical Company "Escoweld 2510."
c. Sika aggregate.
d. U. S. Grout aggregate.
e. Euclid Chemical "Euclid aggregate."
f. Or equal.
4. Aggregate manufacturer shall be the same as the adhesive manufacturer.
5. The aggregate shall be compatible with the adhesive.
6. Each component furnished in separate package for mixing at jobsite.

2.3 MIXES

A. General:
1. Provide concrete capable of being placed without aggregate segregation and, when cured, of developing all properties specified.
2. Ready-mixed concrete shall conform to ASTM C94.
3. All concrete to be normal weight concrete, weighing approximately 145 to 150 LBS per cubic foot at 28 days after placement.

B. Minimum 28-Day Compressive Strengths:

Normal weight concrete fill	3000 psi
Normal weight lean concrete	3000 psi

Normal weight concrete topping	4000 psi
Normal weight all other concrete	4000 psi
Normal weight and lightweight precast concrete	5000 psi
Normal weight concrete pavements	4000 psi
Normal weight concrete integral wearing course	6000 psi

C. Air Entrainment:
   1. Provide air entrainment in all concrete resulting in a total air content percent by volume as follows:
      a. 1-1/2 IN maximum aggregate size: 4-1/2 to 6-1/2 percent total air content.
      b. 1 IN maximum aggregate size: 5 to 7 percent total air content.
      c. 3/4 IN maximum aggregate size: 5 to 7 percent total air content.
      d. 1/2 IN maximum aggregate size: 5-1/2 to 8 percent total air content.
      e. Interior slabs and mats with power trowel finish: Maximum 3 percent total air content.

D. Slump:
   1. 4 IN maximum, 1 IN minimum measured at point of discharge into the concrete construction member.
   2. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
   3. Provide additional water or water reducing admixture at ready mix plant for concrete that is to be pumped to allow for slump loss due to pumping.
      a. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified and the maximum specified water-cement ratio is not exceeded.

E. Proportioning:
   1. General:
      a. Proportion ingredients to produce a mixture which will work readily into corners and angles of forms and around reinforcement by methods of placement and consolidation employed without permitting materials to segregate or excessive free water to collect on surface.
      b. Proportion ingredients to produce proper placability, durability, strength and other required properties.
   2. Normal weight concrete minimum cement contents and maximum water cement ratios:

SPECIFIED STRENGTH (PSI)	MINIMUM CEMENT (LBS/CY)	MAXIMUM WATER CEMENT RATIO BY WEIGHT
3000	517*	0.45
4000	564*	0.45
4500	611*	0.42
5000	611*	0.45
6000	658*	0.45

* If fly ash is proposed for use, the weight of fly ash plus weight of Portland cement shall equal these values.

   3. Fly ash:
      a. For cast-in-place concrete only, a maximum of 25 percent by weight of Portland cement content per cubic yard may be replaced with fly ash at a rate of 1 LB fly ash for 1 LB cement.

b. If fly ash is used, the water to fly ash plus cement ratio not to exceed the maximum water cement ratio specified in this Section.
c. Concrete containing fly ash shall not be used in the construction of the precast concrete units specified.

4. Water reducing, retarding, and accelerating admixtures:
   a. Use in accordance with manufacturer's instructions.
   b. Do not use unless required by these specifications or approved for use by Engineer.
5. High range water reducers (superplasticizers):
   a. Use in accordance with manufacturer's instructions.
   b. Do not use unless required by these Specifications or approved for use by Engineer.
6. Concrete mix proportioning methods for normal weight concrete:
   a. Method 1:
      1) Used when combination of materials proposed is to be evaluated and proportions selected to be on a basis of trial mixes.
      2) Produce mixes having suitable proportions and consistencies based on ACI 211.1, using at least three (3) different water cement ratios or cement contents which will produce a range of compressive strengths encompassing the required average strength.
      3) Design trial mixes to produce a slump within 0.75 IN of maximum specified, and for air entrained concrete, air content within 0.5 percent specified.
      4) For each water cement ratio or cement content, make at least four (4) compression test cylinders for specified test age, and cure in accordance with ASTM C192.
         a) Test for strength at 28 days in accordance with ASTM C39.
      5) From results of these tests, plot a curve showing relationship between water cement ratio or cement content and compressive strength.
      6) From this curve select water cement ratio or cement content to be used to produce required average strength.
      7) Use cement content and mixture proportions such that maximum water cement ratio is not exceeded when slump is maximum specified.
      8) Base field control on maintenance of proper cement content, slump, air content and water cement ratio.
      9) See paragraph hereafter for definition of required average strength.
   b. Method 2:
      1) In lieu of trial mixes, field test records for concrete made with similar ingredients may be used.
      2) Use of proposed concrete mix proportions based on field test records subject to approval by Engineer based on information contained in field test records and demonstrated ability to provide the required average strength.
      3) Field test records to represent materials, proportions and conditions similar to those specified.
         a) Changes in the materials, proportions and conditions within the test records shall have not been more restricted than those for the proposed concrete mix.
         b) Field test records shall meet the requirements of ACI 318 Paragraph 5.3.1.
      4) Required concrete proportions may be established by interpolation between the strengths and proportions of two (2) or more test records each of which meets the requirements of this Section.
7. Required average strength to exceed the specified 28-day compressive strength by the amount determined or calculated in accordance with Paragraph 5.3 of ACI 318 using the standard deviation of the proposed concrete production facility as described in Paragraphs 5.3.1 and 2 of ACI 318.

F. Allowable Shrinkage: 0.048 percent per ASTM C157.

2.4 SOURCE QUALITY CONTROL

A. To assure stockpiles are not contaminated or materials are segregated, perform any test for determining conformance to requirements for cleanness and grading on samples secured from aggregates at point of batching.

B. Do not use frozen or partially frozen aggregates.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Perform concrete tests per Section 03350.

B. Perform strength test on any concrete to which water has been added at the jobsite.

END OF SECTION

SECTION 03311

CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Mixing, placing, jointing, and curing of concrete construction.

B. Related Sections include but are not necessarily limited to:
   1. Section 03108 - Formwork.
   2. Section 03208 - Reinforcement.
   3. Section 03308 - Concrete, Materials and Proportioning.
   4. Section 03348 - Concrete Finishing and Repair of Surface Defects.
   5. Section 03350 - Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
      b. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
      c. 304.2R, Placing Concrete by Pumping Methods.
      d. 305R, Hot Weather Concreting.
      e. 306R, Cold Weather Concreting.
      f. 308, Standard Practice for Curing Concrete.
      g. 309R, Guide for Consolidation of Concrete.
   2. ASTM International (ASTM):
      a. C94, Standard Specification for Ready-Mixed Concrete.
      b. C171, Standard Specification for Sheet Materials for Curing Concrete.
      c. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      d. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
      e. D1056, Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber.
      f. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-Extruding and Resilient Bituminous Types).
   3. Corps of Engineers (COE):
      a. CRD-C572, Specifications for Polyvinylchloride Waterstops.
   4. National Ready Mixed Concrete Association (NRMCA):
      a. Checklist for Certification of Ready Mixed Concrete Production Facilities.

B. Qualifications:
   1. Ready Mixed Concrete Batch Plant: Certified by NRMCA.

1.3 DEFINITIONS

A. Words and terms used in this Specification are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
         1) Procedure for adding high-range water reducer at the jobsite.
      c. Scaled (minimum 1/8 IN per foot) drawings showing proposed locations of construction joints and joint keyway dimensions.
      d. Manufacturers and types:
         1) Joint fillers.
         2) Curing agents.
         3) Construction joint bonding adhesive.
         4) Pressure relief valves.
         5) Waterstops.
   2. Certifications:
      a. Ready mix concrete plant certification.
      b. Waterstops: Products shipped meet or exceed the physical properties specified.

B. Miscellaneous:
   1. Copies of concrete delivery tickets.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery:
   1. Concrete:
      a. Prepare a delivery ticket for each load of ready mixed concrete.
      b. Truck operator shall hand ticket to Contractor at the time of delivery.
      c. Ticket to show:
         1) Mix identification.
         2) Quantity delivered.
         3) Amount of material in each batch.
         4) Outdoor temperature in the shade.
         5) Time at which cement was added
         6) Time of delivery.
         7) Time of discharge.
         8) Amount of water added.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Neoprene Expansion Joint Fillers:
   1. Manufacturers:
      a. Permaglaze.
      b. Rubatex.
      c. Williams Products.
   2. Materials:
      a. Closed cell neoprene.
      b. ASTM D1056, Class SC, 2 to 5 psi compression deflection, Grade SCE-41.

B. Asphalt Expansion Joint Fillers:
   1. Manufacturers:
      a. W R Meadows.
      b. J and P Petroleum Products.

2. Materials: ASTM D994.

C. Fiber Expansion Joint Fillers:
1. Materials: ASTM D1751.

D. Waterstops, Bulb Type:
1. Manufacturers:
   a. Greenstreak Plastics Products.
   b. W R Meadows.
2. Materials:
   a. Virgin polyvinyl chloride compound not containing any scrap or reclaimed materials or pigment.
   b. Standard: COE CRD-C572.
3. In expansion joints:
   a. 9 IN wide x 3/8 IN thick tear web type waterstop.
   b. 2 IN minimum horizontal movement without rupturing.
   c. Similar to Greenstreak Plastic Products Style #700.
4. In all other joints:
   a. 6 IN wide x 3/8 IN thick bulb type.
   b. Similar to Greenstreak Plastics Products Style #705.
5. Provide hog rings or grommets at maximum 12 IN OC along the length of the waterstop.
6. Provide factory-made waterstop fabrications at all changes in direction, intersections and transitions, leaving only straight butt splices for the field.

E. Waterstops, Preformed - Strip Type:
1. Manufacturers:
   a. Hydrotite CJ by Greenstreak Plastics, Inc.
   b. Synko Flex.
   c. Volclay Waterstop Rx.
2. Materials:
   a. Hydrophilic type waterstop manufactured solely for the purpose of preventing water from traveling through construction joints.
   b. Hydrotite type CJ-0725-3K or approved equal.

F. Sand cement grout, non-shrink grout and epoxy grout: See Section 03308.

PART 3 - EXECUTION

3.1 PREPARATION

A. General:
1. Complete formwork.
   a. See Section 03108.
2. Remove earth, snow, ice, water, and other foreign materials from areas that will receive concrete.
3. Secure reinforcement in place.
   a. See Section 03208.
4. Position expansion joint material, anchors and other embedded items.
5. Obtain approval of reinforcement erection and placement prior to placing concrete.
6. Do not place concrete during rain, sleet, or snow, unless adequate protection is provided and approval is obtained.
   a. Plan size of crews with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
   b. Do not allow rainwater to increase mixing water nor to damage surface finish.

7. Coat all construction joints with an approved bonding material, before new concrete is placed.
    a. Apply proprietary bonding adhesive in accordance with manufacturer's instructions.
8. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.
9. Provide slabs of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
    a. For slabs on grade, slope top of subgrade to provide slab of required uniform thickness.

B. Preparation of Subgrade for Slabs On Ground:
1. Subgrade drained and of adequate and uniform load-bearing nature.
2. Obtain approval of subgrade compaction density prior to placing slabs on ground.
3. Maintain subgrade at a temperature above 32 DegF before concrete placing begins for a sufficient amount of time to remove frost.
4. Moisten subgrade to eliminate absorption.
    a. Keep subgrade moist at time of concreting.
    b. Allow no free-standing water on subgrade or soft or muddy spots when concrete is placed.

C. Edge Forms and Screeds:
1. Set accurately to produce designated elevations and contours of finished surface.
2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
3. Use strike off templates, or approved vibrating type screeds, to align concrete surfaces to contours of screed strips.

3.2 CONCRETE MIXING

A. General:
1. Provide all concrete from a central plant conforming to Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
2. Batch, mix, and transport in accordance with ASTM C94.

B. Control of Admixtures:
1. Charge admixtures into mixer as solutions.
    a. Measure by means of an approved mechanical dispensing device.
    b. Liquid considered a part of mixing water.
    c. Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.
2. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.
3. Complete addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.

C. Tempering and Control of Mixing Water:
1. Mix concrete only in quantities for immediate use.
2. Discard concrete which has set.
3. Discharge concrete from ready mix trucks within time limit and drum revolutions stated in ASTM C94.
4. Addition of water at the jobsite:
    a. See Section 03308 for specified water cement ratio and slump.
    b. Do not exceed maximum specified water cement ratio or slump.
    c. Incorporate water by additional mixing equal to at least half of total mixing required.
    d. Perform strength test on any concrete to which water has been added at the jobsite.
        1) See Section 03350.

3.3 PLACING OF CONCRETE

A. General:
   1. Comply with ACI 304R and ACI 304.2R.
   2. Deposit concrete:
      a. Continuously to avoid cold joints.
      b. In layers of 12 to 18 IN.
   3. Locate construction joints at locations approved by Engineer.
      a. Plan size of crews with due regard for effects of concrete temperature and atmosphere conditions to avoid unplanned cold joints.
   4. Place concrete at such a rate that concrete, which is being integrated with fresh concrete, is still workable.
   5. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
   6. Spreaders:
      a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
      b. Embedded:
         1) Obtain approval of Engineer.
         2) Materials: Concrete or metal.
         3) Ends of metal spreaders coated with plastic coating 2 IN from each end.
   7. Do not begin placing of concrete in supported elements until concrete previously placed in supporting members is no longer plastic and has been in place at least a minimum of 2 HRS.
   8. Deposit concrete as nearly as practicable in its final position to avoid segregation.
      a. Maximum free fall: 4 FT.
      b. Free fall exceeding 4 FT:
         1) Place concrete by means of hopper, elephant trunk or tremie pipe extending down to within 4 FT of surface placed upon.
   9. Perform the following operations before bleeding water has an opportunity to collect on surface:
      a. Spread.
      b. Consolidate.
      c. Straightedge.
      d. Darby or bull float.

B. High-Range Water Reducers (Superplasticizers):
   1. Add superplasticizer to the concrete in the truck mixer at the jobsite.
   2. Perform concrete slump test at the jobsite both prior to and after addition of the admixture to the concrete.

C. Cold Weather Concrete Placement:
   1. Comply with ACI 306R.
   2. Do not place concrete on substrates that are below 32 DegF or contain frozen material.
   3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
   4. Temperature of concrete when discharged at site:

AIR TEMPERATURE DEGF	MINIMUM CONCRETE TEMPERATURE, DEGF FOR SECTIONS WITH LEAST DIMENSION LESS THAN 12 IN	MINIMUM CONCRETE TEMPERATURE, DEGF FOR SECTIONS WITH LEAST DIMENSION 12 IN OR GREATER
30 to 45	60	55
0 to 30	65	55
below 0	70	60

5. Heat subgrade, forms, and reinforcement so the temperature of the subgrade, forms, and reinforcement will be between 45 and 70 DegF, when temperature of surrounding air is 40 DegF or below at time concrete is placed.
    a. Remove all frost from subgrade, forms and reinforcement before concrete is placed.
6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 DegF.
7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 DegF.
8. Do not place slabs on ground if temperature is below 40 DegF or if temperature surrounding the slab will be below 40 DegF before structure is enclosed and heated.

D. Hot Weather Concrete Placement:
1. Comply with ACI 305R.
2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
3. Temperature of concrete when placed:
    a. Not to exceed 90 DegF.
    b. Not so high as to cause:
        1) Shrinkage cracks.
        2) Difficulty in placement due to loss of slump.
        3) Flash set.
4. Temperature of forms and reinforcing when placing concrete:
    a. Not to exceed 90 DegF.
    b. May be reduced by spraying with water to cool below 90 DegF.
        1) Leave no standing water to contact concrete being placed.

E. Consolidating:
1. Consolidate in accordance with ACI 309R except as modified herein.
2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
    a. Eliminate:
        1) Air or stone pockets.
        2) Honeycombing or pitting.
        3) Planes of weakness.
3. Internal vibrators:
    a. Minimum frequency of 8000 vibrations per minute.
    b. Insert and withdraw at points approximately 18 IN apart.
        1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
    c. Size of vibrators shall be in accordance with Table 5.1.5 of ACI 309R.
4. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other approved means.
5. Do not use vibrators to transport concrete within forms.
6. Provide spare vibrators on jobsite during all concrete placing operations.
7. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
8. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
9. Prevent construction equipment, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.

F. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.
   1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94.
   2. Horizontal belt conveyors:
      a. Mount at a slope which will not cause segregation or loss of ingredients.
      b. Protect concrete against undue drying or rise in temperature.
      c. Use an arrangement at discharge end to prevent segregation.
      d. Do not allow mortar to adhere to return length of belt.
      e. Discharge conveyor runs into equipment specially designed for spreading concrete.
   3. Metal or metal lined chutes:
      a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
      b. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
      c. Provide end of each chute with a device to prevent segregation.
   4. Pumping or pneumatic conveying equipment:
      a. Designed for concrete application and having adequate pumping capacity.
      b. Control pneumatic placement so segregation is avoided in discharged concrete.
      c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1-1/2 IN.
      d. Do not convey concrete through pipe made of aluminum or aluminum alloy.
      e. Provide pumping equipment without Y sections.

3.4 JOINTS AND EMBEDDED ITEMS

A. General - Construction Joints:
   1. Locate joints as indicated on Contract Drawings or as shown on approved Shop Drawings.
      a. Where construction joint spacing shown on Drawings exceeds the joint spacing indicated in Paragraph B below, submit proposed construction joint location in conformance with the Specification.
   2. Unplanned construction joints will not be allowed.
      a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
   3. In general, locate joints near middle of spans of slabs.
   4. Locate joints in slabs and at tops of foundations unless shown otherwise.
      a. At Contractor's option, beam pockets may be formed into concrete walls.
      b. Size pockets to allow beam reinforcing to be placed as detailed on Drawings.
   5. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
   6. Provide roughened construction joints at all construction joints unless indicated otherwise on Drawings.
      a. Clean the previously hardened concrete interface and remove all laitance.
      b. Intentionally roughen the interface to a full amplitude of 1/4 IN.
      c. Provide recessed flat surface as required to install strip type waterstops.
   7. Provide continuous keyways at all construction joints.
      a. Construction joint keyways shall have the following dimensions, unless shown otherwise on Drawings or directed otherwise by Engineer.
      b. Construction joint keyways in footings, foundations, base slabs, and structural or elevated slabs:
         1) Keyway height not less than 1/3 and not more than 1/2 the footing or slab thickness.
         2) Keyway depth not less than 1-1/2 IN.
         3) Keyway in footing or slab center unless shown otherwise on Drawings.

8. Allow a minimum of 48 HRS before placement of adjoining concrete construction.

B. Construction Joints - Spacing:
   1. General - Structures not intended to contain liquid:
      a. Base slab and floor construction joints:
         1) Placements to be approximately square and not to exceed 3500 SF.
         2) Maximum side dimension of a slab pour to be 80 FT.
   2. Structures intended to contain liquids:
      a. Base slab and floor construction joints:
         1) Placements to be approximately square and not to exceed 2000 SF.
         2) Maximum side dimension of a slab pour to be 60 FT.

C. Bonding at Construction Joints:
   1. Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance from construction joints.
      a. Before new concrete is placed, all construction joints shall be coated with epoxy adhesive, cement grout, or dampened.
      b. General:
         1) Use cement grout or dampening for all construction joints.
         2) At tanks, and structures designed to contain liquids:
            a) Cover the hardened concrete of horizontal joints with a coat of cement grout of similar proportions to the concrete, except substitute fine aggregate for coarse aggregate.
            b) Place grout as thick as possible on vertical surfaces.
            c) Place 1 IN layer of grout in bottoms of wall or column lifts immediately before placing concrete and at least 1/2 IN thick on other horizontal surfaces.
            d) Vibrate grout and first layer of concrete simultaneously.
            e) Place fresh concrete before the grout has attained its initial set.
   2. At other locations:
      a. Roughen the surface of the concrete to expose the aggregate uniformly.
      b. Remove laitance, loosened particles of aggregate or damaged concrete at the surface, or at the Contractor's option, use an approved chemical retarder which delays but does not prevent setting of the surface of the mortar in accordance with the manufacturer's recommendations.
         1) Retarded mortar shall be removed within 24 HRS after placing to produce a clean exposed aggregate bonding surface.
      c. Dampen the hardened concrete (but do not saturate) immediately prior to placing of fresh concrete or grout.

D. Locate control joints in slabs on grade as indicated on Drawings.
   1. Time cutting properly with set of concrete, if saw cut joints are required or permitted.
      a. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw.
      b. Complete before shrinkage stresses become sufficient to produce cracking.

E. Expansion Joints:
   1. Do not permit reinforcement or other embedded metal items bonded to concrete (except smooth dowels bonded on only one side of joint) to extend continuously through an expansion joint.
   2. Use neoprene expansion joint fillers, unless noted otherwise on Drawings.
   3. Seal expansion joints as shown on Drawings.
      a. See Section 07900 for requirements.

F. Waterstops:
   1. Preformed strip type:

a. Install on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.
b. Waterstop to be continuous with splices in accordance with manufacturer's instructions.
c. Use in joints against existing concrete and where indicated on Drawings.

2. Bulb type:
a. Position waterstop accurately in forms.
b. Secure waterstops in correct position using hog rings or grommets spaced along the length of waterstop and tie wire to adjacent reinforcing.
c. Hold horizontal waterstops in place with continuous supports.
d. Install according to manufacturer's instructions.
1) Do not displace reinforcement from required location.
e. Waterstops to be continuous.
f. Splice ends with perpendicular butt splice using electrical splicing iron in accordance with manufacturer's instructions.
g. Unless otherwise noted, use for all construction joints in new construction for all structures indicated on Drawings.

G. Other Embedded Items:
1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.
2. Do not place electrical conduit, drains, or pipes in or thru concrete slabs, foundations, or other structural members unless approved by Engineer.

H. Placing Embedded Items:
1. Position expansion joint material, waterstops, and other embedded items accurately.
2. Support against displacement.
3. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
4. Provide adequate means for anchoring waterstop in concrete.
a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.
b. Work concrete under the waterstops by hand, so as to avoid the formation of air and rock pockets, when placing roof and floor slab concrete around waterstops.

3.5 FINISHING

A. See Section 03348.

B. Coordinate mixing and placing with finishing.

3.6 INSTALLATION OF GROUT

A. Grout Schedule of Use:
1. Sand cement grout:
a. Fill keyways if precast HCU.
b. General use.
2. Non-shrinking non-metallic grout:
a. Filling form tie holes.
b. Other uses indicated on the Drawings.
3. Epoxy grout:
a. Patching cavities in concrete.
b. Grouting of dowels and anchor bolts into existing concrete.
c. Other uses indicated on the Drawings.

B. Grout Installation:
1. Sand cement grout:

a. Fill keyways between precast concrete hollow core slabs with sand cement grout.
b. Consolidate grout by rodding or by other means to assure complete filling of keyways.
c. Cure grout by one of methods specified.

2. Non-shrink non-metallic grout:
   a. Clean concrete surface to receive grout.
   b. Saturate concrete with water for 24 HRS prior to grouting.
   c. Mix in a mechanical mixer.
   d. Use no more water than necessary to produce flowable grout.
   e. Place in accordance with manufacturer's instructions.
   f. Provide forms where base plates and bed plates do not confine grout.
   g. Where exposed to view, finish grout edges smooth.
   h. Except where a slope is indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
   i. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.
3. Epoxy grout:
   a. Mix and place in accordance with manufacturer's instructions.
   b. Apply only to clean, dry, sound surface.
   c. Completely fill all cavities and spaces around dowels and anchors without voids.
   d. Grout base as specified for non-shrinking, non-metallic grout.
   e. Obtain manufacturer's field technical assistance as required to assure proper placement.

3.7 CURING AND PROTECTION

A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
   1. Follow recommendations of ACI 308 except as modified herein.

B. Apply one of the following curing procedures immediately after completion of placement and finishing, for concrete surfaces not in contact with forms.
   1. Ponding or continuous sprinkling.
   2. Application of absorptive mats or fabric kept continuously wet.
   3. Application of sand kept continuously wet.
   4. Continuous application of steam (not exceeding 150 DegF) or mist spray.
   5. Application of waterproof sheet materials, conforming to ASTM C171.
   6. Application of other moisture retaining covering as approved.
   7. Application of a curing compound conforming to ASTM C309.
      a. Apply curing compound in accordance with manufacturer's recommendations immediately after any water sheen which may develop after finishing has disappeared from concrete surface.
      b. Do not use on any surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.
      c. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two coats of the curing compound.
         1) Apply the first coat of curing compound to a vertical surface immediately after form removal.
         2) The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
         3) Allow the preceding coat to completely dry prior to applying the next coat.
         4) A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.

C. Curing Concrete In Contact with Forms:

1. Minimize moisture loss from and temperature gain of concrete placed in forms exposed to heating by sun by keeping forms wet and cool until they can be safely removed.
2. After form removal, cure concrete until end of time prescribed.
   a. Use one of methods listed above.
3. Forms left in place shall not be used as a method of curing in hot weather.
4. The term "hot weather," where used in these specifications, is defined in ACI 305R.
5. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete.

D. Continue curing for at least 7 days for all concrete except high early strength concrete for which period shall be at least 3 days.
   1. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is 1 day old, provided concrete is not permitted to become surface dry during transition.

E. Cold Weather:
   1. Follow recommendations of ACI 306R.
   2. Maintain temperature of concrete between 50 and 70 DegF for required curing period, when outdoor temperature is 40 DegF, or less.
   3. Use heating, covering, insulating, or housing of the concrete work to maintain required temperature without injury due to concentration of heat.
   4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
   5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.

F. Hot Weather:
   1. Follow recommendations of ACI 305R.
   2. Make provision for cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
   3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.

G. Rate of Temperature Change:
   1. Keep changes in temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing period.
   2. Do not exceed a temperature change of 5 DegF in any 1 HR or 50 DegF in any 24 HR period.

H. Protection from Mechanical Injury:
   1. Protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
   2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
   3. Do not load self supporting structures in such a way as to overstress concrete.

3.8 FIELD QUALITY CONTROL

A. Tests in accordance with Section 03350.
   1. Perform a strength test on all concrete to which water or superplasticizer, in addition to the amount stated in the concrete mix design, has been added at the jobsite.
      a. Perform strength test after water or superplasticizer has been added and additional mixing has been performed.

B. Field samples of fabricated waterstop fittings (crosses, tees, etc.) will be selected at random by the Engineer for testing by a laboratory at the Owner's expense.
   1. When tested, they shall have a tensile strength across the joints equal to at least 600 psi.

1 **END OF SECTION**

SECTION 03348
CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete finishing and repair of surface defects.

B. Related Sections include but are not necessarily limited to:
   1. Section 03108 - Formwork.
   2. Section 03002 - Concrete.
   3. Section 03308 - Concrete, Materials and Proportioning.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
   2. ASTM International (ASTM):
      a. C150, Standard Specification for Portland Cement.
      b. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

1.3 DEFINITIONS

A. Vertical Surface Defects:
   1. Any void in the face of the concrete deeper than 1/8 IN, such as:
      a. Tie holes.
      b. Air pockets (bugholes).
      c. Honeycombs.
      d. Rock holes.
   2. Scabbing:
      a. Scabbing is defect in which parts of the form face, including release agent, adhere to concrete.
   3. Foreign material embedded in face of concrete.
   4. Fins 1/16 IN or more in height.

B. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

C. Other words and terms used in these Specifications are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   2. Certifications:
      a. Certification of aggregate gradation.

b. Certification that products being used will not interfere with bonding of future floor or wall finishes.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations and requirements for materials used.

1.6 WARRANTY

A. Provide warranty equal to specified manufacturer's standard warranty for all products used.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Chemical sealer:
      a. L & M Construction Chemicals, Inc.
      b. Euclid Chemical Co.
      c. Dayton Superior.
   2. Bonding agents:
      a. Euclid Chemical Co.
      b. BASF Admixtures, Inc.
      c. L & M Construction Chemicals Inc.

2.2 MATERIALS

A. Chemical Floor Sealer:
   1. Colorless low VOC water-based solution containing acrylic copolymers.
      a. ASTM C1315, Class B, minimum 30 percent solids.
   2. Similar to L & M Construction Chemicals Inc. Dress & Seal WB 30.

B. Bonding Agent:
   1. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
   2. Euclid Chemical Co. "Flex-Con."
   3. BASF Admixtures, Inc. "Acryl-Set."
   4. L & M Construction Chemicals "Everbond."
   5. Thoro System Products "Acryl 60."

C. Cement:
   1. ASTM C150, Type II Portland for areas exposed to sewage.
   2. ASTM C150, Type IV Portland elsewhere.

D. Aggregate:
   1. Sand: Maximum size #30 mesh sieve.
   2. For exposed aggregate finish surfaces: Same as surrounding wall.

E. Water: Potable.

2.3 MIXES

A. Bonding Grout:
   1. One part cement to one part aggregate.
   2. Mix cement and aggregate.
   3. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.

4. Add bonding agent/water mixture to cement/aggregate mixture.
5. Mix to consistency of thick cream.
6. Bonding agent itself may be used as bonding grout if approved by manufacturer and Engineer.

B. Patching Mortar:
1. One part cement to two and one-half parts aggregate by damp loose volume.
   a. Substitute white Portland cement for a part of gray Portland cement to produce color matching surrounding concrete.
2. Mix cement and aggregate.
3. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
4. Add only enough bonding agent/water mixture to cement/aggregate mixture to allow handling and placing.
5. Let stand with frequent manipulation with a trowel, until mix has reached stiffest consistency to allow placement.

PART 3 - EXECUTION

3.1 PREPARATION

A. Repair surface defects within 24 HRS after removal of forms.
1. Chip, wire brush or abrasive blast to completely open defects down to sound concrete.
   a. If chipping is necessary, make edges perpendicular to surface or slightly undercut.
   b. No featheredges will be permitted.

B. Repairing Surface Defects:
1. Fill and repair using patching mortar mix specified in Article 2.3.
2. Clean surfaces to remove dust, dirt, laitance, form oil, grease, or other contaminants.
   a. If required by bonding agent manufacturer, etch surfaces with a muriatic acid solution followed by a thorough rinse with clean water.
   b. Test concrete to determine pH level and continue flushing with clean water until surface pH is within acceptable limits.
3. Dampen area to be patched and an area at least 6 IN wide surrounding it prior to application of bonding grout.
4. Brush bonding grout into the surface after the surface water has evaporated.
5. Allow bonding grout to set for period of time required by bonding agent manufacturer before applying premixed patching mortar.
6. Fill tie holes and areas where honeycombed or defective concrete has been removed.
   a. Fill tie holes in liquid containing structures with non-shrink non-metallic grout. See Section 03308.
   b. Fill all other defects with patching mortar.
   c. Consolidate grout or mortar into place and strike off so as to leave patch slightly higher than surrounding surface.
7. Leave undisturbed for at least 60 minutes before finishing level with surrounding surface.
   a. Do not use metal tools in finishing a patch in a formed wall which will be exposed or coated with other materials.
8. Keep areas damp for 7 days or in accordance with bonding agent manufacturer's directions.

3.2 INSTALLATION AND APPLICATION

A. Do not repair surface defects or apply wall or floor finishes when temperature is or is expected to be below 50 DegF.
1. If necessary, enclose and heat area to between 50 and 70 DegF during repair of surface defects and curing of patching material.

B. Chemical Floor Sealer (Type '1') Application:
   1. Apply to floor areas indicated on the Drawings in accordance with manufacturer's recommendations.
   2. Apply at rate recommended by manufacturer.
   3. After final coat of material is applied, remove surplus in accordance with manufacturer's recommendations.
   4. Do not apply sealer to floors scheduled to receive epoxy floor finish.

C. Concrete Finishes for Vertical Wall Surfaces:
   1. General: Give concrete surfaces finish as specified below after removal of formwork and repair of surface defects.
   2. Finish #1 - As cast rough form finish:
      a. Selected forming materials are not required.
      b. Prepare surface in accordance with Paragraph 3.1A. and repair the following surface defects:
         1) Tie holes.
         2) Honeycombs deeper than 1/4 IN.
         3) Air pockets deeper than 1/4 IN.
         4) Rock holes deeper than 1/4 IN.
      c. Chip or rub off fins exceeding 1/4 IN in height.
      d. Use at unexposed surfaces such as foundations and backfilled surfaces of walls not to be waterproofed.
   3. Finish #2 - NOT USED:
   4. Finish #5 - Grout cleaned finish:
      a. Form facing material shall produce a smooth, hard, uniform texture. Use forms specified for surfaces exposed to view in accordance with Section 03108.
      b. Prepare surface in accordance with Paragraph 3.1A and repair all surface defects.
      c. All contiguous surfaces to be finished shall be completed and accessible before finishing operation begins.
      d. Mix one part Portland Cement and one and one-half parts fine sand with sufficient bonding agent/water mixture to produce a grout with the consistency of thick paint.
         1) White Portland cement shall be substituted for gray Portland cement to produce a color that matches color of surrounding concrete as determined by trial patch for areas not to be painted.
      e. Wet surface of concrete to prevent absorption of water and uniformly apply grout.
      f. Immediately after applying grout mix, scrub the surface with a cork float or stone to coat surface and fill remaining air holes, etc.
      g. While grout is still plastic, remove all excess grout by working surface with rubber float or sack.
      h. After the surface whitens from drying, rub vigorously with clean burlap.
      i. Keep final finish damp for a minimum of 36 HRS after final rubbing.
      j. Provide this finish on all surfaces which are to remain as grout cleaned finish.

D. Related Unformed Surfaces (Except Slabs):
   1. Strike smooth tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
   2. Float surface to a texture consistent with that of formed surfaces.
      a. If more than one finish occurs immediately adjacent to unformed surface, provide surface with most stringent formed surface requirement.
   3. Continue treatment uniformly across unformed surfaces.

E. Concrete Finishes for Horizontal Slab Surfaces:
   1. General: Screed with straightedge, eliminate high and low places, bring surface to required finish elevations; slope uniformly to drains. Dusting of surface with dry cement or sand during finishing processes not permitted.

2. Unspecified slab finish: When type of finish is not indicated, use following finishes as applicable:
   a. Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
   b. All slabs to receive a floated finish before final finishing.
3. Scratched slab finish: After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, roughen surface with stiff brushes or rakes before final set.
4. Floated finish:
   a. After concrete has been placed, consolidated, struck off, and leveled, do no further work until ready for floating.
   b. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operations. Use wood or cork float.
   c. During or after first floating, check planeness of entire surface with a 10 FT straightedge applied at not less than two different angles.
   d. Cut down all high spots and fill all low spots to produce a surface with Class B tolerance throughout.
   e. Refloat slab immediately to a uniform texture.
5. Troweled finish:
   a. Float finish surface to true, even plane.
   b. Power trowel, and finally hand trowel.
   c. First troweling after power troweling shall produce a smooth surface which is relatively free of defects, but which may still show some trowel marks.
   d. Perform additional trowelings by hand after surface has hardened sufficiently.
   e. Final trowel when a ringing sound is produced as trowel is moved over surface.
   f. Thoroughly consolidate surface by hand troweling.
   g. Leave finished surface essentially free of trowel marks, uniform in texture and appearance and plane to a Class A tolerance.
   h. On surfaces intended to support floor coverings, remove any defects that would show through floor covering by grinding.
6. Broom or belt finish: Immediately after concrete has received a float finish as specified, give it a transverse scored texture by drawing a broom or burlap belt across surface.
7. Underside of concrete slab finish: Match finish as specified for adjacent vertical surfaces.
   a. If more than one finish occurs immediately adjacent to underside of slab surface, provide surface with most stringent formed surface requirement.

3.3 FIELD QUALITY CONTROL

A. Horizontal slab finishes will be accepted provided:
   1. Applicable specification requirements are satisfied.
   2. Water does not pond in areas sloped to drain.
   3. Gap between a 10 FT straightedge placed anywhere and the finished surface does not exceed:
      a. Class A tolerance: 1/8 IN.
      b. Class B tolerance: 1/4 IN.
      c. Class C tolerance: 1/2 IN.
   4. Accumulated deviation from intended true plane of finished surface does not exceed 1/2 IN.

B. Unacceptable finishes shall be replaced or, if approved in writing by Engineer, may be corrected provided strength and appearance are not adversely affected. High spots to be removed by grinding and/or low spots filled with a patching compound or other remedial measures to match adjacent surfaces.

3.4 PROTECTION

A. All horizontal slab surfaces receiving applied toppings or sealer compound shall be kept free of traffic and loads for minimum of 10 days following installation of topping or compound.

END OF SECTION

SECTION 03350
TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Materials and concrete testing as required to establish concrete mix design.
   2. Testing of concrete during construction for compliance with Contract Documents.
   3. In-place testing of concrete, if required.

B. Related Sections include but are not necessarily limited to:
   1. Section 03208 - Reinforcement.
   2. Section 03308 - Concrete, Materials and Proportioning.
   3. Section 03311 - Concrete Mixing, Placing, Jointing, and Curing.

1.2 RESPONSIBILITY AND PAYMENT

A. Owner and Contractor each provide and pay for certain testing services:
   1. Owner shall retain the services of a qualified Testing Agency to perform testing services for the following:
      a. Testing of concrete produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
   2. Contractor shall retain the services of a qualified Testing Agency to perform testing services for the following:
      a. Testing of materials and mixes proposed by the Contractor for compliance with the Contract Documents and retesting in the event of changes.
      b. Additional testing or retesting of concrete or other cement-containing products occasioned by their failure, by test or inspection, to meet requirements of the Contract Documents.
      c. Strength testing on any concrete to which water has been added at the jobsite.
      d. In-place testing of concrete as may be required by Engineer when strength of structure is considered potentially deficient.
      e. Other testing services needed or required by Contractor such as:
         1) Field curing of test specimens and testing of specimens for determining when forms, form shoring, or reshoring may be removed.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. T260, Standard Method of Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials.
   2. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete.
   3. ASTM International (ASTM):
      a. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
      b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
      c. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

d. C138, Standard Method of Test for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
e. C143, Standard Test Method for Slump of Hydraulic Cement.
f. C172, Standard Practice for Sampling Freshly Mixed Concrete.
g. C173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
h. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
i. C567, Standard Test Method for Unit Weight of Structural Lightweight Concrete.
j. C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
k. C1019, Standard Test Method for Sampling and Testing Grout.
l. E329, Standard Specifications for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

B. Qualifications:
1. Testing Agency:
a. Meeting requirements of ASTM E329.
b. Provide evidence of recent inspection by Cement and Concrete Reference Laboratory of National Bureau of Standards, and correction of deficiencies noted.

1.4 DEFINITIONS

A. Testing Agency: An independent professional testing firm or service hired by Contractor or by Owner to perform testing and analysis services on materials, mixes, structures, and other items as directed, and as provided in the Contract Documents.

1.5 SUBMITTALS

A. Shop Drawings:
1. Product technical data including:
a. Concrete materials and concrete mix designs proposed for use. Include results of all testing performed to qualify materials and to establish mix designs. Place no concrete until approval of mix designs has been received in writing. Submittal for each concrete mix design to include:
1) Sieve analysis and source of fine and coarse aggregates.
2) Test for aggregate organic impurities.
3) Proportioning of all materials.
4) Type of cement with mill certificate for the cement.
5) Brand, quantity and class of fly ash proposed for use along with other submittal data as required for fly ash by Section 03308.
6) Unit weight of fresh and dry lightweight concrete.
7) Slump.
8) Splitting tensile strength for proposed lightweight concrete mix.
9) Brand, type and quantity of air entrainment and any other proposed admixtures.
10) Total chloride ion content per cubic yard of concrete determined in accordance with AASHTO T260.
11) 28-day compression test results and any other data required by Section 03308 to establish concrete mix design.
2. Certifications:
a. Testing Agency qualifications.
3. Test results:
a. Strength test results on concrete placed during construction including slump, air content, and concrete temperature.
b. Strength test results on concrete core samples of in-place construction if required.

c. Results of load testing in-place concrete construction when load testing is required.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.1 TESTING SERVICES TO BE PERFORMED BY CONTRACTOR'S TESTING AGENCY

A. Review and test Contractor's proposed materials for compliance with the Contract Documents.

B. Review and test Contractor's proposed concrete mix design(s).

3.2 OTHER TESTING SERVICES TO BE PERFORMED BY CONTRACTOR'S TESTING AGENCY AS NEEDED

A. Following services to be performed by Contractor's Testing Agency when necessary at no additional cost to Owner:
   1. Additional testing and inspection required because of changes in materials or proportions requested by Contractor.
   2. Additional testing of materials or concrete occasioned by their failure, by test or inspection, to meet Specification requirements.
   3. Perform strength test on any concrete to which water has been added at the jobsite.
   4. Other testing services needed or required by Contractor, such as; field cured test specimens for determining when forms, form shoring or reshoring may be removed.
      a. An extra strength test is required for concrete subject to either live load or shore removal prior to 28 days after placing concrete.

B. The above services to be performed by the Contactor's Testing Agency may be performed by the Owner's Testing Agency provided these services are performed at no additional cost to the Owner.

3.3 DUTIES AND AUTHORITIES OF TESTING AGENCY

A. Testing Agency to inspect, sample and test materials and production of concrete as required by these Contract Documents and by Engineer. When it appears that any material furnished or work performed by Contractor fails to fulfill requirements of the Contract Documents, Testing Agency to report such deficiency to Engineer and Contractor.

B. Testing Agency to report all test and inspection results to Engineer and Contractor immediately after they are performed. All test reports to include exact location in the work at which batch represented by a test was deposited. Reports of strength tests to include detailed information on storage and curing of specimens prior to testing.

C. Limited Authority of Testing Agency: Any Testing Agency or agencies and their representatives retained by Contractor or Owner for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve or accept any portion of the Work.

3.4 RESPONSIBILITIES AND DUTIES OF CONTRACTOR

A. Provide necessary testing services for qualification of proposed materials and establishment of concrete mix design(s).

B. Use of Testing Agency and approval by Engineer of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

C. To facilitate testing and inspection, perform the following:
   1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
   2. Provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 HRS as required by ASTM C31.

D. Notify Engineer and Owner's Testing Agency sufficiently in advance of operations (minimum of 24 HRS) to allow completion of quality tests for assignment of personnel and for scheduled completion of quality tests.

3.5 EVALUATION OF CONCRETE OR GROUT TEST RESULTS

A. Test results for standard molded and cured test cylinders to be evaluated separately for each mix design. Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards. For evaluation of potential strength and uniformity, each mix design shall be represented by at least three strength tests. A strength test shall be the average of two cylinders from the same sample tested at 28 days.

B. Acceptance:
   1. Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:
      a. Average of all sets of three consecutive strength tests equal or exceed the required specified 28-day compressive strength.
      b. No individual strength test falls below the required specified 28-day compressive strength by more than 500 psi.

3.6 TESTING OF CONCRETE-IN-PLACE

A. In-place testing of concrete may be required by Engineer when strength of structure is considered potentially deficient as specified in Paragraph 3.7D.

B. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer to determine relative strengths at various locations in the structure or for selecting areas to be cored. Such tests shall not be used as a basis for acceptance or rejection.

C. Core Tests:
   1. Where required, obtain and test cores in accordance with ASTM C42. If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 DegF, relative humidity less than 60 percent) for 7 days before test then test dry. If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 HRS and test wet. Testing wet or dry to be determined by Engineer.
   2. Take three representative cores from each member or area of concrete in place that is considered potentially deficient. Location of cores shall be determined by Engineer so as least to impair strength of structure. If, before testing, one or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.
   3. Concrete in area represented by a core test will be considered adequate if average strength of three cores is equal to at least 85 percent of specified strength and no single core is less than 75 percent of specified strength.
   4. Fill core holes with nonshrink grout and finish to match surrounding surface when exposed in a finished area.

3.7 ACCEPTANCE

A. Completed concrete work which meets applicable requirements will be accepted without qualification.

1. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.
2. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents. In this event, modifications may be required to assure that concrete work complies with requirements. Modifications, as directed by Engineer, to be made at no additional cost to Owner.

B. Dimensional Tolerances:
1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Engineer.
2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.
3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.
4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected. Repair or remove and replace if required.
5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.

C. Appearance:
1. Concrete surfaces exposed to view with defects which, in opinion of Engineer, adversely affect appearance as required by specified finish shall be repaired by approved methods.
2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Engineer, the defects impair the strength or function of the member.

D. Strength of Structure:
1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure, including but not necessarily limited to following:
    a. Low concrete strength as specified in Article 3.5.
    b. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Section 03208 or requirements of the Contract Drawings or approved Shop Drawings.
    c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
    d. Curing time and procedure not meeting requirements of these Specifications.
    e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
    f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
    g. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength.
2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.
3. Core tests may be required when strength of concrete in place is considered potentially deficient.

4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with Chapter 20 of ACI 318.
5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Engineer, at Contractor's expense.
6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

END OF SECTION

SECTION 05120
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Finish steel structure package with fasteners, anchor bolts, and hardware necessary to complete all support stands as shown on drawings. Structure types and quantities are designated on the Steel Drawings.

B. The following drawings are hereby made part of this specification (Drawings to be determined):
   1. TWEND-SS-01: Structural Steel – Switch Stands
   2. TWEND-SS-02: Structural Steel – Bus Supports
   3. TWEND-SS-03: Structural Steel – Equipment Supports
   4. TWEND-SS-04: Structural Steel – Misc.
   5. TWEND-SS-05: Structural Steel – Dead End Tower

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Institute of Steel Construction (AISC):
      a. Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
      b. Code of Standard Practice for Steel Buildings and Bridges dated March 7, 2000.
      c. Quality Certification Program for Fabricators
      d. Manual of Steel Construction.
   2. American National Standards Institute (ANSI):
      a. B18.22.1, Plain Washers.
   3. American Society of Civil Engineers (ASCE).
   4. ASTM International (ASTM):
      a. A2, Standard Specification for Carbon Steel Girder Rails of Plain, Grooved, and Guard Types.
      b. A6, Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use.
      c. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      d. A108, Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.
      e. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      f. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
      g. A325, Standard Specification of Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
      h. A354, Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
      i. A490, Standard Specification for Heat-Treated Steel Structural Bolts.
      j. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
      k. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
      l. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

m. A563, Standard Specification for Carbon and Alloy Steel Nuts.
n. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
o. A582, Standard Specification for Free-Machining Stainless Steel Bars.
p. A992, Standard Specification for Steel for Structural Shapes for Use in Building Framing.
q. F436, Standard Specification for Hardened Steel Washers.
r. F593, Standard Specification for Stainless Steel Bolts, Hex Caps Screws and Studs.
s. F959, Standard Specification for Compressible Washer Type Direct Tension Indicators for Use with Structural Fasteners.
t. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

5. Specification for Structural Joints using ASTM A325 or A490 Bolts as approved by the Research Council on Structural Connections (RCSC) of the Engineering Foundation (referred to herein as Specification for Structural Joints).
6. American Welding Society (AWS):
   a. A5.1, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. A5.17, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   c. A5.18, Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding.
   d. A5.20, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   e. A5.23, Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding.
   f. A5.28, Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding.
   g. A5.29, Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding.
   h. D1.1, Structural Welding Code - Steel (referred herein as AWS Code).
   i. Steel stud connectors and their installation to comply with requirements of AWS Code.
7. Specification for the Design, Fabrication, and Erections of Structural Steel for Buildings contained in Steel Construction Manual of the American Institute of Steel Construction.
8. National Electric Safety Code (Standard C2), American National Standards Institute.
9. Where conflicts are present between referenced codes and standards, the code or standard establishing more stringent requirements shall be followed.

B. Qualifications:
1. Steel fabricator: Minimum of 5 years experience in fabrication of structural steel and shall be certified under AISC Quality Certification Program.
   a. Use a professional engineer on fabrication staff.
2. Steel erector: Minimum of 5 years of experience in erection of structural steel.
   a. With an active and enforced quality assurance program in place, as described in the Code.
3. Qualify welding procedures and welding operators in accordance with AWS.

1.3 SUBMITTALS

A. Shop Drawings:
1. Shop drawing submittals shall be sent to the Engineer.

HDR Engineering, Inc.
Attn: Bill Barnhart, Sr., P.E.
2913 Millennium Circle
Billings, MT 59102-7444

a. The standard size drawing size for shop drawings shall be 22" x 34". Drawings shall be laid out in legible, organized manner, with uniformity in appearance, style, contents, and dimensional proportions. Material lists shall be included on the shop drawings.
b. Reproducible drawings to be supplied shall be matte finish, black line on Mylar or high quality vellum, capable of producing high quality drawing prints. Mylar drawings with excessively dark background will be rejected.
c. Electronic files of all shop drawings shall be Autocad "DWG" files and shall include all reference files that will enable the Engineer and Owner to view and generate plot files that will result in an exact match of the submitted hard copy.

2. Fabrication and/or layout drawings:
   a. Prepare Shop Drawings under National Institute of Steel Detailing Quality Procedures Program certification.
   b. Complete Shop Drawings for all of the work showing clearly all pieces, sizes, dimensions, details, connections materials and shop coatings.
      1) All Shop Drawings must be checked and signed "approved" before submittal.
      2) Show all cuts, copes, and holes.
      3) Indicate all shop and field bolts.
      4) Indicate all shop and field welds using AWS symbols.
      5) Be reviewed and sealed by a professional engineer retained by Contractor to verify conformance with design criteria stipulated in the Contract Documents.
   c. Prepare complete erection drawings showing the location and marks of all pieces.
      1) Copies of up-to-date erection drawings shall accompany the Shop Drawings. Use match marks on the erection drawings to indicate the sheet number on which each particular member is detailed.
   d. Correct any incorrect or unacceptable material or fabrication due to incorrect detailing, shop work, or erection, without additional charge.
3. Approval Drawings:
   a. Provide three (3) sets of drawings prior to fabrication. The Engineer will return to the Supplier, within two weeks after receipt, one set of drawings marked "No Exceptions Taken", "Furnish as Corrected", "Revise and Resubmit", or "Rejected" as the case might be.
   b. In the last case, all revisions will be clearly shown on the returned set, which shall be considered as an approved set.
   c. Design revisions, in accordance with corrections shown thereon, may be considered as ready for fabrication.
   d. Corrections or revisions shown on "resubmit" set shall be made, and two revised sets furnished to the Engineer for his approval.
   e. Drawings shall be returned two weeks after notice of requiring resubmittal.
4. Construction Drawings:
   a. Furnish six (6) sets of structural steel shop drawings for construction purposes.
5. "As-Built" Drawings
   a. Supplier shall furnish four (4) sets of "Released for Construction" prints, one (1) set of "Released for Construction" Mylar reproducibles, and an electronic file on CD of all Supplier-furnished structural steel shop drawings.
6. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Detailed supplemental specification relating to load indicator washers or high-strength bolts - alternate design for approval of Engineer (submitted at Contractor's option if desired by Contractor for use).
   d. Source and certification of quality for high-strength bolts, nuts and washers.
7. Certifications:

a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
b. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
c. Welder qualification data and prequalified procedures.

8. Test reports:
a. Certified copies of mill tests.
b. Manufacturer's load test and temperature sensitivity data for expansion anchor bolts and adhesive anchor bolts.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Steel structure, with all associated hardware and fasteners, shall be shipped in one complete shipment.

B. Handle and store steel members above ground on skids or other supports.
1. Keep free of dirt and other foreign material and protect against corrosion.

C. Anchor bolts shall be shipped F.O.B. 6 weeks ARO.

D. Delivery shall be made F.O.B. job site. Interconnect Substation is located in Dickey County, North Dakota near the southern boundary of the state. Latest acceptable delivery date for steel structures is 20 weeks ARO.

1.5 DEFINITION

A. Code: AISC Code of Standard Practice for Steel Buildings and Bridges.

B. Owner: May mean the Owner's Designated Representative for Construction as defined by the Code.

C. Galvanizing: Hot-dipped galvanizing per ASTM A153 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. High-strength bolts:
a. Bethlehem Steel Corporation.
b. Lewis Bolt & Nut Company.
c. Nucor Fasteners.
d. St. Louis Screw and Bolt Company.
2. Load indicator washers for high-strength bolts:
a. Bethlehem Steel Corporation.
b. Mid-South Bolt and Screw Co., Inc.
c. J and M Turner, Inc.
3. Alternate design high-strength bolts:
a. T. C. Bolt Corporation.
b. Construction Fastener Systems Division of Bristol Machine Company.
c. LeJuene Bolt Co.
4. Headed studs and deformed bar anchors:
a. Nelson Stud Welding Division, TRW, Inc.

b. Stud Welding Products, Inc.

B. Acceptable Fabricators:
1. Distran Products, Inc.
2. Falcon Steel
3. Galvinizers, Inc.
4. Meyer T&B Industries
5. Valmont/Tulsa

2.2 MATERIALS

A. Steel, Structural Shapes and Plate (unless noted otherwise on Drawings):
1. All W-shapes and WT-shapes: ASTM A572, Grade 50.
a. Provide ASTM A572, Grade 50 with special requirements per AISC Technical Bulletin #3, New Shape Material, dated March 3, 1997.
b. ASTM A992 may be used in lieu of ASTM A572, Grade 50.
2. All other plates and rolled shapes: ASTM A36.

B. Wide Flange Beams: ASTM A992 (Fy=50 KSI)

C. Plate and Bar: ASTM A36 (Fy=36 KSI).

D. Pipe: ASTM A53, Grade B (Type E or S) (Fy=35 KSI).

E. Hollow Structural Sections (HSS):
1. Round: ASTM A500, Grade B (Fy=42 KSI)
2. Square or rectangular: ASTM A500, Grade B (Fy=46 KSI)

F. High-Strength Bolts, Nuts and Washers, ASTM A325 with A563 Type DH specifications:
1. High-strength bolts:
a. Provide two ASTM F436 washers for all bolts.
b. Provide beveled washers at connections of sloped/tapered sections.
2. High-strength bolts with load indicating devices, ASTM F959, Type 325.
a. Provide at Contractor's option and subject to approval of Engineer.
3. Alternate high-strength design:
a. Provide at Contractor's option and subject to approval of Engineer.

G. Bolts and Nuts, Unfinished: ASTM A307, Grade A.

H. Washers, Plain (Unfinished Bolts): ANSI B18.22.1, Type B.

I. Welding Electrodes (AWS):
1. Shielded metal arc: AWS A5.1 or AWS A5.5, E70XX or E801X-X.
2. Submerged arc: AWS A5.17 or AWS A5.23, F7XX-EXXX or F8XX-EXXX-XX.
3. Gas metal arc: AWS A5.18, E70S-X or E70U-1 or AWS A5.28, ER805-XX, E80C-XXX.
4. Flux cored arc: AWS A5.20, E7XT-X (except 2, 3, 10, GS), AWS A5.29, E7XT-X or E8XTX-X, E8XTX-XM.

J. Anchor Rods and Bolts:
1. ASTM F1554, Grade 55 with weldability supplement S1 or ASTM A36for threaded rods
2. ASTM A307, Grade A for headed bolts.
3. ASTM F593 type 304 or 316 stainless steel with matching nut and washer.

K. Headed Studs and Deformed Bar Anchors:
1. Studs: ASTM A108, complying with AWS Code Section 7, Type B; minimum yield strength 50,000 psi, minimum tensile strength 60,000 psi.
a. Uniform diameter.

b. Heads: Concentric and normal to shaft.
c. Weld end: Chamfered and solid flux.

2. Deformed anchor bars: ASTM A496, complying with AWS Code Section 7 Type C. Minimum yield strength 70,000 psi. Minimum tensile strength 80,000 psi.
   a. Straight, unless indicated otherwise.
   b. Solid flux.
3. After welding, remove ceramic ferrules and maintain free from any substance which would interfere with function, or prevent bonding to concrete.

2.3 FABRICATION

A. Structure:
1. Steel structures shall be fabricated as shown on the Drawings.
2. Supplier shall assume responsibility as noted.
3. Supplier shall verify all dimensions to verify proper fit up of structure connections prior to fabrication.
4. Any deviation in dimension or materials from that shown on the drawings shall be submitted to the Engineer for his written approval prior to fabrication. Such submittals shall be in form of shop fabrication drawings, per Section 1-3 of this specification.

B. Materials:
1. Prior to being worked in any manner, structural materials shall be cleaned of all rust and foreign particles.
2. Material shall be straight within the tolerance allowed by ASTM Specification A6.
3. If straightening is necessary, it may be done by mechanical means or by application of a limited amount of localized heat. Straightening shall be done in a manner that will not injure the material.

C. Punching and drilling shall be done accurately:
1. Center to center distance between holes of a piece shall not vary more than 1/16 inch from the specified dimension.
2. Holes other than those shown on the drawings and those required for the galvanizing process shall be approved by the Engineer. Burrs caused by drilling or punching shall be removed prior to galvanizing.

2.4 GALVANIZING

A. All structural members, hardware and locknuts shall be hot dip galvanized, in accordance with ASTM A123, A143, A153, A384, A385, A386.

B. Steel to be galvanized shall be clean and free from welding slag.

C. All burrs and sharp edges shall be ground smooth.

D. Material on which the galvanizing has been damaged may be redipped, unless damage is local and can be satisfactorily repaired by applying two coats of zinc base paint. Any member which has the galvanized coat damaged after being dipped twice shall be rejected.

E. In order to accommodate the galvanizing process:
1. All tubular column baseplates and closed tubular beam end plates shall have vent holes for pressure relief and drainage or as detailed on the drawings.
2. All gussets shall be cropped on inside corners.
3. All tubular columns with welded top plates shall semi-circular holes cut into the top of the tube.
4. All tubular columns with baseplates to be grouted shall have semi-circular holes cut into the bottom of the tube to serve as weep holes, unless otherwise indicated on the drawings.

2.5 WELDING

A. Comply with AWS Code, and other requirements indicated herein, for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.
   1. Qualify joint welding procedures or test in accordance with AWS qualification procedures.

B. Test and qualify welders, welding operators and tackers in compliance with AWS Code for position and type of welding to which they will be assigned.
   1. Conduct tests in presence of approved testing agency.
   2. Certification within previous 12 months will be acceptable, provided samples of the welder's work are satisfactory.

C. Before Starting Welding:
   1. Carefully plumb and align members in compliance with specified requirements.
   2. Fully tighten bolts.
   3. Comply with Section 5 of AWS Code for assembly and surface preparation.
   4. Preheat base metal to temperature stated in AWS Code.
      a. When no preheat temperature is given in AWS Code and base metal is below 50 DegF, preheat base metal to at least 70 DegF.
      b. Maintain temperature during welding.
      c. Preheat surface of all base metal within distance from point of welding equal to thickness of thicker part being welded or 3 IN, whichever is greater, to specified preheat temperature.
      d. Maintain this temperature during welding.
   5. Each welder shall use identifying mark at welds.

D. Make flange welds before making web welds.

E. Where groove welds have back-up plates, make first three passes with 1/8 IN round electrodes.
   1. Use backup plates in accordance with AWS Code, extending minimum of 1 IN either side of joint.

F. Flame cut edges of stiffener plates at shop or field butt weld. Do not shear.

G. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.

H. Low Hydrogen Electrodes: Dry and store electrodes in compliance with AWS Code.

I. Do not perform welding when ambient temperature is lower than 0 DegF or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.

J. Headed Studs and Deformed Bar Anchors:
   1. Automatically end welded in accordance with the AWS Code and manufacturer's recommendations.
   2. Fillet welding of headed studs and deformed bar anchors is not allowed unless approved by Engineer.

K. Test in-place studs in accordance with requirements of AWS Code to ensure satisfactory welding of studs to members.
   1. Replace studs failing this test.

L. When headed stud-type shear connectors are to be applied, clean top surface of members to receive studs in shop to remove oil, scale, rust, dirt, and other materials injurious to satisfactory welding. Do not shop paint or galvanize metal surfaces to receive field applied studs.

2.6 SOURCE QUALITY CONTROL

A. OWNER pays for inspection and testing:

B. Responsibilities of Testing Agency:
   1. Inspect shop and field welding in accordance with Section 6 of AWS Code including the following non-destructive testing:
      a. Visually inspect all welds.
      b. In addition to visual inspection, test 50 percent of full penetration welds and 20 percent of fillet welds with liquid dye penetrant.
      c. Test 20 percent of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
   2. Inspect high-strength bolting in accordance with Section 9 of the Specification for Structural Joints.
      a. Verify proper pretension for slip-critical bolted connection.
      b. Verify direct tension indicator gaps.
   3. Inspect structural steel which has been erected.
   4. Inspect stud welding in accordance with Article 7.8, AWS Code.
   5. Prepare and submit inspection and test reports to Engineer. Assist Engineer to determine corrective measures necessary for defective work.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor is solely responsible for safety. Construction means and methods and sequencing of work is the prerogative of the Contractor. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, bracing or rigid connections are installed.
   1. Partially complete structural members shall not be loaded without an investigation by the Contractor.
   2. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, furnished, and installed by the Contractor for the partially complete structure.

B. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including wind, construction activities, and operation of equipment is the responsibility of the Contractor.
   1. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
   2. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
   3. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades. If not obvious from experience or from the Drawings, the Contractor shall confer with the Engineer to identify those structural steel element that must be complete before the temporary bracing system is removed.
   4. Remove and dispose of all temporary work and facilities off-site.

C. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work. Report defects in work-in-place which may influence satisfactory completion of the work. Absence of such notification will be construed as acceptance of work-in-place.

D. Field Measurement: Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings. Contractor responsible for the accurate fit of the work.

E. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection. Notify Engineer of any errors or deviations found by such checking.

3.2 ERECTION

A. Framing member location tolerances after erection shall not exceed the frame tolerances listed in Article 3.3.

B. Erect plumb and level; introduce temporary bracing required to support erection loads.

C. Use light drifting necessary to draw holes together. Drifting to match unfair holes is not allowed.

D. Welding:
   1. Conform to AWS D1.1 and requirements of this Specification.
   2. When joining two sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.

E. Shore existing members when unbolting of common connections is required.
   1. Use new bolts for rebolting connections.

F. Clean stored material of all foreign matter accumulated during erection period.

G. Clean bearing and contact surfaces before assembly.

H. Set beam and column base and bearing plates accurately, as indicated, on nonshrink grout.
   1. Set and anchor each base plate to proper line and elevation.
   2. Use metal wedges, shims or setting nuts as required and tighten anchor bolts.
      a. Use same metal as base plate.
      b. Cut off protrusions of wedges and shims flush with edge of base plate.
   3. Fill sleeves around anchor bolts with nonshrink grout.
   4. Pack grout solidly between bottom of plate and bearing surface.

I. Anchor Bolts:
   1. Anchor bolt location tolerance per Section 7.5 of the Code.
   2. Tie anchor bolts in position to embedded reinforcing steel using wire.
   3. Welding or tack welding is prohibited.
   4. Provide steel templates for locating anchor bolts.
   5. Coat bolt threads and nuts with heavy coat of clean grease.

J. Install high strength bolts with hardened washers. Install and tighten in accordance with Section 8 of Specifications for Structural Joints.
   1. Coordinate installation with inspection. Do not start installation until coordination with Testing Agency is complete.
   2. Bearing-type connections: High-strength bolts shall be tightened to snug-tight condition.
   3. Slip-critical connections: Perform calibration testing for all methods of installation of high-strength bolts in accordance with Section 8(b) of Specification for Structural Joints, using ASTM A325 or A490 bolts.
      a. Turn-of-nut tightening: Torque wrenches shall be used only by laboratory personnel.
      b. Calibrated wrench tightening: Calibrate on a daily basis.

c. Direct tension indicator tightening: If previously approved by Engineer.
d. Installation of alternate design bolts: If previously approved by Engineer.

4. In the event any bolt in a connection is found to be defective, check and retighten all bolts in the connection.

K. Do not use gas cutting to correct fabrication errors. In case members do not fit or holes do not match, ream out the holes and insert the next larger size bolt. If the connections require new holes, then drill new holes. Make no such corrections without prior approval of the Engineer.

1. Burning of holes: Not permitted.

L. Prior to making field connections to existing structural steel, remove completely all paint from existing steel which will be in contact with new steel and new welds.

M. Tighten and leave in place erection bolts used in welded construction.

N. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1 in 20 with a plane normal to bolt axis.

O. After bolts are tightened, upset threads of A307 unfinished bolts and anchor bolts to prevent nuts from backing off.

P. After erection, grind smooth all sharp surface irregularities resulting from field cutting or welding; power tool clean welds, bolts, washers and abrasions to shop coat removing all rust and foreign matter.

3.3 FIELD QUALITY CONTROL

A. Testing Agency responsibilities are described in Article 2.6.

B. Erected Frame Tolerance (Unless noted otherwise on the Drawings):

1. Overall finished dimensions shall not exceed cumulative effect of rolling, fabrication and erection tolerance.
2. Erection tolerances are defined relative to member working points and working lines as follows:
   a. Actual centerline of top flange or surface at each end for horizontal members.
   b. Actual center of member at each end for all other members.
   c. Other points may be used, providing they are based on these definitions.
   d. Working line is straight line connecting member working points.
3. Tolerances on position and alignment are as specified in the Code, unless otherwise modified. "Adjustable items" such as lintels, wall supports, curb angles, window mullions and similar members shall be provided with adjustable connections to supporting structural frame.
4. Steel erector shall certify the location of erected structural steel is acceptable for plumbness, level and aligned within tolerances specified. Such certification can be provided upon completion of any part of work and shall be done prior to start of work by other trades that may be supported, attached or applied to structural steel work.

3.4 CLEANING AND REPAIR OF SHOP PRIMER PAINT

A. After erection, clean all steel of mud or other foreign materials, and repair any damage.

END OF SECTION

SECTION 10444
SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Warning signs.
   2. Equipment identification signs.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. C2, National Electrical Safety Code (NESC).

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   2. Schedule of all signs indicating text and graphics.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Safety signs:
      a. Electromark.
      b. Premax.
      c. Or Approved Equal.

2.2 MATERIALS

A. Safety Signs:
   1. Exterior: Plexiglass or 18 gauge steel.

2.3 FABRICATION

A. Warning High Voltage Warning Signs
   1. Provide four (4) "Warning High Voltage" signs.
   2. Signs shall be standard design, colored red, black, and white.

B. Phase Identification Signs
   1. Phase identifications signs shall be located under each phase at the following locations:
      a. At both ends of the 230kV main bus, two (2) sets of signs.
   2. Signs shall be approximately six inches by six inches.
   3. Phases shall be identified by A, B, and C.

C. Switch Signs

1. Switch signs shall be approximately 12 x 16 inches.

D. Power Circuit Breaker Signs
   1. Signs shall be approximately 12 x 16 inches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Safety Signs:
   1. Sign mounting shall be accomplished with self-tapping washer head screws.
   2. Signs larger than 6" x 6" shall be mounted with galvanized channel (B-line B-22 or equivalent) full length across top and bottom of back.
   3. Provide safety markers including guard posts and connecting rope or chain as specified below.

B. Warning High Voltage Warning Signs:
   1. Sign shall be centered along each fence side at a height of 5'-0".
   2. Signs shall be mounted on the outside of the fence, facing outward, as shown on the drawings.

END OF SECTION

SECTION 16122
ELECTRICAL BUS AND OVERHEAD STATIC WIRE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Electrical Bus (Pipe).
      b. Electrical Bus (Cable).
      c. Overhead Static Wire.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronic Engineers/American National Standards Institute (IEEE/ANSI):
   2. American Society for Testing and Materials (ASTM):
      a. B187/B197M-03, Standard Specification for Copper, Bus Bar, Rod, and Shapes.
      b. B188-02, Standard Specification for Seamless Copper Bus Pipe and Tube.
      c. B1, Standard Specification for Hard-Drawn Wire.
      d. B232/B-232M, Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR).
   3. National Fire Protection Association (NFPA):
      a. 70B, National Electrical Code (NEC).

1.3 DEFINITIONS

A. Bus (Pipe): An extruded tubular product used to convey electricity.

B. Alloy: A substance composed of two or more metals.

C. Bus (Cable): Cable used to convey electricity.

D. Overhead Static Wire: Wire used for the protection of equipment from lighting strikes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Bus (Pipe):
      a. Alcoa.
      b. Or Approved Equal.
   2. Bus (Cable):
      a. South Wire.
      b. Or Approved Equal.
   3. Overhead Static Wire:
      a. Okonite.
      b. Or Approved Equal.

2.2 MANUFACTURED UNITS

A. Bus (Pipe):
   1. Alloy to be 6063.
   2. Temper to be type T6.
   3. Bus to be 3½" IPS Schedule 40 Al.
   4. Bus to have smooth surface Industry Class IV finish.

B. Bus (Cable):
   1. 1272 KCM AAC, 61 Strand.
   2. 397.5 KCM AAC, 19 Strand.

C. Overhead Static Wire:
   1. 3/8" H.S.S.

PART 3 - EXECUTION

3.1 INSTALLATION

A. CONTRACTOR to carefully inspect to assure pipe is free of any mars, burrs, rough welds or any defect likely to cause high values of corona discharge.

B. Bus conductor which cannot be suitably repaired shall be rejected.

C. Bus conductor shall be cleaned using emery cloth or other approved means, to a finish that is uniform in appearance and free of discoloration.

D. All tube splices shall be welding-type and designed to insure that maximum strength is retained in the tube section.

E. All bus conductor shall be cut to the proper length and terminated in a manner to insure that mechanical stresses are not transferred to insulators, bushings, or other power equipment.

F. All sections of tubular conductor longer than eight feet between supports shall have damping conductor installed.

G. Damping conductor shall be cut to length approximately four inches shorter than the tubular section and shall be free to move inside the tube.

H. Refer to drawings for Damping conductor size.

I. Buss connectors are specified on the drawings. The "Or Equal" clause will apply to all Contractor furnished connectors where a specific manufacturer part number or type is listed.

J. For equipment rated 600 amps and below, use NEMA 2-hole pads.

K. For equipment rated 1200 and 1600 amps, use NEMA 4-hole, 3"x3" pads

L. Bolted connections shall be fastened with stainless steel bolts.

M. On copper-to-aluminum and aluminum-to-aluminum connections, each bolt shall be furnished with one Belleville and two flat washers.

N. On copper-to-copper connections use one flat and one lock washer.

O. Copper and copper alloy composition connectors shall have tinned contact surfaces where used for copper-to-aluminum connections.

P. Stainless steel Bellville washers shall be a minimum of 7/64" thick by 1-1/16" diameter with a 5000 pound load required to flatten the washer.

Q. Stainless steel flat washers shall be a minimum of 0.125" thick and shall be 1 5/8" diameter.

R. All bolts shall be sized to extend completely through nuts, with a minimum of ⅛" and a maximum of ¼" thread reveal when properly torqued.

S. All bus bolts shall be tightened with a torque wrench to the following specifications, Fastener Material / Diameter / Torque (Ft-Lbs):
   1. Bronze & Stainless Steel / ½" / 40.
   2. Bronze & Stainless Steel / ⅝" / 55.
   3. Lubricated Aluminum / ½" / 25.
   4. Lubricated Aluminum / ⅝" / 40.
   5. Unlubricated Aluminum / ½" / 35.
   6. Unlubricated Aluminum / ⅝" / 50.

T. Using a torque-limiting wrench set at 50% of the recommended value, tighten all bolts in sequence.

3.2 OVERHEAD STATIC WIRE

A. Installation and material requirements for all static wire shall be as shown on the drawings. Installation shall be accomplished in a manner acceptable to the Engineer, with equipment specifically designed for the purpose. Stringing shall be accomplished by means of pulleys or other devices to avoid damage from cable tensioning equipment gripping attachments. No splices in static wire will be allowed.

END OF SECTION

SECTION 16280
WAVE TRAP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Two (2) outdoor wave traps.
      b. Nine (9) coupling capacitors voltage transformers (CCVT).
      c. Two (2) line coupling tuners.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. American Standards Association (ASA).
   3. National Electrical Manufacturer's Association (NEMA).

1.3 DEFINITIONS

A. Wave Trap: An electronic filtering device designed to exclude unwanted signals or interference from a receiver.

B. Line Coupling Tuners: Equipment used for coupling Power-Line Carrier (PLC) equipment to a single phase of high-voltage power lines.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Wave Trap:
      a. ABB.
      b. Ritz.
      c. Areva.
      d. Trench.
      e. Or Approved Equal.

2.2 MANUFACTURED UNITS

A. Line Trap Inductors:
   1. Quantity: Two (2).
   2. Continuous Current: 1.2kA.
   3. Thermal Current Rating: 44kA RMS, 2 Second.
   4. Mechanical Current Rating: 112.2kA.
   5. Inductance (100kHz): 0.265mH (Minimum).
   6. Style: Factory-Adjusted Wide Band.
   7. Blocking Impedance: 1000 Ohm.
   8. Frequency Range: 50-205kHz (Verify with MDU).
   9. Mounting Type: Horizontal Pedestal on Coupling Capacitor.

10. Terminals: NEMA 4-Hole Pad Each End.

B. Coupling Capacitors Voltage Transformer:
   1. Refer to Specification 16461.

C. Line Coupling Tuners:
   1. Quantity: Two (2).
   2. Type of Coupling: Phase to Ground.
   3. Tuner Classification: Band-Pass, Wide-Band.
   4. Dual Frequency.
   5. Frequency Range: 50-205MHz. (Verify with MDU).
   6. Cabinet: Outdoor, 8-unit.
   7. Accessories:
      a. Carrier lead in elbow bushing.
      b. Anti-condensation heater.
      c. Carrier lead in cable (#8 AWG untinned, stranded 5000 volt insulated. Furnish 10 feet with each tuner).
   8. Line Tuner shall be factory tuned for line characteristics and frequency given above.

PART 3 - EXECUTION

3.1 CONSTRUCTION AND PERFORMANCE

A. The electrical characteristics and mechanical features of power line equipment supplied under these specifications shall be capable of meeting all the requirements specified herein and shall conform to the latest revisions of applicable ANSI standards.

3.2 INSTALLATION

A. Install per MANUFACTURER'S recommendations.

B. Power Line Carrier Equipment shall be located as shown on Plan and Elevation Drawings.

END OF SECTION

SECTION 16350
POWER CIRCUIT BREAKER(S)

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Three (3) 230 kV SF_6 outdoor power circuit breaker.
   2. Deliver circuit breaker F.O.B. at OWNER's jobsite located in Dickey County, North Dakota near the southern boundary of the state.
   3. Furnish all labor, equipment and material for the following:
      a. Filling with insulating medium.
      b. Making all necessary adjustments.
      c. Checkout and field testing.
   4. Provide factory trained service representative for technical direction, inspections and testing.

B. Work by others:
   1. CONTRACTOR will provide the following:
      a. Unloading at job site and assembly of all components removed for shipment.
      b. Breaker foundation.
      c. Connection to OWNER's bus.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Perform work in accordance with best present-day installation and manufacturing practices.
   2. Unless specifically noted to contrary, conform with and test in accordance with applicable sections of latest revisions of following codes and standards:
      a. American National Standards Institute (ANSI):
         1) C2, National Electrical Safety Code (NESC).
         2) C37.04, IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
         3) C37.06, American National Standard Preferred Ratings and Related Required Capabilities for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
         4) C37.09, Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
         5) C37.11, Requirements for Electrical Control for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis or a Total Current Basis.
         6) C57.13, IEEE Standard Requirements for Instrument Transformers.
         7) C76.1, Standard General Requirements and Test Procedures for Outdoor Apparatus Bushings.
         8) C76.2, Electrical, Dimensional, and Related Requirements for Outdoor Apparatus Bushings.
      b. American Society for Testing and Materials (ASTM):
         1) ASTM D2472, Specification for Sulfur Hexafluoride.
         2) D3487, Specifications for Mineral Insulating Oil Used in Electrical Apparatus.
      c. National Fire Protection Association (NFPA):
         1) NEC, National Electrical Code.
   3. Conflicts between referenced codes and standards: Code or standard establishing more stringent requirements shall be followed. Engineer shall be the final judge as to which requirement is more stringent.

B. Qualifications:
1. Circuit breakers furnished shall be identical to existing designs having acceptable history of service in similar applications for not less than three years.

1.3 DEFINITIONS

A. Dead Tank Design: Interrupters contained within a grounded metal tank.

B. Vendor or Seller: Manufacturer of power circuit breaker.

C. Contractor: Person responsible for erecting substation equipment.

1.4 SYSTEM DESCRIPTION

A. Application:
1. Breaker will be used for line switching and protection including load splitting (parallel or loop switching), load dropping, line dropping, and fault interrupting.
2. To be installed on an electric system having nominal voltage of 230 kV line-to-line, 3 PH, effectively grounded as shown on drawings.

1.5 SUBMITTALS

A. DRAWINGS AND INSTRUCTION MATERIAL

1. Shop Drawings for Approval:
   a. "Shop Drawings" refers to all the detailed installation drawings prepared by the Seller and/or his suppliers required to construct the material as defined in the specifications, and shall include all fabrication drawings, working drawings, design calculations, foundation loadings, material schedules, detailed layouts, and assembly information.
   b. The Seller agrees that submittals and shop drawings processed by the Engineer are not change orders; that the purpose of submittals and shop drawings by the Seller is to demonstrate to the Engineer that the Seller understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use. The Seller alone accepts all responsibility for assuring that all materials furnished under these specifications meet in full all requirements of the contract documents. The Engineer's review is for general conformance with the design concept and contract documents. Markings or comments shall not be construed as relieving the Seller from compliance with the project plans and specifications, nor departures there from. The Seller remains responsible for details and accuracy for confirming and correlating all quantities and dimensions, for selecting fabrication processes, and for techniques of assembly.
   c. Submit the following shop drawings to the Engineer in the manner specified hereinafter. Make initial submittal of information requested on or before the date specified in the Summary of Proposal:
      1) Certified outline assembly and installation drawings as appropriate for each item.
      2) Complete nameplate data for each item.
      3) Schematic diagrams of all control and alarm circuits.
      4) Bushing current transformer data, including excitation and ratio correction factor curves.
      5) Certified arrangement for anchor bolts.
      6) Factory test reports (at least two weeks prior to shipment). See Section 1-11.
      7) Such other similar information as the Engineer may request.

B. Engineer's Action
1. Engineer will review shop drawings and indicate action taken according to the following classifications:
   a. No Exceptions Taken: Indicates that the shop drawing has been reviewed and appears to be in general agreement with the requirements. Seller may make further distribution of shop drawings and proceed with fabrication and/or installation of the work detailed on the drawing.

b. Furnish As Corrected: Design revisions, deletions, additions, and comments shown on these drawings shall be incorporated into the design before proceeding with fabrication or drawing distribution.

c. Revise and Resubmit: Indicates that the shop drawing, or part thereof, does not appear to be in general agreement with the requirements. Engineer's comments are noted on the shop drawing and/or separate letter. Seller shall recheck and make any necessary revisions and resubmit for Engineer's review.

d. Rejected: Indicates that the shop drawings do not conform to requirements. Reasons for rejection are noted on the shop drawing and/or separate letter.

2. Shop Drawing Submittal and Distribution

a. Initial Submittal (REVIEW): Submit three (3) copies of each shop drawing to the Engineer; direct mailing to the Engineer's address given in Division O. One copy of the shop drawings indicating the Engineer's action will be returned to Seller within three (3) weeks from the date of receipt.

b. Resubmittal: If drawing is returned to the Seller with Engineer's comments and action noted "RESUBMIT", the drawing should be rechecked and revised as necessary with two copies resubmitted in manner described in "Initial Submittal".

c. Final Distribution (CERTIFIED): Within the time schedule listed in the Summary of Proposal, Seller shall submit to the Engineer, final drawings covered in Section B above utilizing AutoCAD software. All drawing information shall be stored and submitted on a compact disk. Direct mailing to the Engineer's address given in Division O.

C. Instruction Manuals, Test Reports, and Parts Lists

1. Seller shall furnish complete instruction manuals covering installation, operation and maintenance for all equipment. Manuals, bound in vinyl and properly labeled to indicate the facilities covered, shall include:
   a. All shop drawings listed in Section 1.5-A.1c. (Reduce as required to fit in manuals).
   b. Specific equipment instruction books.
   c. Renewable parts lists for all replaceable parts and assemblies.
   d. Test report for all shop tests required under Section 3.3.
2. Submit five (5) copies to Engineer for distribution. Engineer's address is given in Division O.

D. Shop Drawing and Instructional Material Transmittal Form

1. Seller may use his own form of transmittal letter for distribution of shop drawings, clearly marked "For Approval" or "Certified" as applicable.
2. Submit one (1) copy of transmittal form with each set of drawings or instructional materials.

E. Seller's Responsibility

1. Prior to submittal, check shop drawings for errors, correctness of details, and conformance with the specifications.
2. Notify Engineer of any inconsistencies or questions regarding approval revisions or comments on the drawings.
3. Review of shop drawings by Engineer does not relieve the Seller of responsibility for errors, correctness of details, or conformance with the specifications.
4. Fabrication and shipment of materials or equipment prior to Owner's release of drawings, data, and information mentioned hereinbefore, shall be at Seller's risk.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Bid shall include delivery F.O.B. jobsite, freight prepaid, with final destination delivery date as specified by the Seller in the Summary of Proposal. Jobsite is located in Dickey County, North Dakota near the southern boundary of the state.

B. The Seller shall notify the Engineer when equipment is ready for shipment. Such notice shall include projected routing and estimated time in shipment.

1. All equipment in this contract with a common delivery destination shall be made in a common shipment. The Seller shall be responsible for all incidental costs incurred by the Owner due to separate shipments of such equipment.
2. Immediately after shipment, Seller shall notify the Engineer of transportation carrier and all transfers and references to permit follow-up on status of shipment and delivery.

C. The Seller shall investigate all limitations in regard to shipping the equipment F.O.B. jobsite. Circuit breakers shall be shipped as completely assembled and as transportation limits and manufacturer warranty allow.

D. In case of rail use for any part of delivery:
1. Equipment shall be shipped on cushioned underframe or end-of-car cushioned railcars on which the cushioning devices have been recently inspected and determined to be 100 percent operable, or other means agreed to by the Engineer.
2. Impact recorders furnished by the Seller shall be properly packaged, oriented and attached to the rail cars as near the equipment bases as possible. The recorders shall indicate impacts separately, on two axes, and the charts shall be stamped adequately to determine the date, time and place of severe impacts. Impact recorders shall be placed in operation before the equipment begins shipment and shall remain attached and in operation until the equipment has been sited at the proper rail siding. Equipment will not be accepted by the Owner until after the Engineer has examined the recorders for impacts and any visible damage to equipment.
3. Final portion of delivery from rail siding to job site shall be by truck.

E. Prior to shipment, all gauge and indicator glass shall be thoroughly cleaned and covered with non-adhesive shipping protectors.

F. Circuit breakers shall be shipped as complete as practical. Gas interrupters shall be pre-charged prior to shipment, with any supplemental gas furnished as part of one single shipment.

G. Delivery shall not be made prior to earliest acceptable delivery specified in Summary of Proposal. Should delivery be made prior to earliest acceptable delivery date, the Owner reserves the right to withhold initial payment without any additional cost until 30 days after the earliest acceptable delivery date. In addition, the supplier shall be responsible for all incidental costs incurred by the Owner due to early delivery.

1.7 EQUIPMENT GUARANTEE

A. Without limiting any other provision of this specification regarding guarantees, guarantee the equipment as follows:
1. Seller shall guarantee to the Owner the complete power circuit breaker, together with all parts included in the original purchase, is free of defect in workmanship and materials and is capable of continuous and satisfactory performance when operated in accordance with the instructions provided by the Seller at the specified rating and capacity.
2. Guarantee shall extend for a minimum of one year from the date of commercial operation. It shall cover all defects and malfunctions of the breaker and accessories. Guarantee shall cover all out-in freight by common carrier in full and the costs of removal from the site and reinstallation after repair. Seller shall not be liable for special, indirect or consequential damages, nor costs of moving structures or associated equipment.

1.8 DEFECTIVE EQUIPMENT

A. Should equipment fail to conform to specifications or to operate satisfactorily, Owner will have right to operate equipment until defects are corrected and guarantees met.

B. Owner will have right to operate rejected equipment until it is replaced, without cost for depreciation, use or wear.

C. Equipment may be removed from operation for examination, adjustment, alteration, or change only at time approved by Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. HVB
   2. ABB
   3. Mitsubishi
   4. Siemens

B. Submit requests for substitution.

2.2 MATERIALS

A. Sulfur Hexafluoride (SF_6) Gas: Meet requirements of ASTM D2472.

B. All exposed unpainted parts shall be fabricated of corrosion resisting metal.

2.3 POWER CIRCUIT BREAKER

A. Service Conditions:
   1. Outdoor, continuous duty.
   2. Altitude: Circuit breaker shall be suitable for operating at an altitude of 2000 feet above sea level. For altitudes above 3,300 feet, apply Altitude Correction Factors to the voltage and continuous current ratings in accordance with ANSI/IEEE C37.04, Table 1.
   3. Ambient Conditions: Circuit breakers shall be suitable for operating at standard ratings for ambient temperatures between -30°C and 40°C as well as for special low temperating rating specified in Section 2-2.A.21. Severe wind with blowing dust and snow is common at this location.
   4. Auxiliary A.C. power available: 120/208 volt, single-phase.
   5. Auxiliary D.C. power available: 125 volt DC
   6. PCB terminal connections shall be constructed to withstand the following mechanical loading: 100 lb applied in any direction.

B. The frame shall be such that the lowest live part on the breaker or lowest point for connection to the breaker shall be at an elevation in accordance with the National Electric Safety Code.

C. The circuit breaker shall not be limited to a specified number of operations within a time period as long as critical gas pressure and critical stored operating energy is maintained within normal ranges. The circuit breaker operating mechanism shall not be thermally limited within the ambient operating temperature range of the breaker.

D. Ratings:
   1. Quantity to be furnished ..... Three
   2. Construction ..... Dead Tank Only
   3. Insulating medium ..... SF_6 Gas
   4. Number of phases ..... Three
   5. Maximum voltage ..... 242 kV
   6. Rated voltage range factor (k) 1.0
   7. BIL ..... 900 kV
      a. Note: Bushings shall meet the BIL after applying any altitude correction factors per Section 2.3-A.2.
   8. Continuous current ..... 1200 A (min.)
      a. Note: All circuit breakers shall meet the continuous current rating after applying any altitude correction factors per Section 2.3-A.2.
   9. Maximum symmetrical interrupting rating ..... 40 KA (min.)
   10. Three second short time current-carrying capability ..... 40 KA (min.)
   11. Rated short circuit current (at rated maximum KV) ..... 40 KA (min.)

12. Closing and latching capability (rms) ..... 108 KA (min.)
13. Interrupting time (cycles) ..... Three (max.)
14. Frequency ..... 60 Hertz
15. Closing control voltage ..... 125 VDC
16. Tripping control voltage ..... 125 VDC
17. Control and auxiliary power protection .....
    a. Separate knife switches with separate fuses for DC trip, DC close and AC.
18. Number of Trip Coils ..... Two
19. Motor voltage ..... 120 VAC 1ϕ
20. Auxiliary heater voltage ..... 120 VAC

E. Switching Performance
1. Circuit breaker shall be suitable for reclosing duty cycle, as specified by ANSI/IEEE C37.04.
2. Circuit breaker line charging switching rating shall be in accordance with Tables 1A, 2A and 3A of ANSI/IEEE C37.06.
3. The recovery voltage during interruption of line charging current shall be a minimum of 2.4 times maximum phase-to-ground voltage at 0.5 cycle and thereafter per ANSI/IEEE C37.09-1979.
4. The circuit breaker shall be capable of out-of-step interruption in accordance with ANSI/IEEE C37.09.
5. The circuit breaker shall be capable of capacitive switching of parallel shunt capacitor banks in accordance with ANSI/IEEE C37.06 Tables 1A, 2A, and 3A as defined in ANSI/IEEE C37.12.

F. Standard Features
1. All porcelain sleeves and bushings shall be wet glazed, ANSI No. 70 light grey. Porcelain condenser bushings shall be in accordance with ANSI/IEEE C76.1, as applicable. Dead and live tank SF_6 circuit breakers shall have SF_6 gas insulated bushings.
2. One mechanical tripped-closed position indicator for mechanically interlocked mechanisms. Non-mechanically interlocked circuit breakers shall be provided with one indicator for each pole or operating mechanism.
3. External emergency manual trip device which shall electrically operate the breaker. Trip device shall be interlocked with SF_6 gas pressure contacts to prevent opening the breaker without sufficient gas interrupting medium. Trip device shall also block against electrical closure of the breaker.
4. Gas circuit breaker standard equipment:
    a. Provide three (3) gas pressure gauges for circuit breakers with individually pressurized poles. Only one (1) pressure gauge is required for single-tank circuit breakers or individually pressurized pole breakers with common piping.
    b. The SF_6 system shall be supplied with separate shut off valves to each interrupter. All SF_6 devices shall be piped to a common manifold to allow for filling or testing from a single connection point without affecting the SF_6 pressure in all of the interrupters. There shall also be a main shut off valve for the SF_6 system.
    c. Provide temperature compensated low pressure alarm and cutout switches for each separately pressurized interrupter module. For single-tank and three-tank systems with common piping, only one (1) alarm and one (1) cutout switch will be required. Low pressure alarm should be set to operate, due to either leakage or "critically low" gas pressure, at a higher pressure than cutout switch, actual pressure settings to be per manufacturer's recommendations. Cutout switches shall be provided with a sufficient number of contacts to block tripping of all three phases of the circuit breaker plus two additional contacts for customers use as cutout alarm.
    d. Complete mounting stand for circuit breaker and any required oil filled current transformers.
    e. Breakers shall be shipped with partial internal SF_6 gas pressure to eliminate the need for evacuation of the pole unit for installation.

f. An operating mechanism mounted and enclosed in a weatherproof enclosure for opening and closing the contacts. Operating mechanism shall be trip free with latch check switch and anti-pumping device. Features and performance shall be in conformance with NEMA Standard SG-4, Part 3, where applicable. Other features shall include the following for specific mechanism, types or combinations thereof.
   1) For spring-drive operated mechanisms:
      a) Closing spring shall both close the breaker and tension the opening spring.
      b) With the tensioning motor inoperative, the number of available close operations shall not be less than one with the breaker closed and closing spring tensioned upon last close operation, i.e., breaker shall be capable of an open-close-open cycle.
      c) Tensioning motor shall be rated for operation at specified A.C. motor voltage and D.C. control voltage. Control shall include a throw-over circuit that will automatically switch to the DC source if the AC motor voltage is lost. Include 3 minute delayed alarm upon loss of VAC.
      d) The time required to tension the springs to operating level shall not exceed 15 seconds.
      e) Closing mechanism shall be manually operable from outside of the tank.
      f) Alarm contact indicating that the spring is not fully charged. Alarm shall include a 3 minute delay.

g. Standard (NEMA) two bolt ground terminal pads on opposite corners of frame(s).

h. Operations counter visible from outside the mechanism enclosure.

i. Manufacturer's standard screened strip heater(s) mounted in mechanism and control enclosures for anti-condensation purposes. Heaters shall be rated for operation at voltage listed in Section 2.3-A.4 above.

j. Special tools and devices required to install or to dismantle and reassemble breaker, including maintenance closing device for manual operation.

k. Terminal boards for control wiring shall be rated 600 V, 30 A, molded block type with insulating barriers between terminals. Terminals shall be strap screw type connections for ring lugs. Blocks shall have a removable marking strip and cover. Approximately 10 percent spare terminals shall be provided on each block for terminating spare conductor and control cables. The arrangement and location shall be such that incoming and outgoing cables can be supported. Adjacent rows of terminal blocks shall be separated at least six (6) inches edge-to-edge, and at least six (6) inches from sides, top, or bottom of cabinet, for all wiring which will be made in the field. Wiring which will be done at the factory may be made in a space which is not less than three (3) inches. Blocks used for interpanel wiring shall be readily accessible. Heavy-duty terminal blocks with barriers shall be furnished and installed for external power supply cables if required.

2.4 ACCESSORIES

A. Control Panel:
   1. Provide hinged panel in mechanism enclosure.
   2. Furnish equipment and devices, factory mounted on panel and interconnected, as follows:
      a. One each - Control switch with lights.
      b. One each - "Remote/Local" switch.
   3. Control features:
      a. Local control switch to have lockout position (pull out).
      b. Lights to be as follows:
         1) Green: Circuit breaker open.
         2) Red: Circuit breaker closed.
      c. Furnish a "closed in released position only" contact for use with alarm circuit.
      d. For "Remote/Local" switch, breaker cannot be operated from a remote location if the switch is set for "Local" operation.
   4. Furnish nameplates (black with white cut letters) with lettering approved by ENGINEER for all devices and relays mounted on panel.

2.5 REQUIRED ACCESSORIES

A. Two NEMA standard grounding lugs per stand for use with 4/0 to 350 MCM copper conductor. Grounding lugs shall be Royal Type DT or approved equal.

B. Manufacturer sized standard control cabinet strip heater for anti-condensation which shall be on continuously. Additional strip heaters rated 1-1000 watt and 1-500 watt strip, each to have a control thermostat with an adjustable control range which includes 0°F to 45°F for operation during severe weather conditions shall be furnished. Heater(s) shall be rated for operation at the voltage listed in Section 2.3-A.4 and screened to protect maintenance personnel from physical contact. Accessory heaters shall have overcurrent protection devices separate from those for standard heaters. AC heater circuits must be supplied with alarm circuits with a 3 minute time delay on loss of AC. Provide heaters in mechanism and control compartments as required.

C. Motor start counter for spring operated mechanisms.

D. Minimum of 14 "a" and 14 "b" spare auxiliary switch contacts available for customer's use. In addition, Breaker shall be supplied with two (2) adjustable delayed "b" contacts. These contacts shall be adjustable from 3 to 120 cycles and shall be for customer use only. Manufacturer shall provide additional contacts, as required, for standard breaker control and alarm functions. Auxiliary switches shall be mounted in a dust tight enclosure to prevent contact exposure to foreign particles. Enclosure shall be removable for access to each switch contact. Auxiliary contacts shall be field convertible to either normally open or normally closed.

E. Mechanism cabinet illuminating light with clear safety globe. Light shall be push button controlled, activated by opening cabinet door.

F. 120 VAC, NEMA 5-20R convenience receptacle, ground fault interrupter type.

G. Control switch (52CS) for electrically operating circuit breaker. Switch shall be Electroswitch series 24 or equal, with pistol handle and spring return.

H. Local-Remote Selector switch (43LR) for selecting between the local test control switch (52CS) and remote operation of the breaker. Switch shall be Electroswitch Series 24 or equal, with oval handle and maintained contacts. The Local-Remote selector switch shall be furnished with the following minimum numbers of electrically separate contacts wired in the breaker control circuits or to outgoing terminal blocks as required:
   1. Contacts as indicated below that close in the "Remote" and open in the "Local" position to disconnect the following circuit:
      a. Remote closing
      b. Remote reclosing
      c. Remote tripping (including red lamp). One contact for each trip coil.
      d. Remote green lamp
      e. One breaker "a" contact for supervisory indication.
      f. Two breaker "a" contacts used in the auxiliary tripping relay circuits.
      g. Two contacts for future use.
   2. Contacts that close in the "Local" and open in the "Remote" position:
      a. Local control switch close circuit.
      b. Local control switch trip circuit. One contact for each trip coil.
      c. Two contacts for future use.

I. A copper bar, twelve (12) inches in length, one (1) inch in width, and 1/4 inch thick, shall be mounted near the bottom of the control cabinet. Where the control cabinet is not mounted directly on the frame of the circuit breaker, the ground bar shall be mounted on insulated supports. Where the control cabinet is mounted directly on the frame of the circuit breaker, the ground bar shall be grounded on the cabinet. The ground bar shall be drilled and tapped for #10/32 screws to ground control cable shields and spare conductors.

J. Provide all necessary hoses, regulators, or other devices normally required to perform gas filling operations for SF_6 breakers.

K. Provide thermostatically controlled tank heaters as required to maintain adequate gas temperature and pressure for operation at minimum operating temperature specified in Section 2-2. Heaters shall be rated to operate at voltage listed in Section 2.3-A.4, wattage, as required. Thermostat shall be variable over a minimum range of 0°F to 45°F. Provide low voltage circuit breaker for heater circuit overcurrent protection.

L. Provide one current monitor relay which will supply a 3 minute time delayed alarm to indicate the failure of any of the tank heaters or loss of AC to tank heaters.

M. Provide phase discordance protection for all circuit breakers with non-mechanically interlocked poles. Protection shall utilize auxiliary switch contacts from circuit breaker poles to detect failure to close any circuit breaker. Provide an auxiliary tripping relay to initiate re-trip upon detection of phase discordance conditions. Relay shall be rated to operate at DC control voltage listed in Section 2.3-A.5. Provide a minimum of two spare contacts from auxiliary relay for customer's use.

N. Current Transformers
   1) Two relaying accuracy multi-ratio bushing current transformer s on bushings 1, 3 and 5 (total of nine current transformers with short-circuiting terminal boards in mechanism cabinet. Bushing current transformers shall be rated 1200:5 multi-ratio, C800 accuracy class.

   2) Two relaying accuracy multi-ratio bushing current transformer on bushings 2, 4 and 6 (total of nine current transformers), with short-circuiting terminal boards in mechanism cabinet. Bushing current transformers shall be rated 1200:5 multi-ratio C800 accuracy class.

O. Provide one bolted, bronze tin plated, stud to NEMA 4 hole pad connector on each bushing.

2.6 REQUIRED SPARE PARTS

A. One complete set of gaskets.

B. One trip coil and one close coil.

C. All spare parts shall be shipped with the power circuit breaker to the destination as quoted in the Summary of Proposal, Section A. Provide engineer with a signed receipt acknowledging delivery of all spare parts to owner.

2.7 OPTIONAL ACCESSORIES/SPARE PARTS

A. Provide a manufacturer's list of recommended spare parts and costs for these parts. This section will not be used in the bid evaluation.

2.8 FABRICATION

A. Fabrication:
   1. All connecting parts to fit together accurately and permit erection without cutting or mutilation of members.
   2. Bent, warped or otherwise improperly fabricated members will be rejected.

B. Paint and Finish
   1. Preparation for and application of paint to exterior of tank frame and accessories shall meet or exceed requirements of RUS specification S-4. Color shall be ANSI 70, light grey. Provide two quarts of touch-up paint for each circuit breaker.
   2. All masking materials shall be removed from the equipment prior to shipment. Protective shipping covers for gauges, etc., shall be provided in accordance with Section 1.6.

2.9 SOURCE QUALITY CONTROL

A. Breaker furnished to be identical to existing designs having acceptable history of service in similar applications for not less than 3 years.

B. Perform design tests per ANSI C37.09 (required for general design of breaker furnished).

C. Perform all applicable production tests included in ANSI C37.09.

D. Other Factory Tests:
   1. Measure actual contact opening time from energization of trip coil to contact parting.
   2. Provide travel record curve from a time travel device. (Provide equivalent timing information for breakers not adaptable to time travel devices.)
   3. Measure maximum DC resistance of the power carrying circuit from terminal to terminal of circuit breaker when new.

2.10 MAINTENANCE MATERIALS

A. Spare Parts and Tools:
   1. All special tools required for installation of breaker.
   2. Complete set of special tools or other devices required to dismantle and reassemble the circuit breaker.
   3. One quart of touch-up paint for each breaker.
   4. For SF_6 puffer circuit breakers, furnish filling hose with regulator and gauge.

B. Time Travel Device:
   1. When time travel device is adaptable to breaker, include provisions for mounting.
   2. If time travel device is not adaptable to breaker, provide instructions and any required devices for such timing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receiving:
   1. CONTRACTOR shall furnish all labor, material and equipment required for receiving and inspection.
   2. If any damage is observed or suspected, provide written report to OWNER describing damage and proposed remedy (include pictures of any visible damage)
   3. Repair damage to OWNER's satisfaction..
   4. Verify that all parts have been received in accordance with the shipping list.
   5. Advise OWNER of inspection results.

3.2 INSTALLATION

A. Assembly and Installation:
   1. Equipment will be received, unloaded, assembled and connected by CONTRACTOR.
   2. Assemble exactly to Vendor's recommendations.
   3. Short all current transformer secondaries at terminal blocks in mechanism enclosure (unless directed otherwise by relay test technician).
   4. Make connections to external wiring in accordance with the Drawings, these Specifications, and Vendor's instructions and drawings (as required to permit checkout and testing of breaker).
   5. Make adjustments recommended by Vendor.
   6. Paint any scratched surfaces with touch-up paint.

B. Fill with Insulating SF_6 Gas:
   1. Follow Vendor's recommendations.
   2. Schedule shipments of SF_6 gas.
   3. Use procedures and equipment which insure integrity of the insulating SF_6 gas.

3.3 FIELD QUALITY CONTROL

A. Coordinate with factory service representative so that he may be present during assembly and installation, filling with insulating SF_6 gas checkout and field testing, and placing in service.

B. Inspect Installed Breaker and Components (Checkout):
   1. Satisfactory workmanship.
   2. Conformance with Specifications and Drawings.
   3. Correct nameplate information and ratings.
   4. Proper alignment and fit.
   5. Required grounding connections including frame, mechanism and current transformers.
   6. Tightness of bolting hardware.
   7. Tightness of wiring terminals.
   8. Tap setting and shorting of current transformers.
   9. SF_6 gas pressure, where applicable.
   10. Make functional check of all controls.
   11. All inspections recommended by Vendor.
   12. Make field tests (see below).

C. CONTRACTOR shall furnish all labor, material, and equipment required for field tests.

D. Perform the following field tests:
   1. Timing tests (ANSI C37.09-1979, Article 5.12).
   2. Measure DC resistance of the power carrying circuit from terminal to terminal (use 100 ADC minimum).
   3. Current transformers:
      a. Ratio test (use primary current injection).
      b. Polarity test.
      c. Megger between secondary leads (all phases tied together) and ground. Use 1000 V test voltage for 1 minute, or until reading remains constant for 15 seconds.
      d. Acceptable megger reading: 5 megohms, minimum.
   4. Single-phase motors:
      a. Visual inspection.
      b. Megger motors with supply cables connected (but disconnected at source).
      c. Motor to be at ambient temperature.
      d. Use 500 V test voltage for 1 minute, or until reading remains constant for 15 seconds.
      e. Megger between phase and neutral conductor, tied together, and ground.
      f. Acceptable reading: 5 megohms, minimum.
      g. Verify satisfactory performance and rotation by running motor.
      h. Check lubrication.
   5. Sensors and alarm/control contacts:
      a. Megger between leads and case (see manufacturer's instructions for test voltage).
   6. Energize cabinet heaters and thermostat and verify operation.
   7. Verify proper operation of manual trip.

E. For Acceptance: Pass all inspections and tests.

F. Records:
   1. Statement that equipment has passed all inspections.
   2. Megger readings versus time data, including converted values and ambient temperature at time of test.
   3. Contact resistance values.
   4. Results of timing tests.
   5. Results of CT tests.
   6. Results of all tests recommended by Vendor.

3.4 DUTIES OF SERVICE REPRESENTATIVE

A. Vendor's factory trained service representative shall perform services described within the following constraints of this Contract:
   1. Service representative's time at site shall be as needed to complete the job.
   2. One trip to site shall be furnished.
   3. Provide service representative's transportation and living expense.
   4. Inspect the mechanical and electrical installation and certify the equipment has been installed in accordance with manufacturer's instructions and is ready for startup and initial operation.
   5. Instruct personnel designated by OWNER in operation and maintenance of equipment.

B. Service representative shall supervise the following:
   1. Assembly and installation.
   2. All inspections, adjustments and tests required by the Vendor.
   3. Field tests and checkout described herein.
   4. Placing equipment in operation.

C. Testing equipment and procedures subject to approval and direction of factory service representative.

D. A written report shall be completed by the service representative following all successful testing before leaving the jobsite. Formal documentation six (6) certified copies must be received within ten (10) working days.

END OF SECTION

SECTION 16411
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 GENERAL

A. Section Includes:
   1. One (1) automatic transfer switches.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Standard for Safety Enclosed and Dead-Front Switches.
      b. 1008, Standard for Safety Switch Equipment.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:

B. Operation and Maintenance Manuals:
   1. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the listed manufacturers are acceptable:
   1. Automatic transfer switches:
      a. Automatic Switch Company.
      b. Kohler.
      c. Onan.
      d. Russelectric.
      e. Zenith Products.

2.2 AUTOMATIC TRANSFER SWITCH

A. Construction:
   1. Electrically operated mechanically held, double throw, air-break type.
   2. Silver-surface main contacts and protect by arcing contacts.
   3. Switch shall have provisions for visual inspection of switch blades and contacts.
   4. Mechanical design will positively open all ungrounded conductors from normal source before connection is made to alternate source and will positively open alternate source before connection is made to normal source.
   5. Mechanical interlock to ensure the switch cannot be readily disabled, disconnected, improperly adjusted, removed or otherwise made inoperative.

6. Make all contacts and coils readily accessible for replacement from front of panel without major disassembly.
7. Ratings:
   a. Continuous duty in both normal and emergency.
   b. Single phase, three pole, three wire.
   c. Voltage rating to be 240V.
   d. Current rating to be 600A.
   e. Short circuit withstand rating equal to or greater than the normal source electrical gear.
8. Standards: UL 1008.

B. Operation:
1. Microprocessor based control module.
2. Open transition.
3. Red and green indicating lights with fuses, identification nameplates, and test switch on front to simulate normal power failure at switch.
4. Engine starting contacts and all other auxiliary contacts and accessory devices for functions to be performed.
5. Supervisory voltage relays on each phase of normal source and single phase supervisory voltage and frequency relay for emergency source.
   a. Normal source voltage sensing.
      1) Adjustable pickup from 85-100 percent of rated voltage, factory set 90 percent.
      2) Adjustable dropout from 75-98 percent of pickup setting, factory set 85 percent.
   b. Emergency source voltage and frequency sensing:
      1) Adjustable pickup from 85-100 percent of rated voltage, factory set 90 percent.
      2) Fixed voltage dropout at 85 percent of pickup setting.
      3) Adjustable pickup from 90-100 percent of rated frequency, factory set 95 percent.
      4) Fixed frequency dropout at 88 percent of pickup setting.
6. Time delays:
   a. Engine start, adjustable from 0 to 10 seconds, factory set at 4 seconds, to avoid unnecessary starting caused by short time outages.
   b. Transfer to generator, adjustable from 0 to 120 seconds, factory set at 10 seconds.
   c. Retransfer to normal, adjustable from 2 to 30 minutes, factory set at 15 minutes to avoid erratic operation caused by short time reestablishment of normal source.
      1) Automatically bypassed when emergency source fails and normal source is available.
   d. Generator cool down, adjustable from 0 to 60 minutes, factory set at 10 minutes.
7. Exerciser timer:
   a. Enable and disable function.
   b. Selectable to exercise with or without transferring load.
   c. Adjustable exercise duration from 1 minute to 24 HRS, factory set at 15 minutes.
   d. Adjustable day of the week exercise setting, factory set for Monday.
8. Inphase monitor:
   a. Compare the phase relationship and frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency differences.
   b. Inphase transfer accomplished if both sources are within 2 Hz of rated frequency and 70 percent or more of rated voltage.

C. Enclosure:
1. NEMA 1 rated.
2. Body and cover: Sheet steel finished with a rust inhibiting primer and manufacturers standard paint inside and out.
3. No knockouts, hinged and lockable door.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Connect as indicated in AC one-line diagram.

C. Mounting of automatic transfer switches:
   1. Wall-mounted.

3.2 FIELD QUALITY CONTROL

A. Automatic Transfer Switch Testing:
   1. Simulate power outage by opening normal source overcurrent device.
      a. Verify engine generator starts and switch transfers in the specified time.
   2. Close normal source overcurrent device to simulate the return of normal power.
      a. Verify the switch retransfers and engine generator shuts down in the specified time.
   3. Perform a manual transfer and retransfer.
   4. Verify the indicator lights function properly.

END OF SECTION

SECTION 16412
HIGH VOLTAGE GROUP-OPERATED DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 GENERAL

A. Section Includes:
   1. 230 kV Vertical Break Group-Operated Disconnect Switch shall be three-pole, single-throw outdoor, group-operated disconnect switches for use on three-phase 60 hertz ungrounded, effectively grounded and solidly ground systems. The switches shall include insulators, operating mechanisms and other accessories, as specified.

B. Work By Others:
   1. CONTRACTOR will provide the following:
      a. Switch Foundation and Structural Steel.
      b. Connection to OWNER's Bus.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Work shall be performed in accordance with best present-day installation and manufacturing practices.
   2. Unless specifically noted to the contrary, equipment shall conform to and be tested in accordance with applicable sections of the latest revisions of the following codes and standards:
      a. American National Standards Institute (ANSI).
      b. National Electrical Manufacturer's Association (NEMA).
   3. Conflicts between referenced codes and standards:
      a. Code or standard establishing more stringent requirements shall be followed. Engineer shall be the final judge as to which requirement is more stringent.

1.3 SUBMITTALS

A. Manufacturing Progress Reports
   1. Within 30 days of order, the MANUFACTURER shall furnish to the Engineer a manufacturing schedule for switches to be furnished under this specification. MANUFACTURER's schedule shall include projected time allotment for engineering, major materials delivery, all major divisions of fabrication and assembly, testing, and shipment. This schedule shall allow for work completed on each item to be shown in conjunction with projected schedule in a manner which allows updating for furnishing progress reports.

B. Shop Drawings For Approval
   1. "Shop Drawings" refers to all detailed installation drawings prepared by the MANUFACTURER and/or his suppliers required to construct the equipment as defined by the specifications, and shall include all fabrication drawings, working drawings, catalog data, manufacturer's specifications, equipment and material scheduled, detailed layouts, and assembly information.

2. The MANUFACTURER agrees that submittals and shop drawings processed by the Engineer are not change orders; that the purpose of submittals and shop drawings by the MANUFACTURER is to demonstrate to the Engineer that the MANUFACTURER understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use. The MANUFACTURER alone accepts all responsibility for assuring that all materials furnished under these specifications meet in full all requirements of the contract documents. The Engineer's review is for general conformance with the design concept and contract documents. Markings or comments shall not be construed as relieving the MANUFACTURER from compliance with the project plans and specifications, nor departures there from. The MANUFACTURER remains responsible for details and accuracy for confirming and correlating all quantities and dimensions, for selecting fabrication processes techniques of assembly.
3. Submit the following shop drawings to the Engineer in the manner specified hereinafter. The following drawings shall be submitted not later than 30 days after receipt of order and steel structure drawings showing switch mounting details.
   a. Switch pole outline with dimensions.
   b. Mounting base detail.
   c. Location and size of mounting holes for all steel support brackets.
   d. Control arrangement for group operated switches.

C. Engineer's Action
1. Engineer will review shop drawings and indicate action taken according to the following classifications:
   a. No Exceptions Taken: Indicates that the shop drawing has been reviewed and appears to be in general agreement with the requirements. MANUFACTURER may make further distribution of shop drawings and proceed with fabrication and/or installation of the work detailed on the drawing.
   b. Make Corrections Noted: Design revisions, deletions, additions and comments shown on these drawings shall be incorporated into the design before proceeding with fabrication or drawing distribution.
   c. Amend and Resubmit: Indicates that the shop drawing, or part thereof, does not appear to be in general agreement with the requirements. Engineer's comments are noted on the shop drawing and/or separate letter. MANUFACTURER shall recheck and make any necessary revisions and resubmit for Engineer's review.
   d. Rejected: Indicates that the shop drawings do not conform to requirements. Reasons for rejection are noted on the shop drawing and/or separate letter.
2. Shop Drawing Submittal and Distribution
   a. Initial Submittal (Review): Submit three (3) copies of each shop drawing to the Engineer; direct mailing to the Engineer's address given in Division O. One copy of the shop drawings indicating the Engineer's action will be returned to MANUFACTURER within three (3) weeks from date of receipt.
   b. Resubmittal: If drawing is returned to the MANUFACTURER with Engineer's comments and action noted "RESUBMIT", the drawing should be rechecked and revised as necessary and two copies resubmitted in manner described in "Initial Submittal".
   c. Final Distribution (Certified): Within the time schedule listed in the Summary of Proposal, MANUFACTURER shall submit to the Engineer, final drawings covered in Section B above utilizing AutoCAD software. All drawing information shall be stored on a compact disk. Direct mailing to the Engineer's address is given in Division O.

D. Instruction Manuals, Test Reports, and Parts Lists
1. MANUFACTURER shall furnish complete instruction manuals covering installation, operation, and maintenance for all equipment. Manuals, bound in vinyl and properly labeled to indicate the facility covered, shall include:
   a. All shop drawings listed in 1.3-B.3 (Reduce as required to fit in manuals).

b. Specific equipment instruction books.
c. Renewal parts lists for all replaceable parts and assemblies.

Furnish five (5) copies at least two weeks prior to shipment. Manuals shall be submitted to the Engineer, Division O for distribution.

E. Shop Drawing and Instructional Material Transmittal Form
1. MANUFACTURER may use his own form of transmittal letter for distribution of shop drawings, clearly marked "For Approval" or "Certified" as applicable.
2. Submit one (1) copy of transmittal form with each set of drawings or instructional materials.

F. MANUFACTURER's Responsibility
1. Check shop drawings prior to submittal for errors, correctness of details and conformance with the specifications.
2. Notify Engineer of any inconsistencies or questions regarding approval revisions or comments shown on the drawings.
3. Review of shop drawings by Engineer does not relieve the MANUFACTURER of responsibility for errors, correctness of details, or conformance with the specifications.
4. Fabrication and shipment of materials or equipment prior to OWNER's release of drawings, data, and information mentioned hereinbefore, shall be at MANUFACTURER's risk.
a. Fabrication and/or layout drawings.
b. Certifications:
c. Test reports:

1.4 DELIVERY, STORAGE, AND HANDLING

A. All bids shall include F.O.B. destination jobsite, located in Dickey County, North Dakota near the southern boundary of the state.

B. The MANUFACTURER shall notify the Engineer when equipment is ready for shipment. In addition, MANUFACTURER shall advise Engineer of method of shipment, projected routing and estimated time in shipment.
1. Provide shipping papers on all materials and equipment.
2. Immediately after shipment, MANUFACTURER shall notify Engineer of transportation carrier and all transfers and references to permit follow-up on status of shipment and delivery.

C. The MANUFACTURER shall investigate all limitations in regard to shipping the equipment F.O.B. jobsite.

D. Vertical opening switches rated 115kv and above shall be shipped with the live parts and bearing assembled and bolted into position on the bases with blades securely secured closed into the contacts. Insulators shall be separately packaged. Switches rated below 115kv and all "V" type switches shall be shipped with each pole fully assembled. The operating mechanism and interphase linkages shall be packaged separately. All accessories or parts shall be crated or boxed and shipped with the switches. Switches shall be shipped with all components secured to prevent damage. The blade contact surfaces, hinge, contact fingers, and contact subassemblies shall be protected to prevent abrasion of the contact surfaces due to movement between the blade and contact fingers during handling and shipment. Nuts and heads of all bolts used only for shipping purposes shall be painted a bright identifying color.

1.5 EQUIPMENT GUARANTEE

A. Without limiting any other provision of this specification, guarantee of the equipment shall be as follows:
1. MANUFACTURER shall guarantee to the OWNER that the equipment, together with all parts included in the original purchase, is free of defect in workmanship and materials, and is capable of continuous and satisfactory performance when operated in accordance with the instructions provided by the MANUFACTURER at the specified rating and capacity.

2. Guarantee shall extend for a minimum of one year from the date of commercial operation. It shall cover all defects and malfunctions of the switch and accessories. Guarantee shall cover all out-in freight by common carrier in full and the costs of removal from the site and reinstallation after repair. MANUFACTURER shall not be liable for special, indirect, or consequential damages, nor costs of moving structures or associated equipment.

1.6 DEFECTIVE EQUIPMENT

A. Should equipment fail to conform to specifications or to operate satisfactorily, OWNER will have right to operate equipment until defects are corrected and guarantees met.

B. OWNER will have right to operate rejected equipment until it is replaced, without cost for depreciation, use or wear.

C. Equipment may be removed from operation for examination, adjustment, alteration, or change only at time approved by Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the listed manufacturers are acceptable:
1. Pacific Air Switch Corp (PASCOR)
2. Southern States
3. USCO Power Equipment

B. Submit request for substitution.

2.2 CONSTRUCTION AND PERFORMANCE

A. The electrical characteristics and mechanical features of the disconnect switches supplied under these specifications shall be capable of meeting all the requirements specified herein and shall conform to the latest revisions of all applicable NEMA and ANSI Standards.

B. Switches and operators shall be designed to be located where extremes of temperature and severe icing conditions exist. Satisfactory operation will be required over a temperature range of -50°F to +110°F and icing conditions up to 3/4 inch of ice.

2.3 CONTACTS

A. Switch contact surfaces shall be finished with high pressure silver to silver contacts which meet all applicable ANSI, IEEE and manufacturer's practices and recommendations.

B. All contacts shall be self-cleaning.

C. Temperature rise testing shall be in accordance with IEEE C37.34. Temperature rise limitations shall be in accordance with IEEE C37.30.

2.4 LINE TERMINALS

A. Terminal drilling shall be 6-hole for use with either 4-hole or 2-hole NEMA terminals.

B. For copper or copper alloy switches the terminal pads shall be tinned. For aluminum switches, the terminals may be of high-conductivity aluminum.

2.5 INSULATORS

A. NEMA standard strength porcelain station-post insulators with ANSI #70 gray glaze shall be provided by the switch manufacturer.

2.6 OPERATING MECHANISM

A. Group operated disconnect switches shall be furnished with an operating mechanism as specified in Section 2.7, complete with inter-phase pipes, fittings, levers, clevises, operating pipe and grounding strap.

B. Operators shall be furnished with position indicators and provisions for padlocking in "open" or "closed" position, fully adjustable for operator rotation from fully closed to fully open. Operator shall be left-handed or right-handed as required for operator location. Operators shall be located as required to provide proper rotation of operator pipe. Provide proper grounding straps to bond operating pipe immediately above operator to steel structure.

C. Manufacturer shall provide any mounting hardware and steel supports required for attaching the operating mechanism to steel structures. Manual swing operating handles should be mounted approximately 3 feet above the base of the switch-stand and manual crank and motor operators should be mounted approximately 2 feet 6 inches above the base of the switch-stand.

D. Mounting bolts for complete switch, including pole units and all additional steel shall be furnished by the Bidder. All mounting hardware and steel shall be hot-dip galvanized.

E. The operating mechanism shall travel over center beyond the open position to prevent possible accidental closing of an open switch.

F. All inter-phase and control pipes shall be continuous with fittings located only at extremities. All pipe connections on the vertical control pipe shall be secured with positive locks. (Puncture bolts or piercing screws.)

G. If motor operator is specified in Section 2.7, ratings and accessories shall be as follows:
   1. Motor and control rated for DC operation as specified in Section 2.7.
   2. Local electrical control and provision for remote operation.
   3. Provisions for manual operation with the motor engaged and disengaged.
   4. Mechanical position indicator for "open" and "closed" position.
   5. Weatherproof, dustproof control cabinet with provisions padlocking.
   6. Thermostatically controlled 150 watt control cabinet strip heater 120/240 volt AC operation.
   7. Operations counter.
   8. Laminated safety plate window for inspection of position indicator and operations counter.
   9. Control cabinet light with switch.
   10. DC protection provided by fused knife switches.
   11. Minimum of four 'a' and four 'b' contacts which correspond to motor operator position plus a minimum of three 'a' and three 'b' contacts in a separate assembly which correspond directly to the switch/operator pipe position for customer use.

2.7 GROUP OPERATED DISCONNECT SWITCHES

A. Ratings
   1. Quantity ..... Six
   2. Type ..... 3-pole Group Operated, Vertical Break
   3. Maximum Operating Voltage ..... 242 kV
   4. BIL ..... 900 kV
   5. Nominal Cont. Current Rating ..... 1200 A
   6. Momentary Current Rating ..... 61 KA
   7. Mounting Orientation ..... Horizontal

8. Phase Spacing ..... 16' -0"
9. Height to Switch Terminal ..... 15'-0"
10. Switch Live-Parts Material ..... Aluminum
11. Insulators TR-304
12. Operating Mechanism ..... Swing Handle

PART 3 - EXECUTION

3.1 INSTALLATION

A. The OWNER anticipates that equipment will be received, unloaded at jobsite, assembled and connected by CONTRACTOR.

3.2 TESTING

A. Shop Tests
   1. Perform tests on switches in accordance with ANSI C37.34.
      The switches shall be completely assembled, adjusted and tested at the factory.
   2. Provide Engineer with five (5) certified copies of all test data. Copies shall be in the form that they can be bound into instruction books by others.

B. Field Tests
   1. Field Service Engineer will conduct tests and inspection as he deems necessary to determine that equipment functions properly after installation. Any special test equipment will be furnished by Field Service Engineer.
   2. If equipment fails to function properly because of defects, MANUFACTURER will make necessary corrections, and upon completion thereof, demonstrate to Engineer that these defects have been corrected.

END OF SECTION

SECTION 16441
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Power distribution panelboards
      a. One (1) - 120/240V, 1PH, 400A with 42 Branch Pole Positions.
   2. DC distribution panelboards
      a. Two (2) – 125VDC, 225A with 40 Branch Pole Positions.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 1, Panelboards.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
      a. 50, Cabinets and Boxes.
      b. 67, Panelboards.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Fabrication and/or layout drawings:
      a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Cutler-Hammer.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.

2.2 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. Ratings as follows unless indicated otherwise on Drawings:
   1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
   2. Panelboards rated 240 Vac or less: 10,000 amp minimum short circuit rating.

C. Construction:
   1. Service entrance rated as indicated on Drawings.

2. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
3. Multi-section panelboards: Feed-through or sub-feed lugs.
4. Main lugs: Solderless type approved for copper and aluminum wire.

D. Bus Bars:
1. Main bus bars: Plated aluminum or copper sized to limit temperature rise to a maximum of 65 DegC above an ambient of 40 DegC. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
2. Ground bus and isolated ground bus, when indicated on Drawings: Solderless mechanical type connectors.
3. Neutral bus bars: Insulated 100 percent rated or 200 percent rated, when indicated on the Drawings and with solderless mechanical type connectors.

E. Enclosure:
1. Boxes: Code gage galvanized steel, furnish without knockouts.
2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
3. Power distribution panelboard:
   a. Trims cover all live parts with switching device handles accessible.
   b. Less than or equal to 12 IN deep with gutter space in accordance with NEC.
   c. Clear plastic cover for directory card mounted front of enclosure.
   d. NEMA 1 rated.

F. Overcurrent and Short Circuit Protective Devices:
1. Main overcurrent protective device:
   a. Molded case circuit breaker.
2. Branch overcurrent protective devices:
   a. Mounted molded case circuit breaker.
3. Factory installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on Drawings, in accordance with the NEC, and in accordance with manufacturer's instructions.

B. Provide NEMA 1 or rated enclosure as indicated on the Drawings.

C. Provide each panelboard with a typed directory:
1. Identify all circuit locations in each panelboard with the load type and location served.
2. Mechanical equipment shall be identified by Owner-furnished designation if different than designation indicated on Drawings.
3. Room names and numbers shall be final building room names and numbers as identified by the Owner if different than designation indicated on Drawings.

END OF SECTION

SECTION 16461
CAPACITIVE COUPLING VOLTAGE TRANSFORMER(S)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Nine (9) outdoor Capacitive Coupling Voltage Transformers (CCVT).

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. National Electrical Manufacturer's Association (NEMA).

1.3 DEFINITIONS

A. CCVT: Is a transformer used in power systems to step-down extra high voltage signals and provide low voltage signals either for measurement or to operate a protective relay.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Capacitive Coupling Voltage Transformer:
      a. Ritz.
      b. ABB.
      c. Or Approved Equal.

2.2 MANUFACTURED UNITS

A. Capacitive Coupling Voltage Transformer:
   1. Quantity: Nine (9).
   2. Voltage Class: 230kV.
   3. Basic Insulation Level (BIL): 900kV.
   4. Nominal Capacitance: 0.003uf, High C.
   5. Frequency: 60Hz.
   6. Primary Terminals: Top Cover Adapter Plate with 5 inch bolt circle drilling for pedestal mounted line trap.
   7. Type Mounting: Vertical Base.
   8. Color of Porcelain and Tank: ANSI #70 Light Grey.
   9. Accessories:
      a. Carrier Accessories.
      b. Carrier lead in bushing.
      c. Anti-condensation heater.
      d. Ground terminal connector for #2-250 KCM copper cables.

PART 3 - EXECUTION

3.1 CONSTRUCTION AND PERFORMANCE

A. Instrument transformers shall be suitable for continuous operation for altitudes up to 1000 meters and ambient temperatures between -30°C and 40°C.

3.2 INSTALLATION

A. Install per MANUFACTURER'S recommendations.

B. Capacitive Coupling Voltage Transformer shall be located as shown on Plan and Elevation Drawings.

END OF SECTION

SECTION 16471
BATTERY AND BATTERY CHARGER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Battery and Charger.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronic Engineers/American National Standards Institute (IEEE/ANSI) 1106 and 1115:
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 70B, National Electrical Code (NEC).

1.3 SUBMITTALS

A. Proposal Data:
   1. Battery Bank and Charger:
      a. General Information:
         1) Manufacturer.
         2) Model.
         3) Catalog Number.
         4) Weight of entire bank with stand.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Battery Bank and Charger:
      a. ALCAD.
      b. EXIDE.
      c. C&D.
      d. Or Approved Equal.

2.2 MANUFACTURED UNITS

A. Battery and Charger:
   1. Nickel Cadmium Battery:
      a. One hundred fifty (150) amp-hr. with a capacity at eight (8) hour discharge rate to 1.75 volts per cell final at 77°F. The float charge shall have a range of 2.15 to 2.25 volts per cell. Plate composition shall be lead calcium.
      b. Inter-cell and inter-step connections (plus two spares with bolts and nuts).

c. Terminal connectors with plated copper lugs for connection of the battery's main positive and negative terminals to 4/0 A.W.G copper power cable.

2. Battery Accessories:
   a. Protective cover to prevent accidental contact with the terminals.
   b. Lifting straps and lifting hardware.
   c. Cell numerals with polarity indicators for all cells furnished.
   d. Battery nameplates and warning labels.
   e. One half-pin of No-Oxide grease.
   f. Installation and maintenance instructions.
   g. Any other accessories required by OSHA, including Material Safety Data Sheets.
3. Battery Rack:
   a. Provide back-to-back two step battery rack.
   b. Rack shall be designed to fit in area given.
   c. Rack shall allow individual cell replacement.
   d. Rack shall be constructed of steel with acid-resistant insulation between the cells and the steel of the rack as per IEEE Std. 484.
4. Battery Charger:
   a. Furnish one (1) floor mounted complete automatic battery charger with as a minimum, the following ratings and accessories.
   b. Rated input: Single-phase, 240 volts AC, 60 Hz.
   c. Output: 125 VDC, 25 amps.
   d. Filtered battery eliminator option.
   e. DC ammeter rated 2% accuracy, scale per MANUFACTURER's recommendation, based on charger output.
   f. DC output voltmeter, 2% accuracy, expanded scale.
   g. AC input and DC output circuit breakers.
   h. Dual-rate capability with float/high-rate switch and float/high-rate voltage adjustment potentiometer.
   i. High DC voltage shut-down.
   j. Automatic charging control with timer and high-rate charge indicator light.
   k. Alarm relays for AC power loss, DC failure, high and low VDC and ground fault.
   l. Terminal block for termination of all relay alarm contacts, factory wired.
   m. Installation, operation, and maintenance instructions and parts lists.
   n. 120V, 20 amp auxiliary output contact to close during equalize charge.
   o. Ground connector.
5. Enclosure:
   a. One (1) enclosure with hinged doors, ANSI-61 grey finish for location within inside of building. Enclosure shall be sized to include supporting the batteries and battery charger.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install per MANUFACTURER'S recommendations.

B. Battery and Charger shall be located as shown on Plan and Elevation Drawings.

END OF SECTION

SECTION 16494
ELECTRICAL INSULATORS AND LIGHTNING ARRESTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Station Post Insulators.
      b. Suspension Insulators.
      c. Lightning Arresters.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronic Engineers/American National Standards Institute (IEEE/ANSI):
      a. ANSI Class 52-6.
      b. C62.11, Metal-Oxide Surge Arresters for Alternating Current Power Circuits.
      c. C62.22, Guide for Application of Metal-Oxide Surge Arresters for Alternating Current Systems.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 70B, National Electrical Code (NEC).

1.3 DEFINITIONS

A. Insulator: Insulating material, often glass or porcelain, in a unit form designed so as to support a charged conductor and electrically isolate it.

B. Arrester: Protective devices for limiting surge voltage due to lightning strikes or equipment faults.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Insulators (Station and Post):
      a. LAPP.
      b. NGK Locke.
      c. Sediver.
      d. Or Approved Equal.
   2. Arresters:
      a. Ohio Brass.
      b. General Electric Company.
      c. Or Approved Equal.

2.2 MANUFACTURED UNITS

A. Insulators:

1. 230kV Station Post Insulator:
   a. 900kV BIL, TR-304.
   b. Gray.
   c. Standard Strength.
   d. 5 inch Bolt Circle.
2. 230kV Suspension Insulator:
   a. 30,000lbs Minimum Ultimate Tensile Strength.
   b. Gray.
   c. 10 inch diameter.
   d. Ball to Socket.

B. Lightning Arresters:
1. 230kV Arrester:
   a. 140kV MCOV.
   b. Polymer housed station class Type PVN.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Clamp supports and associated hardware shall have a strength exceeding that of the insulator.

B. Insulators shall be located as shown on Plan and Elevation Drawings.

END OF SECTION

SECTION 16495
Optical Current Sensor

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Optical Current Sensor.

1.2 DEFINITIONS

A. Optical: Relating to or using visible light.

1.3 SUBMITTALS

A. Proposal Data:
   1. Optical Current Sensor:
      a. General Information:
         1) Manufacturer.
         2) Model.
         3) Catalog Number.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Optical Current Sensor:
      a. NXTPhase.
      b. Or Approved Equal.

2.2 MANUFACTURED UNITS

A. Optical Current Sensor:
   1. Column Mechanical and Electrical Ratings:
      a. Maximum Voltage: 245kV.
      b. BIL Level: 900kV.
      c. Column Height: 110" (2.80m).
      d. Minimum Creep Distance: 193" (4.90m).
      e. Weight: 144lbs (65kg).
      f. Static Withstand: 900lbs (4000N).
   2. Environmental:
      a. Operational Temperature Range: -40°C to 55°C (-40°F to 131°F) Outdoor Service Conditions.
      b. Seismic Capability: 0.5g.
   3. Mechanical:
      a. Standard Pollution Withstand: IEC Level II.
      b. Insulation: Solid composite insulator.

4. Electronics:
   a. Low Energy Analog Interface: $4V_{rms}$ metering, $200mV_{rms}$ protection.
   b. Bandwidth: 0.5 Hz to 6 kHz.
5. Input Power Requirements:
   a. $70V_{dc}$ to 150 V_{dc}, Typical power 50W.
6. Electronic Turns Ratio:
   a. User selectable.
7. Electrical Performance:
   a. Metering Accuracy: IEC Class 0.2S.
   b. Continuous Current: 4000A Max (4000 A, RF = 1; or 3000 A, RF= 1.33, or 2500 RF = 1.5).
   c. Short time Thermal Current: 63 kA_{rms} for 1s.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install per MANUFACTURER'S recommendations.

B. Optical Sensor shall be located as shown on Plan and Elevation Drawings.

END OF SECTION

SECTION 16550
Control Building

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   a. One (1) Steel Control Building.

B. Work by others:
   1. CONTRACTOR responsible for:
      a. Furnishing and erecting one complete steel control building as specified herein.

C. The following drawings are hereby made part of this specification:
   1. TWEND-CH-01: Control House.
   2. TWEND-CH-02: Control House.
   3. TWEND-CH-03: Control House.
   4. TWEND-CH-04: Control House.
   5. TWEND-CH-05: Control House.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. "Recommended Design Practices Manual", Metal Building Manufacturer's Association (MBMA).
   2. "Steel Construction Manual", American Institute of Steel Construction (AISC).
   3. "Cold Formed Steel Design Manual", American Iron and Steel Institute (AISI).
   4. "Aluminum Construction Manual", The Aluminum Association.
   5. "Code for Welding in Building Construction", American Welding Society.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Steel Control Building:
      a. Steelox Building Systems.
      b. Butler Manufacturing Co (with MR-24 roof).
      c. Stran-Steel Corportation.
      d. Walker/Parkersburg (with Parkseal roof).
      e. Trachte Channelframe Buildings.
      f. Or Approved Equal.

B. The following criteria shall be applicable in other phases of design:
   1. Building Code having jurisdiction over the area in which the site is located.

2.2 BUILDING DESCRIPTION

A. Characteristics:
   1. Metal building shall be of self-framing, or straight column and beam, steel construction.

2. Interior shall be free of supports.
3. Fire rating shall be specified in 2.2.C.

B. Dimensions:
1. Outside dimensions shall be as indicated on drawings.
2. Minimum allowable inside dimensions shall be as indicated on drawings.
3. Minimum unrestricted height throughout the interior shall be as indicated on drawings.

C. Design Criteria:
1. Live load 30psf.
2. Wind load 90mph.
3. Seismic load Zone 0.
4. Wall fire rating 1hour.
5. Insulating Values (Min.):
   a. Roof – R38.
   b. Walls – R19.

D. Roof:
1. Slope shall be not less than 2:12 nor more than 4:12.
2. System shall be devoid of any valleys.
3. Panels shall be a minimum of 26 gauge with galvanized coating conforming to G90 (1¼ oz.) standards.
4. Panels shall be of "standing-seam interlocking" design.
5. Standing seams shall have a factory-applied, non-hardening sealant, and the seam shall be continuously locked or crimped together by mechanical means during erection.
6. Roof panels with lap-type seams shall not be considered acceptable.
7. Exterior surface shall have factory applied baked-on or laminated color finish.
8. Shall carry an UL Construction (Uplift) rating of not less than Class 30.

E. Exterior Wall Panels:
   a. Exterior wall panels shall be a minimum of 26 gauge with galvanized coating conforming to G90 (1¼ ox.) standards.
   b. Exterior surface shall have factory applied baked-on or laminated color finish.
   c. Wall panels shall be fastened to its supports with zinc-coated screws or bolts on the side of the panel, concealed in joint, or by other means so as to eliminate exposed primary fasteners.
   d. Exposed (non-leadbearing) stainless steel or aluminum screws, bolts and/or rivets shall be acceptable for securing trim, fascias, gutters and miscellaneous flashings to either the wall or roof panels.
   e. Wall panels shall be pre-cut for proper building eave height, no splices shall be permitted.
   f. Top, bottom and intermediate panel closures, flashings, fascias, gutters and trim shall be caulked with non-hardening sealant to achieve weather-tightness and to prevent entrance of insects.
   g. Sealant shall be the building manufacturer's standard.

F. Interior Wall Panels:
   a. Provide interior liner panels which encase all structural members with a box, and produce a continuous inner wall surface between structural members.
   b. Interior wall panels shall be a minimum of 26 gauge with galvanized coating conforming to G90 (1¼ ox.) standards.
   c. Wall panels shall be vertically applied, pre-cut for proper building height.
   d. Liner panel shall be of interlocking or similar type design, such that the only exposed fasteners are at base, top and accessory trim.
   e. Surface of interior panels shall be smooth or have a fine embossed texture.

f. Sculptured panels or panels with moderate projections or depressions shall not be acceptable.

G. Ceiling:
   a. Liner panels shall be a minimum of 26 gauge galvanized steel with factory applied painted finish ceiling panel shall be of interlocking or similar type design, such that the only exposed fasteners are at the corners and trim.
   b. Fasteners shall be prepainted with same color finish as liner panels.
   c. Surface of ceiling panel shall be smooth or have a fine embossed texture.
   d. Sculptured panels or panels with moderate projections or depression shall not be acceptable.

H. Color Coding:
   a. Exterior color shall meet the following performance standards after continuous exposure in normal conditions for time periods as stated:
      1) Panels shall show no evidence of blistering, peeling or chipping for a period of 10 years.
      2) Panels shall not show surface chalking in excess of the No. 8 rating D659-44 per ASTM for a period of 5 years.
      3) Panels shall, after cleaning, not show color change in excess of seven units per ASTM-D-2244-64T for period of 10 years.

I. Building Insulation:
   a. All insulating materials shall be non-combustible rigid material, fiberglass batts/blankets or spray applied foam of type and insulating quality listed below.
   b. Suitable means of preventing moisture entry into building shall be provided.
   c. Where used, rigid insulation shall be integral with steel liner panel.
   d. Fiberglass batt/blankets shall be faced with a flexible vapor barrier.
   e. Fiberglass batts used for roof insulation shall be supported with wire mesh; insulation shall not be compressed between the roof panels and purlins.
   f. Insulation shall not be laid on top of ceiling panels.
   g. Spray on urethane insulation shall be given an overall fire retardant coating, National Cellulose "Ure-K", or equal.
   h. All composite insulation/vapor barrier/fire retardant materials shall carry a UL fire hazard rating indicating a flame spread of 25 or less.

J. Interior Partitions:
   a. Interior partitions shall be metal liner panel over wood stud or steel frame construction.
   b. Wood studs shall be dense select structural grade douglas fur.
   c. Metal liner panels shall meet requirements for "Interior Liner Panels".
   d. Maximum stud spacing shall be 16" on center.
   e. Wall shall be attached to concrete floor with 3/8" x 3½" galvanized lag bolts and anchors, 2' on center.
   f. Partitions shall be full room height.
   g. Top of interior partitions shall be securely anchored to building structural members as approved by the Engineer.

K. Interior Partitions:
   a. The standard of quality for swing doors and frames shall be that established by the Steel Door Institute and that set forth as a minimum by the U.S. Department of Commerce Standard PS 4-66.
   b. Exterior flush steel doors shall be 1¾" thick, insulated and weather-stripped.
   c. Exterior single doors shall be equipped with a heavy duty commercial-grade hydraulic closer and panic exit mechanism on the interior and a entrance handle on the exterior.

L. HVAC, Ventilators, Louvers, and Accessories:
   a. Building Contractor responsible for installing and sizing all equipment required for a complete HVAC system.

M. Gutters and Downspouts:
   a. Gutter and downspouts shall be continuous type, 22 gauge galvanized steel with a baked enamel coating.
   b. Gutter shall be 5" and attached to fascia with hanger brackets or sleeve nails intended for that purpose.
   c. Downspouts shall be 3"x5" and be attached to exterior wall with strap type hanger brackets.
   d. Gutter and downspout hanger spacing shall be a maximum of four feet.
   e. All attachment hardware and other accessories required for a complete installation shall be furnished and have a finish matching the gutter and downspout finish.
   f. All joints and ends shall be water-tight upon completion of installation.

N. Floor Finish:
   a. Control house flooring includes complete installation of vinyl composition floor tile as specified below:
      1) Material: Vinyl Composition Tyle, Manufacturer (Armstrong Cork Company or approved equal), Tile size (12"x12"x1/8" thickness), Color (Beige, or as approved by Engineer), Series (Imperial Modern Excelon Vinyl Composition Tile).
      2) Adhesive: Armstrong S-160 emulsion, S-90 cement.
      3) Installation: Refer to Section 3.2.

O. Safety Equipment:
   a. Ladders:
      1) Provide one new 24 foot Fiberglass extension ladder, Type 1A industrial with 300 pound duty rating and one new 6' portable fiberglass step ladder, Babcock "Electric Step Ladder", or equal.
      2) Ladders shall be U.L. listed and meet OSHA requirements.
   b. Fire Extinguisher:
      1) One Potter-Roemer, or approved equal, twenty pound dry chemical fire extinguisher.
      2) Extinguisher shall carry a U.L. rating of 10A-40BC.
      3) Extinguisher shall be fully charged, complete with surface mounting bracket.
   c. Eyewash Kit:
      1) One emergency eyewash kit for mounting near station battery.
      2) North Health Care #12-60-32 or equal.
   d. Exit Lights:
      1) Provide exit lights as shown on the Control Building General Arrangement.
      2) Exit lights shall be 120VAC with power pack, Lithonia LES-I-R.
   e. Smoke Detector:
      1) Provide smoke detectors as shown on the Control Building General Arrangement.
      2) Smoke detectors shall be 120VAC, ionization type with a normal open relay contact for remote alarm, Simplex 2098-9576 with 2098-9536 base or equal.

P. Accessories:
   a. Distribution Panels: See drawing CH-01 and Specification 16441.
   b. Battery and Charger: See drawing CH-01 and Specification 16471.
   c. Transfer Switch: See drawing CH-01 and Specification 16411.
   d. Receptacles and Lighting: See drawing CH-02 and CH-04 for details.
   e. Cable Tray: See drawing CH-05 for details.

PART 3 - EXECUTION

3.1 ERECTION

A. Erection of the metal building, accessories, insulation and the interior finish shall be performed by one of the following:
   a. Authroized dealers or builders of the manufacturer.
   b. Building manufacturer's crews.
   c. Erectors authorized by the manufacturer as trained and qualified to erect that manufacturer's product.

3.2 INSTALLATION

A. Prior to beginning work, floor surface shall be inspected by the Engineer.

B. Unacceptable conditions shall be corrected and Engineer's approval obtained before work begins.

C. Cracks and expansion joints shall be filled.

D. Feather out tile so that it scribes and butts all accessories that protrude from the floor.

E. Tile shall be laid true, level, and even, with tight joints.

F. Samples of all material shall be submitted, if requested, to the Engineer for approval.

G. Floor preparation, priming, and application of paint shall be in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 16600
SUBSTATION FENCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Substation chain link fence.

1.2 DEFINITIONS

A. Chain Link Fence: Is a type of woven fence usually made from galvanized or LLDPE coated steel wire.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. General:
   1. Fence is to be non-climable type equivalent to Real Lock Type 423.
   2. Fence should be 7' high unless otherwise specified with a bracket of 3 strands of barbed wire extended above the 7' height; and cantilevered to the outside.
   3. Fence is to be constructed in a workmanlike manner with material as listed in 2.1.B.
   4. Posts and top railings are to be aligned as straight as possible and must have a pleasing appearance.
   5. Gates and removable sections, if required, to be installed where shown on drawings.
   6. All materials except aluminum to be heavily galvanized by the hot-dip process.
   7. All end, corner and gate posts to be furnished with diagonal braces where required.

B. Fence Characteristics:
   1. Type 423 (Heavy Construction):
      a. 2-1/2" O.D. pipeline posts, 3.65 lb/ft.
      b. 1- 5/3" Top rail, 2.27 lb/ft.
      c. End, corner and gate posts: 3" O.D. pipe, 5.79 lb/ft or approved equal, H-Section Posts and Rails.
   2. Gates:
      a. 2" O.D. pipe frame, 2.72 lb/ft.
      b. All joints welded and braced wherever necessary; covered with fabric to metal fence.
      c. Furnished with suitable hinges and locking devices.
   3. Fabric:
      a. 2" O.D. pipe frame, 2.72 lb/ft.
      b. 2" mesh, No. 11 gauge basic open hearth steel, hot-dip galvanized after fabrication.
      c. 1.2 oz. of zinc per ft. squared of wire surface.
      d. Standard finish, twisted and barbed salvage top and bottom.
   4. Post Settings:
      a. Posts to be set in concrete to a depth of 36".
   5. Fittings:
      a. Malleable iron, pressed steel, and/or aluminum.
   6. Ties:
      a. Aluminum and/or galvanized steel wire.

b. For line posts, furnish one tie to every foot of fabric height.

C. Barbed Wire:
   a. Three strands of galvanized steel running entire length of fence above fabric and gates.
   b. Composed of two strands of 12-1/2 gauge wire, 4 point, spaced approximately 3" apart, supported on the line posts by means of heavy galvanized mallcable iron tops with pressed steel extension arms at an angle of 45°.
   c. Where H-Sections are used, arms maybe fabricated as an integral part of the posts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All post holes shall be clean and loose material removed before placing concrete.

B. Concrete shall be formed up to finish grade around each post, a minimum of 6" above grade, and sloped to provide drainage way from the post.

C. Fence fabric and barbed wire shall be stretched according to manufacturer's instructions, leaving no slack and forming a neat appearance.

END OF SECTION

SECTION
SINGLE-MODE FIBER OPTIC CABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Single-Mode Fiber Optic Cable.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Telcordia:
      a. GR-20-CORE, Optical Fiber and Optical Fiber Cable.
   2. Insulated Cable Engineers Association (ICEA):
      a. S-87-640-1999, Optical Fiber Communication Cables Intended For Outdoor Use.
   3. International Organization for Standards (ISO):
      b. ISO 9001-14001-TL 9000
   4. ASTM:
      a. D4565-90a, Standard Test Methods for Physical and Environmental Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).

   Underwriters Laboratories, Inc. (UL):

B. Qualifications:
   1. Cable technician:
      a. Three years experience in handling, terminating and splicing single-mode fiber optic cable.
      b. Specifically trained by a factory representative on the terminations and splices to be used on the project. If not trained on the products to be used, on-site training by the factory representative shall be preformed before any terminations or splices are made.

1.3 SUBMITTALS

A. Miscellaneous:
   1. Cable Technician qualifications.
   2. Independent testing organization qualifications.
   3. Engineering Technician qualifications.
   4. Cable test reports signed by the engineering technician including the following information:
      a. Summary of Project.
      b. Description of equipment/components tested.
      c. Visual inspection report.
      d. Description of tests.
      e. Test results including appropriate test forms.
      f. Conclusions and recommendations.
      g. Identification of test equipment used.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Ship cable with removable watertight end seals, and store in dry place.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Single-Mode Fiber Optic Cable:
      a. Superior Essex, Inc.
      b. Alcoa Fujikura.

2.2 SINGLE-MODE FIBER OPTIC CABLE

A. Cable Construction:

1. Double Jacket: Double Jacket cable offers additional mechanical protection except in heavily infested rodent areas. The design shall provide reliable transmission performance over a broad temperature range.

2. Physical Description: Optical fibers shall be placed inside gel filled buffer tubes in loose tube cable or bundles in solid designed cable. Core construction shall be by stranding the buffer tubes or fiber groups around a central member using a reverse oscillated lay. Central strength member shall be dielectric.

3. Fiber Protection: The Core shall be wrapped with flexible strength members covered with a water blocking tape and encased with a black polyethylene inner jacket. A second jacket shall have water-blocking yarns and a block polyethylene outer jacket. Rip cords shall be located under each jacket.

B. Standards:
   1. GR-20-CORE, Optical Fiber and Optical Fiber Cable.
   2. S-87-640-1999, Optical Fiber Communication Cables Intended For Outdoor Use.
   3. ISO 9001-14001-TL 9000.
   4. D 4565-90a.

C. Physical Characteristics:
   1. Fiber cables shall be within the range listed below.

Fiber Content	Nominal Diameter In. (mm)	Nominal Weight Lbs.kft (ka/km)	Max. Tensile Loading Lbs (N)	Min. Bend Radius In. (mm)
12	0.56 (14.3)	95 (147)	200 (890)	11.3 (286)

D. Environmental:
   1. Operating Range: The fiber shall be capable of withstanding operation and storage temperatures of -50°C/-122°F to +70°C/+158°F and installation temperatures of -30°C/--86°F to +75°C/+167°F.
   2. Stress: Fiber cable shall meet the requirements of ASTM D 4565-90a.

E. Optical Specifications:
   1. Outside Plant: Fiber optic cable shall meet the following requirements:

Fiber Type:	Single-Mode	Attenuation
	8.3/125µm	62.5/125µm
Wavelength	1310-1550nm	850µm/1300nm
Max. Attenuation	0.40/0.30dB	3.50µm/0.00dB/km
Typical Attenuation	0.35/0.20dB	3.00-0.80dB/km
Min. Band Width	-----	220-600(MHz-km)

F. Light:

1. The single-mode fiber shall be lit by a laser-based light transmitted down the core of the fiber for communications applications.

G. Splicing:
1. The single-mode fiber shall be spliced with mechanical splices.

H. Identification:
1. Each cable reel shall be either stenciled or tagged firmly with the following information.

OPTICAL FIBER

Number of Fibers
Armored or Non-Armored
Year of Manufacture
Name of Cable Manufacturer
Length of Cable
Continuous – Sequential Numbering in One-Foot Increments
Reel Number
Fiber Attenuation dB/km @ 1350/1550 Single-Mode
Dry or Flooded Cable
Size of Buffer Tubes in nm
Results of Factory Tests on 20% of Fibers in Cable

I. Fiber and Buffer Tube Identification:
1. The buffer tubes and individual fibers shall be color-coded to meet the ANSI/TIA/EIA-568A Standards.

END OF SECTION

Tatanka Wind Energy

Monthly Progress Report - January 2008
February 14th, 2008

1. Safety Items

a) **Orientations** continue to take place on Tuesdays and Thursdays. Second orientations, required after two weeks on site, take place on Tuesdays and third orientations, required after five weeks on site, take place on Thursdays.
b) **Training:** Mortenson corporate personnel have been on site several times to hold special Zero Injury training classes as well as classes on Incident Investigations, Pretask Planning, Activity Observations and Forklift Training. ***Due to crew reconfiguration, Mortenson has brought in all erection crews for a complete review if IWI's.***
c) **Site traffic congestion**: Farmers and ranchers harvesting crops, turbine deliveries, crane movement, increased manpower, etc. have increased traffic congestion. Proper and clear communication when blocking off roads and routing traffic is essential to having consistently safe traffic flow.
d) **Near misses** have been turned in on a regular basis. The near miss program is designed as an educational tool. Workers turn in brief reports of things they saw in the field that could have resulted in an accident. These 'learning opportunities' are discussed amongst the group the next day at our morning 'stretch & bend' sessions so all can learn from the incident. We are currently receiving at least seven near miss reports each week.
e) **Speeds:** Nearly everyday at stretch and bend people are reminded about keeping speeds down not only on the project site but also traveling to and from the site. Employees who choose not to follow the speed limits have been removed from the project. Signage has been posted reminding drivers to stay to the right. Mortenson has been assisted by the local Sheriff's department as they have been patrolling incoming and outbound routes. ***New speeding policy has been enacted with receipt of speed gun.***
f) **Erection activities continue** and naturally attract many visitors. If you are not involved in the operation, please stay back and out of the way. Permission is required from the erection crew to proceed past their orange cones which identify the erection area.
g) From our last incident on December 28th, 2007 this project has successfully completed **34 days** of work without an incident that resulted in personal injury by the end of January .

Total Project Work Hours
As of 1/31/2007: 14113 +

Project Recordables/ Incidents

6/27/07 - Aron Zieler, a Rebbar Setters employee, broke his clavicle while lifting rebar. No current status.
6/22/07 - Douglas Job, an Aggregate Industries concrete truck driver, his back while driving to a turbine site. No lost time. Two weeks restricted duty.
6/20/07 - Lawrence Azure, a Mortenson laborer, was using a utility knife when his hand slipped and the knife cut his palm. He received 5 stitches. No lost time. No restrictions.
8/17/07 – Darren Hassel aggravated a preexisting back condition by building bolt cages. On light duty from 8-22-07 to 8-31-07.
NONE in September.
October 2, 2007 *- William Loftis – Strain shoulder.*
10/06/07*- Ken Grahm - Aggravation of pre-existing hernia.*
10/17/07 *- Mike Hendrickson – Broken finger*
11/01/07 *- Terry Brissette – Aggravated pre-existing lower back.*
11/06/07*- Fatality – Robert Kramer*
11/06/07 *- Jim Lund - Sprained elbow*
11/10/07 *– James Sterzinger – Shoulder strain.*
11/17/07*- Winston Johnson - Sore rib cage area.*

12/02/07 *– Darin Hassel – Aggravated existing back condition climbing ladder when cleaning.*
12/06/07 *– Arc Flash in Nacelle no injury.*
12/10/07 *– James Sterzinger – Bruised & swollen big toe.*
12/18/07 *– Lauri Hasz-Hustoft – Right shoulder strain/sprain. OSHA Recordable.*
12/18/07 *- Jeremy McCombs – Left Shoulder sprain. Pre-existing injury from a non-work related car accident.*
12/28/07 *– Don Desselle – Fractures- Right leg. Tibia and Fibula. Lost Time, OSHA Recordable.*

Project Vehicle and Equipment Incidents
6/29/07 - Russ Raff, a Mortenson crane operator, was operating a crane during a crane walk. During the crane walk the crane struck a power line. It was later determined that the power line was not charged.
7/12/07 - Larry Chelgren, a gravel truck driver for Aggregate Industries, was stopped at a stop sign near the office area. When he proceeded, the welds connecting his trailer broke loose causing his trailer to become disconnected.
6/9/07 - Damage to fork on forklift while assembling a crane.
7/20/07 - An Acciona Wind Power employee was traveling down the road when he lost control of his vehicle, entered the ditch, and rolled the vehicle onto its side.
8/7/07 - A gravel truck driver for Aggregate Industries
got to close to the shoulder of the road and entered the ditch. The truck tipped onto its side and spilled the load of gravel.
8/28/07 – While backing up a pressure washer near a parked delivery truck, the fender of the pressure washer made contact with the bumper of the truck cause minor scuffs.

9/27/07 – Before work, Larry Ford, a Mortenson employee, had just arrived to work and was backing into his spot to park. He hit a Mortenson pickup on the front drivers side. He pulled out and pulled back in and hit another small personal vehicle on the other side. He was drug and alcohol tested and returned negative results.
9/21/07 – The local fire department was called to address an unattended fire just beyond the project limits. Later is was discovered this was a planned event by the land owner.
October: Trespassing on USFWS land.
11/06/07 - Traffic accident on public road. 66th. Ave. GSW truck and prospective Mortenson Employee.
11/17/07 – Traffic accident. Icy conditions /fresh snow. Hwy 11, west of Ellendale. Mortenson truck enters ditch & rolls on his way to work.

2. Quality Assurance

d) Acciona has expressed concern that the grout Mortenson is placing between the bottom base flange and the foundation may have air pockets. This concern was in response to some small gaps that they noticed between the flange and sections of the grout. It has since been determined that the small gaps do not indicate that air pockets are present. HDR has suggested an epoxy repair compound. GH has agreed. Mortenson is waiting on final sign-off from Acciona to begin repairs. ***Initial product suggested by HDR did not work. Recently approved SIKA-35, Hi Mod, LV, to be tested by Mortenson*** **when heaters are available from North Dakota.** ***HDR recommended using SIKA -31 Hi Mod, Gel. The gaps outside of 11 towers have been fixed. Options to complete inside gaps are either during 200 hour retorq or in the spring.***
e) The amount of threads that Acciona requested to be exposed on the studs that connect the top to the nacelle has been causing issues. Acciona has sent longer studs. Mortenson is waiting for approval of the cost proposal to change out the studs in the towers that were erected before the bolts arrived. ***Final procedure has been accepted and change out is in process under T&M agreement. The stud change-out work has been completed by Jan. 5, 2008.***
f) Mortenson continues to find more damaged cables.
g) Road asbuilt near SD48 has been reviewed by local "Service" rep. **Leave as is if agreeable with owner?**
h) **Balance of delivery for several items….bolts kits, wiring kits, cables.**
i) **Ability to unwrap cables in extreme cold temps.**
j) **Westwood came to site and worked with Muth Electric to get more accurate as-built results for the questionable areas of the collection system trenched cable. The required results have been gathered and issue is closed.**

3. Major Work Activities for this Period (through 01-31-8)

Description	Total Req.	UOM	Total to Date	Period
Roads w/ gravel	120	ea	120	0
Bases poured	120	ea	120	0
Pedestals poured	120	ea	120	0
Pieces received	960	ea	960	0
Base/mids erected	120	ea	120/120	0/3
Top, nacelle, rotor	120	ea	120	3

Tower wiring completed	120	ea	27	7
Term. Padm. Transformers	120	ea	118	4
Mechanical Completion	120	ea	21	2
Energized	120	ea	14	5

a) **Collection System:** A total of 122 padmount transformers have been delivered to site. A total of 118 have been terminated. Waiting on replacement of two bad switchgears before finishing. Testing transformers is complete including the re-work of the Voltran issues as of 2/6/08.
b) **Tower Wiring:** Work has completed in circuit 7 and started in circuit 5. A total of 33 turbines have been completed 100% for tower wiring. Many turbines have experienced cable damage, bad Kellum grips, heat shrink out of stock, W/301 cable defection, and so on.

4. Planned Activities for Next Reporting Period

CIVIL

a) Completing roads behind erection activities, tune up of site areas and crane pads. Reseeding ***will proceed in the Spring based upon manufacturer's recommendation.***.

ELECTRICAL

a) Energize Circuits 5, 8, 1, 2, 3, and 4
b) Tower wiring activities to continue in SD and ND.
c) First day cable drops in ND.

5. Major Item Procurement

6. Schedule Update

a) **Road Work**
Dressing up after erection activities and seeding are all that remain.
b) **Erection**
The final rotor was erected on January 9th.
c) **Collection System**
The circuits will be energized through circuit 5, 8, 1, 2, 3, and then 4 as they are ready in SD and ND pending Voltran repairs.
i) **O&M Building**
Moved in for client on 1-17-08.

Critical Path Activities

a) Receipt of missing Acciona supplied material….cables & bolts & gratings and elec. Gear
b) Support of tower wiring activities.
c) Support of blade torquing activities.

7. Cost Information

	BOP	Erection
a) Contract Value	$ 55,001,183	$14,651,339
b) Change Orders	$ 292,607	$ 1,757,324
c) Revised Contract Value	$55,293,790	$16,408,663
d) Period Progress for Jan. 08	$ 107,783	$ 515,410
e) JTD Progress thru Jan. 08	$51,824,402	$15,023,081

Note: JTD Progress amounts stated above are gross amounts

Note: Request approval of submitted Change Orders.

8. Pending Cost Issues: (See attached summary)

9. Manpower

a) Mortenson (General Contractor) = 60
b) Acciona WP = 7
c) Ingateam = 10
d) GES = 5
e) Goian = 2
f) Acciona Energy = 2
g) Borneke (Earthwork) = 2
h) Muth (Collection) = 9
i) Rebar Setters (Rebar installers) = 0
j) Aggregate Industries (Concrete Supplier) = 0
i) Great Southwest (T-line) = 0
h) Vinco (Tower Wiring) = 60
i) Xtreme Concrete Pumping = 0
j) North Central Steel = 0
k) **Project Total = 157**

10. Areas of Concern

a) ***Support from Acciona to promote additional blade torquing crews***
b) ***Delivery of damaged cable replacements***
c) ***Delivery of balance of bottom end wiring kits (need 6 kits)***
d) ***Metal pole ID numbers for T line poles.***
e) ***Documentation of ladder tie off***
f) ***SO cord for heater…coming from Spain…incorrect cord***
g) ***Pad mount transformer issues***
h) ***FAA light installation deficiencies***
i) ***Waterline routing issues from the north***
j) **Additional SCADA control**
k) **Pole #8, x-brace connect bracket loose at intersection. GSW has been contacted regarding issue and is looking into fix. To coordinate issue with Mortenson before completing.**
l) **Paint under grounding strap**

m) **Request for lights converted to 60 Hz. / retro fit.**
n) **Replace Nacelle studs in final 6 locations?**
o) **Acciona QC of issues / damages in front of crews**
p) **Heat shrink**
q) **Kellum grips**
r) **W301 Cable**
s) **'Damaged' mid level transformers**
t) **Goian lifts**
u) **Switchgear ground cart for grounding collection system circuits.**

11. Outstanding RFIs

RFI 103---Top Section Ladder Too Short is still pending. AWP responded per SGS formal report.

Tatanka Wind Energy

Monthly Progress Report - November 2007
December 13th, 2007

1. Safety Items

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g) From our last incident on December 2nd, 2007 this project has successfully completed **8 days** of work without an incident that resulted in personal injury.

Total Project Work Hours
As of 10/31/2007: 201,989 Manhours – to be updated for November

Project Recordables/ Incidents

6/27/07 - Aron Zieler, a Rebbar Setters employee, broke his clavicle while lifting rebar. No current status.
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11/17/07 – Traffic accident. Icy conditions /fresh snow. Hwy 11, west of Ellendale. Mortenson truck enters ditch & rolls on his way to work.

2. Quality Assurance

a) Average 7 day concrete breaks are 4,191 psi for 28 day 5000 psi concrete.
b) Average 14 day concrete breaks are 4,867 psi for 28 day 5000 psi concrete.
c) Average 28 day concrete breaks are 5,981 psi.
d) Acciona has expressed concern that the grout Mortenson is placing between the bottom base flange and the foundation may have air pockets. This concern was in response to some small gaps that they noticed between the flange and sections of the grout. It has since been determined that the small gaps do not indicate that air pockets are present. HDR has suggested an epoxy repair compound. GH has agreed. Mortenson is waiting on final sign-off from Acciona to begin repairs. ***Initial product suggested by HDR did not work. Recently approved SIKA-52 to be tested by Mortenson*** **when heaters are available for North Dakota.**
e) The amount of threads that Acciona requested to be exposed on the studs that connect the top to the nacelle has been causing issues. Acciona has sent longer studs. Mortenson is waiting for approval of the cost proposal to change out the studs in the towers that were erected before the bolts arrived. ***Final procedure has been accepted and change out is in process under T&M agreement.***

f) While tensioning foundation bolts at SD-08 and SD-31, the threads were stripped on one of the foundation bolts. Mortenson has asked Acciona in RFI 153 what repair procedure they would suggest. Mortenson has also suggested in RFI 177 that these bolts be tensioned to 64 kips and left. Mortenson has not received a response to either request. Previous similar situation at SD-08 has been resolved by the tensioning of these bolts to the specified amount. ***Issued resolved and closed*****.**
g) Damaged switch cabinet at SD24 has been replaced**. Issue resolved and closed.**
h) Mortenson has brought all switch cabinets from in front of erection crews and placed in containers.
i) Vandalism at site SD 22 will cause rework of power cables.
j) Mortenson continues to find more “no OK “cables.
k) Damaged Nacelle to be moved to ND06. Procedure approved. Repair procedure to start on 12-10-7.
l) Placement of Crosby clamps at bottom of safety cable continues by Mortenson.
m) Road asbuilt near SD48 has been reviewed by local “Service” rep.
n) **Cable ties reportedly shatter during the installation process at extreme cold temperatures.**
o) **Some pieces are being delivered with excessive mud and grime from transportation.**
p) **Balance of delivery for several items….controllers, cabinets, transformers, wtg pieces**
q) **Rigging for stabbing blades….sets getting worn.**
r) **Replacement Foundation washers requested by Mortenson.**
s) **QC / tech & Elevator support during Christmas Holiday.**
t) **Ability to unwrap cables in extreme cold temps.**
u) **Damaged hub / nose cone at ND12 being repaired by Bob Gibbons.**
v) **Ice in towers upon delivery.**

3. Major Work Activities for this Period (through 11-30-7)

Description	Total Req.	UOM	Total to Date	Period
Roads w/ gravel	120	ea	120	0
Bases poured	120	ea	120	0
Pedestals poured	120	ea	120	0
Pieces received	960	ea	770	190
Base/mids erected	120	ea	94/93	39/38
Top, nacelle, rotor	120	ea	86	17
Tower wiring completed	120	ea	18	13
Term. Padm. Transformers	120	ea	77	41
Mechanical Completion	120	ea	0	0

a) **Installation of site access roads:** The roads in North and South Dakota side are complete for construction traffic. Final "dress-up" and completion of the roads and turbine sites has begun on the south side of the project. ***Final dress up activities have been put on hold pending completion of electrical activities.***

b) **Pouring of foundations:** Pouring of the foundations was completed on September 21st.

c) **Backfilling of foundations:** Backfilling of the foundations was completed on September 29th. Foundation completion certificates ***have been submitted for all foundations.***

d) **Pedestal conduit and grounding:** Completed with foundations.

e) **Substation:** Switchgear is on site and bus 2 was been commissioned. The fence was completed and grounded. Major electrical equipment and components have been installed and wired. All yard terminations have been completed and tested. EPS Company has been testing electrical devices and equipment. Cable termination inside the switchgear has been completed. Station transformers have been installed and terminated. Relays were completed and tested. Surface rock was finished.

f) **Interconnect Substation:** Pascor has adjusted the Switches. Finish relay installation and functional testing. Surface rock was finished. Station was energized on 11/30.

g) **Collection System:** A total of 122 padmount transformers have been delivered to site. A total of 78 have been terminated. Areva has finished the re-wiring work on padmounts. Testing transformer in ND has been started. Re testing of the transformers has been completed on Circuit 6. A VLF test of the Underground Cables and Hi-Pot Test of 12 KV Cable have been completed on Circuit 6. Termination within the turbines has completed in SD and started in ND.

h) **Transmission Line:** Jumpers have been installed at the Substation and Interconnect. Structure 83 was replaced. Fiber Optic wires have been completed and tested. Vibration dampers have been installed on OPGW and static wires. T-line has been completed and energized 11/30/07.

i) **Turbine Deliveries:** As of November 30th, 101 Bases, 102 Mids, 95 Tops, 98 Nacelles/Hubs, and 91 Blade sets have been delivered to site. This accounts for nearly 80% of deliveries.

j) **Erect Base & Mid Sections:** As of November 30th. 94 Bases and 93 Mids have been erected.

k) **Erect Top, Nacelle & Rotor:** As of November 30th, 86 towers are fully erected.

l) **Tower Wiring:** Work has completed in circuit 6 and started in circuit 7. A total of 18 turbines have been completed 100% for tower wiring and 5 have been completed to about 50%.

4. Planned Activities for Next Reporting Period

CIVIL

a) Completing roads behind erection activities, tune up of site areas and crane pads. Reseeding ***will proceed in the Spring based upon manufacturers recommendation.***.

b) O&M building ***enclosure & finishes***.

ERECTION

a) Complete receiving turbine pieces in North Dakota

b) Erection of Turbine components in North Dakota. Possible completion of setting base - mids.

c) Continue to turn over towers to Acciona in South Dakota

ELECTRICAL

a) Padmount transformer terminating and testing, fiber optic work in turbines, interior turbine grounding, and cable testing and commissioning.

b) Project substation Energization on bus 1.

c) Energize Circuit 7 and 5.

d) Tower wiring activities to continue in SD.

5. Major Item Procurement

a) **Padmount Transformers**
A total of 122 transformers have been delivered to site by Acciona.

b) **Transmission Line Materials**
All material are on site.

c) **Project Substation Switchgear**
Switchgear delivered on site.

6. Schedule Update

a) **Road Work**
Dressing up after erection activities and seeding are all that remain.

b) **Concrete Foundations**
Foundation work completed.

c) **WTG Component Receiving**
The delivery of turbine pieces continues to lag behind the original schedule but continues to stay just ahead of erection activities. AIt is anticipated all turbine deliveries will be here by 12-21-07.

d) **Erection**
All erection activities are behind original schedule due mainly to more than anticipated 'wind days.' By scheduling erection activities for 7 days per week, Mortenson is still forecasting to be complete ***within several weeks of the*** original schedule. ***This will be dependant upon turbine component***

deliveries and winter conditions. It is currently anticipated all erection activities may be completed by Jan 11, 2008.

e) **Collection System**
Padmount transformer re-testing and re-terminating will continue in circuits 7, 5 and 8 in SD and circuit 1 in ND. The circuits will be energized through circuit 7, 5 and then 8 as they are ready in SD.

f) **Project Substation**
The switchgear is in place and bus 2 has been energized. The testing on the switchgear number 1 will be completed the week of 10/12/07. The main power transformer number 1 will be energized the week of 12/10/07. The collection circuits will be energized as needed. The static jumpers from the T-line to the substation dead-end structure to be completed during scheduled shutdown.

g) **Interconnect Substation**
The interconnect substation is completed and was completely energized 11/30/2007. Pascor is scheduled to install the switch hinge end wire guides at the next shutdown period. The jumpers from the substation to the transmission line to be installed. The circuit breaker heaters will be installed during the shutdown.

h) **Transmission Line**
The transmission line is completed and was energized 11/30/2007.

i) **O&M Building**
Interior finishes are in progress.

Critical Path Activities

a) Enclosure and finish activities at the O&M building.
b) All erection activities including deliveries must be addressed each and every day.
c) Receipt of missing Acciona supplied material….cables & bolts & gratings and elec. Gear

7. Cost Information

	BOP	Erection
a) Contract Value	$ 55,001,183	$14,651,339
b) Change Orders	$ 292,607	$ 333,378
c) Revised Contract Value	$55,293,790	$14,984,717
d) Period Progress for Nov.	$ TBD	**$** TBD
d) JTD Progress thru Nov. 07	$	$

Note: JTD Progress amounts stated above are gross amounts

Note: Request approval of submitted Change Orders.

Early release of retainage for civil subs?

8. Pending Cost Issues: (See attached summary)

c) **Testing of main power transformers –** Per request of Acciona**,** Mortenson dispatched a Vankooy representative to witness testing of transformers.
e) **Containers –** Additional containers are required as well as additional offloading due to Method of loading at origin.

f) **Replacement of Acciona rigging –** Several pieces of Acciona supplied rigging needed to be replaced because they were chains or missing capacity verification.

i) **Sunday 9-30-7 Offload –** Mortenson was approved additional compensation to offload turbine pieces on 9-30-07.

k) **Late pad mound transformer delivery schedule –** The slipped delivery schedule will cause the schedule to compress, thus more costs.

m) **Padmount Transformer Re-terminating for Voltran –** padmount transformers needed to be retested due to the re-wiring by the manufacturer. This also caused significant delay costs.

n) **400 Amp Dead Break Fittings in Turbines –** The tower gear came with a 400 amp dead break with a European interface. No information was provided or available at the time of bid for the interface requirements. The cost for the European style materials are considerably higher than the price included with the bid that was for the same interface that the transformers have on the secondary side; the 300 amp load break. The European style materials also take approximately twice and much time to install.

o) **Thermal Backfill Costs –** per contract, costs for thermal backfill requires have been submitted. Mortenson is waiting for approval.

p) **Replace top to nacelle studs –** Change current studs for longer studs.

q) **Generator for Goian lift –** Extra costs of generator rental costs to power lift during tower wiring activities.

r) **Premium time for Sunday offloads**

s) **Delay costs for excessive wind days**

t) **Delay costs for lack of turbine components.**

u) **Procedure for torquing of blades….actual vs bid doc.**

9. Manpower

a) Mortenson (General Contractor) = 105
b) Acciona = 17
c) Borneke (Earthwork) = 2
d) Ventus (Substations) = 2
e) Muth (Collection) = 11
f) Rebar Setters (Rebar installers) = 0
g) Aggregate Industries (Concrete Supplier) = 0
i) Great Southwest (T-line)= 0
h) Vinco (Tower Wiring)= 27
i) Xtreme Concrete Pumping = 0
j) North Central Steel = 5
k) **Project Total = 187**

10. Areas of Concern

a) **WTG Component Delivery Schedule** – The deliveries continue to be behind the v26 schedule.
b) **WTG Non-Compliance with OSHA –** Ladder over run at the top of the top section, exterior platforms and electrical plugs appear to be in non-compliance with OSHA. Mortenson is experiencing additional costs for temporary solutions to be OSHA compliant during construction.

c) **Loose Connections in Towers** – Mortenson continues to find loose bolts or components with out any bolts in the tower sections. Acciona must verify that all connections have been checked and are safe for construction personnel
d) **Existing County Roads** - Mortenson has expended funds against the allowance for the maintenance and upgrading of public road.
e) **Blade Repairs –** The blade manufacture is making repairs to the blades after they are loaded on the transport trucks. The delivery of the blades is delayed up to 4 hours due to the repairs. In these cases Mortenson is expending premium time to unload the blades.
f) **Tower ladders –** Goian is on site to analyze and resolve tower ladder issues.
g) **Tower Wiring –** Many turbines have been delivered to site with either missing or damaged wires. Others have also been damaged on site. The extra quantity of materials needed to finish the project needs to be determined and ordered as soon as possible.
h) **Turbine decals / numbers** are to be supplied by Acciona and are needed to apply prior to cold weather.
i) **Missing or** late delivered owner supplied material will continue to cause inefficiencies to complete tower.
j) **Amount of rubbish –** wood crates for Acciona supplied materials ….burn pit?
k) Condition of **smooth platforms** and slip hazards**.**
l) ***Labor unrest –*** *due to short weeks due to delays…wind, parts, mtls.*
m) ***Excessive wind*** *days.*
n) *Missing* ***bolt caps.***
o) ***Shoulder pain / strains*** *– ladder design – resting platform*
p) ***County road restoration***
q) ***Water*** *for O&M building*
r) ***Schedule slip into the winter months***
s) ***Rewiring of Pad mount transformers***
t) ***Retrofit of turbines to accept US power.***
u) ***Ice in tower sections being delivered***
v) ***More blade pitch pumps to promote additional torquing crews***

11. Outstanding RFIs (see Attached listing)

153 – SD-08 Stripped Bolt – Acciona will provide special tools to Mortenson to tension this bolt although Mortenson has not received the tools yet. Acciona orally agree that it won't halt the turnover work of this tower. Mortenson has not received any response in writing from Acciona except that Cory Stuber responded on Oct. 26, 2007 that he thought it is acceptable.

177 – 1 Anchor Bolt Unable to Tension --- Acciona agreed that one bolt would not impact the safety of the tower. (Victor responded in email dated on 10/26/07)

179 – Cutting of Grating --- Special grating or tramex is required for the type of switch cabinets we have on this project. In order to be able to route the stator cables into the switch cabinet to be terminated the grating must have a

hole in it. Acciona has ordered the specially fabricated grating for this purpose. However, this special ordered grating will not arrive soon enough to allow Vinco to complete this work in a timely manner. On site Acciona representatives have asked Mortenson to provide a quote for cutting the grate.

186 – Turbine Cable Drop Orientation --- Acciona technicians worked closely with Mortenson's tower wiring subcontractor on the first few turbines to properly train the workers how to complete tower wiring. It has recently been discovered that the way the Acciona technicians have taught our subcontractor to route the cables through the nacelle and top section varies slightly from how the Acciona Installation Manual indicates.
Acciona's personnel on site have determined that the way the Acciona technicians have taught Mortenson's subcontractor is the best method. (Sent to Patxi on 11/11/07).

Tatanka Wind Energy

Monthly Progress Report - September 2007
October 11th, 2007

1. Safety Items

a) **Orientations** continue to take place on Tuesdays and Thursdays. Second orientations, required after two weeks on site, take place on Tuesdays and third orientations, required after five weeks on site, take place on Thursdays.
b) **Training:** Mortenson corporate personnel have been on site several times to hold special Zero Injury training classes as well as classes on Incident Investigations, Pretask Planning, Activity Observations and Forklift Training.
c) **Site traffic congestion**: Farmers and ranchers harvesting crops, turbine deliveries, crane movement, increased manpower, etc. have increased traffic congestion. Proper and clear communication when blocking off roads and routing traffic is essential to having consistently safe traffic flow.
d) **Near misses** have been turned in on a regular basis. The near miss program is designed as an educational tool. Workers turn in brief reports of things they saw in the field that could have resulted in an accident. These 'learning opportunities' are discussed amongst the group the next day at our morning 'stretch & bend' sessions so all can learn from the incident. We are currently receiving at least fifteen near miss reports each week.
e) **Speeds:** Nearly everyday at stretch and bend people are reminded about keeping speeds down not only on the project site but also traveling to and from the site. Employees who choose not to follow the speed limits have been removed from the project. Signage has been posted reminding drivers to stay to the right. Mortenson has been assisted by the local Sheriff's department as they have been patrolling incoming and outbound routes.
f) **Erection activities continue** and naturally attract many visitors. If you are not involved in the operation, please stay back and out of the way. Permission is required from the erection crew to proceed past their orange cones which identify the erection area.
g) From our last incident on August 17th, 2007 this project has successfully completed **42 days** of work without an incident that resulted in personal injury. We have continued to celebrate this accomplishment with safety lunches for the whole jobsite.

Total Project Work Hours
As of 9/29/07: 144,414 Still need Acciona's hours

Project Recordable Incidents

6/27/07 - Aron Zieler, a Rebbar Setters employee, broke his clavicle while lifting rebar. No current status.
6/22/07 - Douglas Job, an Aggregate Industries concrete truck driver, his back while driving to a turbine site. No lost time. Two weeks restricted duty.
6/20/07 - Lawrence Azure, a Mortenson laborer, was using a utility knife when his hand slipped and the knife cut his palm. He received 5 stitches. No lost time. No restrictions.
8-17-07 – Darren Hassel aggravated a preexisting back condition by building bolt cages. On light duty from 8-22-07 to 8-31-07.
NONE in September.
October 6, 2007- Ken Grahm - Aggravation of pre-existing hernia.
October 2, 2007 – William Graft – Strain shoulder.

Project Vehicle and Equipment Incidents
6/29/07 - Russ Raff, a Mortenson crane operator, was operating a crane during a crane walk. During the crane walk the crane struck a power line. It was later determined that the power line was not charged.
7/12/07 - Larry Chelgren, a gravel truck driver for Aggregate Industries, was stopped at a stop sign near the office area. When he proceeded, the welds connecting his trailer broke loose causing his trailer to become disconnected.
6/9/07 - Damage to fork on forklift while assembling a crane.
7/20/07 - An Acciona Wind Power employee was traveling down the road when he lost control of his vehicle, entered the ditch, and rolled the vehicle onto its side.
8/7/07 - A gravel truck driver for Aggregate Industries got to close to the shoulder of the road and entered the ditch. The truck tipped onto its side and spilled the load of gravel.
8/28/07 – While backing up a pressure washer near a parked delivery truck, the fender of the pressure washer made contact with the bumper of the truck cause minor scuffs.
9/27/07 – Before work, Larry Ford, a Mortenson employee, had just arrived to work and was backing into his spot to park. He hit a Mortenson pickup on the front drivers side. He pulled out and pulled back in and hit another small personal vehicle on the other side. He was drug and alcohol tested and returned negative results.
9/21/07 – The local fire department was called to address an unattended fire just beyond the project limits. Later is was discovered this was a planned event by the land owner.
October: Trespassing on USFWS land.

2. Quality Assurance

a) Average 7 day concrete breaks are 4,193 psi for 28 day 5000 psi concrete.
b) Average 14 day concrete breaks are 4,874 psi for 28 day 5000 psi concrete.
c) Average 28 day concrete breaks are 5,987 psi.
d) Acciona has expressed concern that the grout Mortenson is placing between the bottom base flange and the foundation may have air pockets. This concern was in response to some small gaps that they noticed between the flange and sections of the grout. It has since been determined that the small gaps do not indicate that air pockets are present. HDR has suggested an epoxy repair compound. GH has agreed. Mortenson is waiting on final sign-off from Acciona to begin repairs.
e) The amount of threads that Acciona requested to be exposed on the studs that connect the top to the nacelle has been causing issues. Acciona has sent longer

studs. Mortenson is waiting for approval of the cost proposal to change out the studs in the towers that were erected before the bolts arrived.

f) While tensioning foundation bolts at SD-08 and SD-31, the threads were stripped on one of the foundation bolts. Mortenson has asked Acciona in RFI 153 what repair procedure they would suggest. Mortenson has also suggested in RFI 177 that these bolts be tensioned to 64 kips and left. Mortenson has not received a response to either request. Previous similar situation at SD-08 has been resolved by the tensioning of these bolts to the specified amount.

3. Major Work Activities for this Period

Description	Total Req.	UOM	Total to Date	Period
Roads w/ gravel	120	ea	120	6
Bases poured	120	ea	120	14
Pedestals poured	120	ea	120	18
Pieces received	960	ea	390	185
Base/mids erected	120	ea	45/45	20/20
Top, nacelle, rotor	120	ea	36	29
Collection system	291,000	lf	127,000	82,150
Tower wiring	120	ea	3 @ 95%	1 @ 95% 2 @ 85% 1 @ 70 % 3 @ 60% 1 @ 40% 3 @ 25% 1 @ 20% 1 @ 3%
Mechanical Completion	120	ea	0	0

a) **Installation of site access roads:** The roads in North and South Dakota side are complete for construction traffic. Final "dress-up" and completion of the roads and turbine sites has begun on the south side of the project.
b) **Pouring of foundations:** Pouring of the foundations was completed on September 21st.
c) **Backfilling of foundations:** Backfilling of the foundations was completed on September 29th. Foundation completion certificates are in progress.
d) **Pedestal conduit and grounding:** Completed with foundations.
e) **Substation:** The second transformer has been set. Grounding has been completed underground. The circuit breakers and switches have been set. The bus work has been completed. Conduit runs have been installed and backfilled. Surface rock has been placed, but still needs to be leveled. The fence posts have been concreted into the ground.
Interconnect Substation: Construction activities have increased this month as the schedule closes on the MDU tie-in week. All of the concrete pier foundations have been completed and all steel has been set. Grounding has been completed and backfilled. About 35% of the above grade grounding has been completed. All underground conduit is completed. Above ground conduit into junction boxes and devices is underway. All three circuit breakers have been set. All 7 switches have been constructed and placed.

Three switches have been adjusted and are operational. All bus insulators have been set. All bus work is completed and ready for jumpers. Jumper installation has been started and is about 20% complete. The MOCTs and arresters have been set. The fence is currently being installed. Surface rock is being delivered and will be spread starting 10/6/07. Static wire has been strung between the dead-end structures. Pulling of control wiring is scheduled to start on 10/9/07. This wire will be pulled through the conduit and rolled up outside of the control building as we wait for the control building delivery. Waiting on 9 CCVTs, wave traps, line tuners, and the control building.

f) **Collection System:** The installation of the underground cables has been completed in ND and SD with 32 splice locations with completed splices. A total of 27 padmount transformers have been delivered and set in place. One transformer has been terminated as of the end of the month. Fiber splices continue closely behind trenching activities. All low voltage cable has been pushed through the foundation conduit.

g) **Transmission Line:** All of the structures have been set in place. Guy anchors and wires have been installed on over 50% of the structures that require them. A minor amount of framing of structures in the air remains. Pulling conductor and fiber to start 10/6/07.

h) **Receiving of Mortenson erection equipment:** Receiving of erection equipment is essentially complete except for additional fork lifts and mobile cranes that might be required to be mobilized to support an accelerated delivery schedule of WTG components.

i) **Turbine Deliveries:** As of September 30th, 53 Bases, 51 Mids, 48 Tops, 47 Nacelles/Hubs, and 144 Blades have been delivered to site. This accounts for nearly 36% of deliveries.

j) **Erect Base & Mid Sections:** As of September 30th. 45 Bases and 45 Mids have been erected.

k) **Erect Top, Nacelle & Rotor:** As of September 30th, 36 towers are fully erected.

l) **Tower Wiring:** Vinco has been completing all possible work in turbines. They were tasked with installing the missing switch cabinets in the first 6 turbines and have completed this work. Vinco continues to be delayed from completing the tower wiring until missing wiring components are delivered to site. Letters regarding these issues have and will be sent to Acciona. Vinco has had to jump around to many turbines to remove cable brackets to install in turbines that have been delivered without them. The tramex sections will be cut, with Acciona's approval, by Mortenson to allow work to begin for terminating and landing the stator cables. About 12% of the tower wiring work has been completed in South Dakota.

4. Planned Activities for Next Reporting Period

CIVIL

a) Completing roads behind erection activities, tune up of site areas and crane pads. Reseeding.
b) O&M building structural work and completion of switch gear and M&E rooms.

ERECTION

a) Receiving turbine pieces
b) Erection of Turbine components

c) Begin to turn over towers to Acciona

ELECTRICAL

a) Padmount transformer setting and terminating, fiber optic work in turbines, interior turbine grounding, cable testing and commissioning.
b) Project substation and interconnect substation completion.
c) Transmission line completion.
d) Tower wiring activities to continue in SD and start in North Dakota.

5. Major Item Procurement

a) **Padmount Transformers**
A total of 27 transformers have been delivered to site by Acciona.
b) **Transmission Line Materials**
Almost all of the materials have been delivered to site. Only lacking minor framing materials.
c) **Circuit Breakers**
All interconnect and step-up sub circuit breakers have been delivered.
d) **Project Substation Switchgear**
Switchgear is currently scheduled to deliver on November 6th. Temporary switchgear will be on site and ready for use for Acciona to commission by early November after the MDU tie-in work and energization is completed.
e) **CCVTs**
9 CCVTs will arrive 10/8/07. The final 3 to be installed in the project substation will arrive November 5th.
f) **Interconnect Control House**
The delivery schedule for the control house is on the critical path. Scheduled for half of the building 10/13/07 and the second half 10/16/07.
g) **Wave traps**
The wave traps have been sent from the factory in Brazil. At this point they are behind schedule for delivery and cannot be located by the shipper.

6. Schedule Update

a) **Road Work**
Dressing up after erection activities and seeding are all that remain.
b) **Concrete Foundations**
Foundation work completed this month.
c) **WTG Component Receiving**
The delivery of turbine pieces continues to lag behind the original schedule but continues to stay just ahead of erection activities.
d) **Erection**
All erection activities are behind original schedule due mainly to more than anticipated 'wind days.' By scheduling erection activities for 7 days per week, Mortenson is still forecasting to be complete very close to original schedule.
e) **Collection System**
The underground fiber and collection splicing will continue into the next period. The 3rd party testing company will be on site 10/10/07 to start transformer and collection cable testing. Transformer termination work will ramp up to be ready for commission and energization.
f) **Project Substation**

The main focus will be on the electrical room work and preparing conductor and control wiring for the installation of the permanent switchgear. Third party testing will be conducted for commissioning work. Fence work will be completed and surface rock will be smoothed out. Preparations for the utilization of temporary switchgear will be completed. Final grounding terminations on structures and fencing will be completed.

g) **Interconnect Substation**
The tie-in work with the MDU line will start 10/17/07 with a total of 2 weeks duration for the shutdown. The schedule of the interconnect work continues to be critical. Control wire will be pulled and ready before the control building is delivered to site 10/13/06 and 10/16/07. The CCVTs will be installed the week of 10/8/07. Line tuners have been delivered to MDU in Bismarck for testing. The wave traps were scheduled to arrive as well but remain lost. A second shipment of wave traps is scheduled to leave the factory 10/16/07 that will need to be improved upon.

h) **Transmission Line**
Stringing of conductor and fiber will start 10/6/07. The sagging and clipping will closely follow. Guy anchor and wire installation will be completed.

i) **O&M Building**
Footings, stem walls, underground mechanical & electrical activities are complete. Concrete slabs will be poured the first week of October followed closely by steel erection. Completion of switchgear room is scheduled for 10-20-07.

Critical Path Activities

a) The completion of the interconnect substation and tie-in work with MDU are on the critical path to be completed and energized by November 2nd.
b) All activities at the project substation are critical and are being monitored with subcontractor on a daily basis.
c) Activities at the O&M building to complete the M & E rooms.
d) All erection activities including deliveries must be addressed each and every day.
e) Receipt of missing Acciona supplied material….cables & bolts & misc.

7. Cost Information

	BOP	Erection
a) Contract Value	$ 55,001,183	$14,651,339
b) Period Progress for Sept 07	$ 7,889,822	$ 3,368,792
d) JTD Progress thru Sept 07	$ 46,891,789	$ 7,118,466

Note: Progress amounts stated above are gross amounts

8. Pending Cost Issues: (See attached summary)

a) **Relocate ND 46 & 28** – Relocate foundations to avoid grassland areas.
b) **Cody Sands Easement –** Currenty Mortenson sees no impact.
c) **Testing of main power transformers –** Per request of Acciona**,** Mortenson dispatched a Vankooyey representative to witness testing of transformers.
d) **Cable tray repair –** per request from Acciona, Mortenson repaired several cable trays attached to ground controller frames that were damaged during shipping.

e) **Containers –** Additional containers are required as well as additional offloading due to Method of loading at origin.
f) **Replacement of Acciona rigging –** Several pieces of Acciona supplied rigging needed to be replaced because they were chains or missing capacity verification.
g) **Temp. MET Towers –** Per request of Acciona, Mortenson accelerated and performed certain activities out of sequence to support the installation of temp. MET Towers.
h) **Anchor Bolt Issues –** The assembly of the bolts, the incorrect length of the PVC sleeves and the tardiness of the replacement bolts impacted Mortenson's operations.
i) **Sunday 9-30-7 Offload –** Mortenson was approved additional compensation to offload turbine pieces on 9-30-07.
j) **Furnish FAA Bracket -** Acciona requested that Mortenson fabricate the brackets from the drawings supplied by Acciona.
k) **Cable tray relocation –** Controller stands have the trays mounted in the incorrect locations. Acciona requested for Mortenson to properly re-located.
l) **Install switchgear bridge kits –** This work is not included in the original scope or installation manuals.
m) **Top end heat shrink -** This work is not included in the original scope or installation manuals.
n) **Switch cabinet installation -** Switch Cabinet equipment was not on site when the first six base sections were set. Acciona has requested that Mortenson install this equipment through the turbine door.
o) **Cable brackets -** Removal of cable brackets in erected turbines to supply brackets to tops arriving without brackets.
p) **Remobe to install btm. End 12kv cables –** Vinco required to remobilize to the turbines they had previously completed work in to install the cables that arrived late.
q) **Install one 12kv stator cable –** Acciona informed Mortenson that the turbine at SD12 was delivered without one of the required stator cables.
r) **Storage containers & material issues –** The storage containers that the tower wiring materials were delivered in were not left on site for the proper storage of materials.
s) **Replace damaged rotor cables –** Acciona has requested that Vinco replace the cables found to be damaged upon delivery.
t) **Base section cable tray installation –** Acciona stated that they will be installing these trays. Trays are not coming pre-installed.
u) **Remobe and install FAA lights –** The required FAA lights for the project are not arriving to site in time to be installed prior to erection.
v) **Wire two extra owner trailers –** Acciona acquired two extra office trailers. Muth Electric was asked to provide the power "hook ups" for both of the trailers.
w) **Met Tower trenching –** Trenching needed between the permanent met towers and temp met towers and turbine locations.
x) **T-line structure #3 redesign –** Due to landowner easement issues affecting the transmission line, structure number 3 was re-designed and moved.
y) **Cut hole in grating –** Grating or "Tramex" with proper cut-out per IRT0125 has not arrived to site prior to needs. Will cut hole in the mean time to continue work.
z) **Late pad mound transformer delivery schedule –** The slipped delivery schedule will cause the schedule to compress, thus more costs.

aa) **T-line adjustments due to cottonwood trees –** Shifts in the route of the transmission line per landowner issues after structures had been framed in this area.
bb) **Replace top to nacelle studs –** Change current studs for longer studs.
cc) **Removed damaged material from top section –** Acciona requested that Vinco assist in removing materials to use as spare parts for the project.
dd) **Generator for Goian lift –** Extra costs of generator rental costs to power lift during tower wiring activities.

9. Manpower

a) Mortenson (General Contractor) = 140
b) Acciona = 17
c) Borneke (Earthwork) = 16
d) Ventus (Substations) = 16
e) Muth (Collection) = 38
f) Rebar Setters (Rebar installers) = 0
g) Aggregate Industries (Concrete Supplier) = 0
i) Great Southwest (T-line)= 22
h) Vinco (Tower Wiring)= 6
i) Xtreme Concrete Pumping = 0
j) North Central Steel = 10
k) **Project Total = 265**

10. Areas of Concern

a) **WTG Component Delivery Schedule** – The deliveries continue to be behind the v26 schedule.
b) **WTG Non-Compliance with OSHA –** Ladder over run at the top of the top section, exterior platforms and electrical plugs appear to be in non-compliance with OSHA. Mortenson is experiencing additional costs for temporary solutions to be OSHA compliant during construction.
c) **Loose Connections in Towers** – Mortenson continues to find loose bolts or components with out any bolts in the tower sections. Acciona must verify that all connections have been checked and are safe for construction personnel
d) **Existing County Roads** - Mortenson has expended funds against the allowance for the maintenance and upgrading of public road.
e) **Blade Repairs –** The blade manufacture is making repairs to the blades after they are loaded on the transport trucks. The delivery of the blades is delayed up to 4 hours due to the repairs. In these cases Mortenson is expending premium time to unload the blades.
f) **Tower ladders –** Goian is on site to analyze and resolve tower ladder issues.
g) **Padmount Transformer Deliveries** – The delivery schedule keeps changing for the padmount transformers. The continuing slippage of the transformer deliveries *will* have cost and schedule impacts to the project. In addition, Muth will be incurring additional costs if the transformers are not delivered at a rate 3 trucks minimum per delivery Monday through Friday.

h) **Tower Wiring –** Tower wiring cannot be completed until Acciona supplies missing wire, conduit and splice kits.
i) **Turbine decals / numbers** are to be supplied by Acciona and are needed to apply prior to cold weather.
j) **Missing or** late delivered owner supplied material will continue to cause inefficiencies to complete tower.
k) **Use of J hooks** for offloading? Marks on tower imply this is being done by someone.
l) **Amount of rubbish –** wood crates for Acciona supplied materials ….burn pit?
m) Condition of **smooth platforms** and slip hazards**.**
n) ***Labor unrest –*** *due to short weeks due to delays…wind, parts, mtls.*
o) ***Lift installation,*** *certification, and coordination.*
p) ***Excessive wind*** *days.*
q) *Missing* ***bolt caps.***
r) ***Shoulder pain / strains*** *– ladder design – resting platform*
s) ***County road restoration***
t) ***Water*** *for O&M building*
u) ***Blade repair*** *@ LM*
v) ***Thanksgiving Holiday***

11. Outstanding RFIs

103 – Top Section Tower Ladder Too Short
126 – Tray Installation
146 – Ladder Fit Up
153 – SD-08 Stripped Bolt
176 – Air Rad Use in Towers
177 – 1 Anchor Bolt Unable to Tension
Several others have been verbally approved and require signatures.

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April 1, 2008

Steven Blondo
Cultural Resource Specialist
Westwood Professional Services
7699 Anagram Drive
Eden Prairie, MN 55344

NDSHPO REF. : 07-0003i USFWS Tatanka Wind Farm Class III CRI

Dear Steve:

We have received the final report: "Tatanka Wind Farm, Dickey and McIntosh Counties, North Dakota, McPherson County South Dakota," by Ryan P. Grohnke, Steven J. Blondo, Anne E. Anderson, and Amanda M. Gronhovd, (Westwood Professional Services, March 2008) and find it acceptable.

Thank you for the opportunity to review the project. If you have questions please contact either Paul Picha at (701) 328-3574 or Susan Quinnell at (701) 328-3576.

Sincerely,

Merlan E. Paaverud, Jr.
State Historic Preservation Officer (North Dakota)
and
Director, State Historical Society of North Dakota

c: Meg VanNess, FPO, USFWS
c: Susan Wefald, Commissioner, ND PSC

Tatanka Wind Farm
Post-Construction Compliance Monitoring Report And Restoration Management Plan

Dickey and McIntosh Counties, ND
McPherson County, SD

Prepared for:
Tatanka Wind Power, LLC
333 W Wacker Dr
Suite 1500
Chicago, IL 60606

Prepared by:

Ronald P. Peterson, JD
Ryan P. Grohnke

Westwood Professional Services, Inc.
7699 Anagram Drive
Eden Prairie, MN 55344
(952) 937-5150

Project Number: 20062569.00

November 2, 2009

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TABLES

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Appendix A: Annotated Maps
Appendix B: Representative Photos
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Appendix D: Noxious Weed Guide

1.0 INTRODUCTION

Westwood Professional Services, Inc. (Westwood) was retained by Tatanka Wind Power, LLC (Tatanka) to conduct post-construction environmental and cultural resource compliance monitoring for the Tatanka Wind Farm (TWF). The purpose of this effort was to determine whether TWF was in compliance with all post-construction environmental and cultural resource permit conditions and, if not, to provide recommendations for restoration and/or management measures that would bring the project into compliance. Because the monitoring effort took place after construction was completed, we did not endeavor to confirm compliance with permit conditions that were applicable only during the pre-construction or construction phases of the project.

TWF is located in Dickey and McIntosh Counties, North Dakota and McPherson County, South Dakota. Compliance was monitored with regard to provisions and conditions defined in the: (1) the North Dakota Public Service Commission (PSC) transmission line route permit, (2) the U.S. Fish and Wildlife Service (USFWS) Special Use Permit (SUP) and Right-of-Way Permit, (3) U.S. Army Corps of Engineers (USACE) Section 404 permits and (4) National Pollution Discharge Elimination System permits.

In-field compliance monitoring was conducted September 1st through September 3rd, 2009. Ronald P. Peterson, Westwood Director of Environmental Services conducted in-field environmental compliance monitoring. Ryan P. Grohnke, Westwood Cultural Resource Specialist conducted in-field cultural resource compliance monitoring. Annotations from our field observations are provided in the map section contained in **Appendix A**. Representative site photos are provided in **Appendix B**.

The following report details the level of permit compliance observed during the in-field post-construction compliance monitoring and identifies recommended protocols for ongoing monitoring, restoration, and/or maintenance by TWF Operations & Maintenance staff to ensure ongoing compliance.

2.0 PUBLIC SERVICE COMISSION (PSC) ROUTE PERMIT CONDITIONS

The North Dakota PSC has jurisdiction over transmission lines within the state. Tatanka was required to obtain a PSC Certificate of Corridor Compatibility and Transmission Line Route Permit prior to construction of the transmission line in Dickey and McIntosh Counties, ND. The Findings of Fact, Conclusions of Law, and Orders issued by the PSC on March 21, 2007, set forth specific conditions for the Route Permit approval. Based on the field review, Tatanka has complied with all conditions established in the PSC Orders. The Orders specifically addressed here are Orders 5, 9, 13, and 15.

2.1 Other Permits and Licenses: PSC Order 5

Permit Requirements

PSC Order 5 states: "Tatanka shall comply with the rules and regulations of all the agencies having jurisdiction over any phase of its proposed transmission line, and it shall obtain all other necessary licenses and permits; and shall provide copies of all licenses and permits to the Commission which were not included in its application or which have not otherwise been provided to the Commission as of the date of this order prior to the construction of the transmission line."

Compliance

PSC Order 5 represents a pre-construction permit condition. However, coordination was undertaken with Mr. Jerry Lein of the North Dakota Public Service Commission (PSC) staff to confirm that the PSC was satisfied that it had on file copies of all required licenses and permits for the TWF transmission line. Mr. Lein indicated that he had "not tried to review whether all required permits/approvals [had been] received, but if there were any, including SHPO concurrence, road crossing permits, storm water drainage, or other such approvals, then those should have been filed."

Conclusions and Recommendations

It is unclear whether TWF fully complied with PSC Order 5. We recommend that the documents listed by Mr. Lein be compiled and sent to the PSC for filing.

2.2 Cultural Resources: PSC Order 9

Permit Requirements

PSC Order 9 states: "If any cultural resource, paleontological site, archaeological site, historical site, or gravesite is discovered during construction, it shall be marked, preserved and protected from any further disturbance until a professional examination can be made by the State Historical Society, a report of such examination is filed with the Commission, and clearance to proceed is given by the Commission." While PSC Order 9 does not expressly state that previously known cultural resources be avoided and preserved, this was clearly intended and was a commitment made in the route permit application. Since PSC Order 7 required that "Tatanka build and operate the transmission line in the manner described in its application and at the hearing…", ongoing protection of known cultural resources was also required.

Compliance

Coordination was undertaken with Mr. Bill Jackson of M. A. Mortenson Construction and he confirmed that no new cultural resources, paleontological sites, archaeological sites, historical sites or gravesites were encountered during construction. Known archaeological sites 32DI91 and 32DI92, which were identified within the transmission line corridor during the TWF Class

III/Level III cultural resources survey, were visually inspected in the field by Westwood. Both sites were found to have been unaffected by construction of the transmission line and both are far enough from transmission line structures that they should be unaffected by future structure maintenance or replacement activities. Thus PSC Order 9 has been complied with and no future compliance issues are anticipated.

Conclusions and Recommendations

The contractor was able to totally avoid all cultural resources within the transmission line corridor. No corrective actions or follow up efforts appear to be required.

2.3 Reclamation & Re-Seeding: PSC Order 13

Permit Requirements

PSC Order 13 states: "Reclamation, fertilization and reseeding is to be done by Tatanka according to the Natural Resource Conservation Service and County Farm Service Agency recommendations for CRP, native prairie and other lands unless otherwise specified by the landowner and approved by the Commission."

Compliance

No CRP lands were affected by the TWF transmission line. Twenty-five transmission line structures were installed on lands identified as native grassland, of which three were on USFWS grassland easement land. The areas affected by the installation of each structure were limited to the footprints of each pole and entailed so little disturbance that reclamation was unnecessary. We observed no evidence of ancillary disturbance associated with structure installation, equipment movement or the stringing of conductors. These activities were accomplished without any discernable effect on native plant communities. Accordingly, we saw no need for any specific reclamation activities at the structure locations. We also reviewed the substation locations and O & M building area. Impacts in these areas were limited to former cropland acquired by Tatanka. No native grasslands were affected in these locations.

Conclusions and Recommendations

No corrective actions or follow up efforts appear to be required regarding transmission line structures on native grasslands.

2.4 Tree Replacement: PSC Order 15

Permit Requirements

PSC Order 15 states: "Trees and other wooded vegetation must be replaced at a rate of two for every one removed along the route. Landowners shall be given the option of having replacement trees/shrubs planted off the right-of-way on the landowners' property or waiving that requirement in writing and allowing Tatanka to plant replacement trees/shrubs elsewhere. Tatanka shall inspect tree replacements once a year for three years and send a report on or

shortly before October 1 of 2008, 2009, and 2010 to the Commission documenting work completion and condition of woodlands planting. The Commission may order additional plantings if survival rates are less than 75% of the required ratio of two for one."

Compliance

Westwood staff visited the locations considered for tree removal during the in-field monitoring. We did not observe any evidence of trees having been removed during construction of the transmission line. In particular, we examined the tree line east of 66th Ave SE in Section 7 of Albertha Township. In this location, steel monopoles were use used instead of H-frame transmission line structures to avoid tree removal. **Photos 1** and **2** in Appendix B, document that the entire tree line in this location remains intact and that no trees were removed.

Conclusions and Recommendations

Because the contractor was able to totally avoid tree removal within the transmission line corridor, no tree replacement was necessary. No corrective actions or follow up efforts appear to be required.

3.0 USFWS SPECIAL USE PERMIT (SUP) CONDITIONS

3.1 Vegetation Management

Permit Requirements

Stipulation 2 of the Compatibility Determination of the USFWS SUP requires that "[d]isturbed grasslands will be reseeded to weed free native plant species and non-native plants will not be allowed. Sites will be monitored to ensure successful re-vegetation." Westwood Professional Services worked with staff at the Kulm Wetland Management District of the USFWS to arrive at acceptable seeding specifications for use on grassland easement lands. The seeding specifications approved by the USFWS are provided in **Appendix C**. The approved seeding specifications state that the specified seed mix was to be obtained from Chesak Seed House in Bismarck, ND and that these tags were to be submitted to and approved by the project environmental scientist before installation.

Compliance

The seed tags for work done on grassland easement lands by Borneke Construction (the earthwork contractor) and Muth Electric, Inc. (the contractor installing underground collector cables) are included in Appendix C. These seed mixes were in substantial compliance with the seeding specifications with slight variations in percentages and one additional native species (false sunflower) included by Muth Electric. It is unknown whether these tags were submitted to the project environmental scientist prior to installation. Supplemental seeding was performed in May of 2009 by TWF to encourage native prairie re-vegetation. Again, the seed mix used was in substantial compliance with the USFWS-approved specifications.

During the September 2009 field review, it was evident that native seeding had taken place as required in the SUP. Re-vegetation of subsurface collector cable alignments was sufficiently successful that the vegetation along these alignments could not be readily distinguished from the adjacent pre-existing native prairie vegetation. Re-vegetation of temporarily disturbed areas along access roads and aro8und turbine pads within grassland easement lands was less successful. It was readily evident that these areas had been seeded with native plants, as rows of seeded grasses were visible in most locations (see representative **Photos 3** and **4** in Appendix A). However, the only native species visible were western wheatgrass (*Agropyron smithii*) and prairie coneflower (*Ratibida columnifera*) and these were generally very sparse in their growth habit.

It typically takes 3 to 4 years for plantings of native prairie plants to become fully established. Accordingly, full re-vegetation would not be expected after only two growing seasons. However, it is likely that re-vegetation of temporarily disturbed native grassland on grassland easement areas will take much longer, due primarily to the paucity of topsoil. In some locations the planting substrate is so gravelly or stony that full re-vegetation in such locations will likely take decades. Noxious weed competition and cattle grazing of new shoots are also factors that further inhibit native re-vegetation in such areas. However, without an adequate growing medium, controlling noxious weeds and/or excluding cattle would not be sufficient to facilitate successful re-vegetation with native species within a reasonable time frame.

The stipulations set forth in the SUP do not specifically discuss topsoil segregation, re-spreading or amendment. Accordingly, there is no express provision in the SUP that would require TWF to add amend topsoil on grassland easement lands. However, the stipulations in the SUP do require successful re-vegetation of temporarily disturbed areas with native species. For the reasons stated above, compliance with this stipulation is unlikely to be accomplished within any reasonable time frame without topsoil being added or amended.

Non-native plants, including several noxious weed species, were observed in many temporarily disturbed locations on grassland easement lands (as well as many other locations across the overall TWF project). **Table 1** lists the state and local listed noxious weeds that are known to occur in Dickey and McIntosh counties, ND and McPherson County, South Dakota. On USFWS grassland easement lands in both North and South Dakota, noxious weed species that were particularly evident included absinth wormwood (*Artemesia absinthium*) (see **Photo 5** in Appendix B), Canada thistle (*Cirsium arvense*) (see **Photo 6** in Appendix B)and diffuse knapweed (*Centaurea diffusa*). In some locations, noxious weed populations outside of the TWF right-of-way were much higher than within it and it was clear that adjacent rangeland was contributing to the observed infestations. It appeared that some noxious weed control had been undertaken, as some specimens of Canada thistle appeared to have been killed with herbicide.

The stipulations contained in the SUP do not expressly require noxious weed control efforts but such efforts were clearly contemplated by the USFWS as elements of a successful re-vegetation program. Stipulations 2 and 3 emphasize that seed and hauled in materials be weed free and that seed mixtures consist of native species only. Also, while not stated in the SUP, both North and

South Dakota have statutory requirements for noxious weed control. These requirements apply across the entire TWF project and are not limited to USFWS easement lands.

Conclusions and Recommendations

Topsoil Amendment

We recommend the use of a mixture of compost and native seed be applied in areas with little or no topsoil. For several reasons, this option would be preferable to hauling in natural topsoil from off-site. First, sources of natural topsoil are limited in the TWF area (Mick Erickson, USFWS Kulm Wetland Management District, pers. Comm.). Second, ensuring that large quantities of hauled in topsoil are weed free would be very difficult. Third, adding natural topsoil would require the re-installation of silt fencing, erosion control fabric and other applicable erosion control measures in the locations affected. For these reasons, we view hauling in topsoil from off-site as a corrective measure of last resort.

Blower application of a compost and native seed mixture would provide seed, a suitable growth medium and mulch for erosion control all in one procedure. The use of this procedure would obviate the need to re-install silt-fencing and erosion control blankets on affected portions of TWF. An unfertilized compost/seed mixture has been found to facilitate re-vegetation much more rapidly than standard hydromulching. "Terraseeding" is one version of this method:

http://www.expressblower.com/terraseeding.html

A number of state transportation agencies have been using compost in the re-vegetation of roadsides. It does not appear that either the North or South Dakota Departments of Transportation have done so to date. Neither agency has a standard specification for compost use for roadside re-vegetation[1]. However, the Minnesota Department of Transportation (Mn/DOT) has been using compost as a growth medium for some time on highway projects where topsoil is degraded or lacking. Mn/DOT Standard Specification 3890 provides specifications for compost:

http://www.dot.state.mn.us/pre-letting/spec/2005/3835-3973.pdf#compost

A 2 to 3 inch layer of Grade 2 compost, as described in the Mn/DOT Standard Specifications, would be appropriate for use as a growth medium and erosion control measure in areas of TWF where topsoil is lacking. As an initial step in pursuing this approach, we recommend preliminary coordination with the USFWS Kulm and Sand Lake Wetland Management Districts to determine

[1] See http://www.dot.nd.gov/manuals/environmental/2008-Vol01.pdf and http://www.sddot.com/operations/Specifications/specbook_div2_04.htm

whether this approach would be considered an acceptable way to improve re-vegetation on grassland easement lands. A site review with USFWS staff would also be helpful to identify locations of particular concern to them.

If initial coordination with USFWS is favorable, we recommend that further research be undertaken to quantify the area requiring treatment, anticipated material quantities and approximate costs. Assuming this research indicates that this approach would be feasible and desirable, a Request for Proposals (RFP) would be developed and sent to potential compost vendors and applicators.

The Minnesota Department of Transportation (Mn/DOT) has been using compost as a topsoil replacement and has developed a standard specification for compost and its application as a Best Management Practice (BMP). I contacted Dwayne Stenlund, Certified Professional in Erosion & Sediment Control (CPESC) with Mn/DOT's Office of Environmental Services, to obtain information on application rates, methods and success rates. His response to my inquiry is paraphrased below.

Mr. Stenlund indicated that compost is nearly routine as a punchdown BMP when soils will not establish, or when rills occur on slopes that cannot be retilled. Mn/DOT has not applied compost on any projects in the western part of Minnesota, where conditions would be similar to those on TWF. However, for MnDOT projects in the Anoka sand plain area, it is a common BMP. For example, on the new design-build project on Trunk Highway 610 (which started October 26, 2009), 25,000 cubic yards of compost is being required for native plant establishment. Compost has been used for all plant community types and is an EPA approved BMP for erosion control. See also:

http://www.epa.gov/reg5rcra/wptdiv/solidwaste/recycle/compost/roundtable.htm

Mr. Stenlund recommended use of Grade 2 compost as plant feedstock, because few vendors will certify manure or animal feedstock composts. A layer of compost 2 inches thick (270 cubic yards per acre) is applied either by skidsteer placement or blower truck. Compost-amended soils still need water but in the cooler months ryegrass will be up in 3 to 7 days (early cover crop). Typical plant growth is superior with compost and average annual rainfall.

The primary cost in the use of compost is in shipping. Mn/DOT has paid as little as $4 and as much as $12 per cubic yard for compost and up to $25 per cubic yard to haul the material. Similar or higher shipping costs would be likely if compost is used on TWF, due to the project's remote location and distance from potential sources. Mr. Stenlund indicated that Huron and Rapid City, South Dakota both have "really good compost". Mr. Stenlund did not know of any compost sites in North Dakota that could meet the U.S. Composting Council Seal of Testing Assurance (STA) or Mn/DOT specs for 3890.

Mr. Stenlund recommended obtaining the compost using a back haul method with the trucking industry, spread it by any means available and lightly till it in to keep it from blowing. He recommended seeding, then fertilizing with a plant starter (MnDOT Type 4 natural base 12-13-8

at 200 lbs/acre) and then covering with a new BFM with fibers (see Flexterra (Profile) or FlexGuard (Mat Inc.), a 12 month hydromulch).

The as-built survey of TWF was limited to turbine locations and the centerlines of roads and collector cables. The areas actually graded during construction were not quantified in the as-built survey. The Compatibility Determination that is part of the SUP estimated that approximately 25.9 acres of temporary disturbance was to occur (6.7 acres associated with access roads and 19.2 acres associated with turbine pads). We recommend that the actual area of temporary impact caused by grading activity on grassland easement be quantified to facilitate cost estimating for restoration efforts. Assuming the acreages in the Compatibility Determination are reasonable estimates, the application of 2 to 3 inches of compost/seed mixture topsoil would equate to about 7,000 to 10,500 cubic yards of material.

Topsoil amendment as described above would be desirable on other non-easement lands that lack topsoil and have not yet successfully re-vegetated. While such supplementation would not be required under the USFWS SUP, it may be necessary to achieve final stabilization under the NPDES permits for the project (see Section 6.0 below). Assuming compost application is considered cost effective by Tatanka, we recommend that treatment of USFWS grassland easement lands be done as a pilot effort in 2010. If results are favorable, the method could then be applied to other areas of TWF to facilitate successful re-vegetation.

Seeding

Seed would be applied after the compost mixture has been laid down, using the method described above. Seed can be either be drilled with a native seed drill or broadcast seeded. We recommend that the originally approved seed mix be used in this application.

Noxious Weed Control

To facilitate noxious weed control by TWF O & M staff, an illustrated guide to the noxious weed species potentially occurring on the TWF is provided in **Appendix D**. Some species are biennials and have a relatively obscure rosette stage the first year followed by a more noticeable flowering stage the second following year (e.g. thistles, knapweeds, sowthistle, starthistle and yellow toadflax). These species are most vulnerable to herbicide applications during the rosette stage. Most of the listed species can be controlled with Glyphosate (trade names: RoundUp™, Rodeo™, Pond Master™) but Dalmatian toadflax, hoary cress and the knapweed species may be more successfully control using Picloram (trade names: Grazon™ and Tordon™). We recommend that the O & M staff become familiar with all of these species and that a program of spot herbicide applications be integrated with other maintenance activities on TWF. We did not observe leafy spurge in during the field review in September but O & M staff should pay particular attention to this species. Leafy spurge is extremely difficult to control and early detection is critical to preventing it from invading disturbed areas.

A typical noxious weed control program would involve spot treatments in early May followed by a second round in June or July. The second round of treatments would serve to eliminate individuals missed in the first rotation and ensure that these plants do not go to seed. We recommend that county weed control extension specialists be invited to meet with O & M staff to provide their local knowledge on herbicide application rates and dates to maximize treatment efficacy.

Cattle Exclusion

An additional option to consider in re-seeded areas is the temporary exclusion of cattle from access road rights of way by using electric fencing. This method should be used only in areas where heavy grazing is adversely affecting re-vegetation and where approved by the landowner.

3.2 Wetlands

Permit Requirements

Stipulation 5 in the SUP required that all wetlands be avoided on USFWS easement lands, including grassland, wetland and FmHA easements.

Compliance

During our field investigation, no wetland impacts were observed on easement lands. The locations of wetlands on TWF and along the transmission line route are shown in Appendix A.

Conclusions and Recommendations

No corrective actions or follow up efforts involving wetlands on USFWS easement lands appear to be required.

3.3 Cultural Resources

Permit Requirements

Stipulation 7 of the SUP required Tatanka to "comply with Section 106 of the National Historic Preservation Act, including consultation with the North Dakota and South Dakota State Historical Preservation Offices and Native American Tribes historically associated with the project area."

Prior to construction, Westwood coordinated with the Regional Historic Preservation Specialist for the USFWS, who determined that Section 106 of the National Historic Preservation Act (NHPA) applied only to the portions of TWF that lies on USFWS grassland easement land. Notwithstanding this determination, as a matter of due diligence, Tatanka retained Westwood to conduct cultural resource surveys on all transmission structure locations, turbine locations, road alignments and cable routes regardless of whether Section 106 applied. Cultural resource surveys were project-wide and were not limited to USFWS easement lands. Two archaeological

sites potentially eligible for the National register of Historic Places (NRHP) were located on USFWS grassland lands. These sites were avoided in the design of the TWF. One potentially eligible site was located on non-grassland easement land that could not be avoided in the design of the project. While not required under Section 106, Tatanka retained Westwood to conduct a data recovery on this site to mitigate for unavoidable impacts. As lead federal agency, the USFWS conducted the necessary consultations with the North and South Dakota State Historic Preservation Offices and interested Tribes and reviewed the reports prepared by Westwood. In July of 2007, the USFWS issued a "No Effect" determination under Section 106.

Compliance

In order to comply with Section 106 on an ongoing basis, the potentially NRHP eligible archaeological sites on grassland easement land must be preserved in an undisturbed state. Post-construction monitoring by Westwood Staff of cultural resources at TWF in September 2009 revealed that all recommendations as put forth in the Final Class III/Level III Cultural Resource Report for the TWF Project were completely followed. Sites 32DI99 and 32DI45 located on USFWS grassland easement lands were observed in the field by Westwood staff. Both sites were found to have been completely avoided by all construction activities. The posts from protective fencing were still in place and were helpful in locating the boundaries of these sites (see **Photo 7** in Appendix B). We also coordinated with TWF O & M staff members who indicated that they were aware of these cultural resource locations and would continue to protect them. Accordingly, the 2007 "No Effect" determination remains valid and TWF remains in compliance with SUP Stipulation 7.

Finally, all cultural resources that were Westwood recommended be avoided on private lands within the TWF were examined by Westwood Staff and found to have been avoided by construction activities. One site on private land, 32DI95, was impacted by construction; however, the impacted portion of the site had been first mitigated by the data recovery mentioned above. The entire process regarding the mitigation of 32DI95 was undertaken in consultation with the North Dakota State Historic Preservation Office (SHPO). This undertaking represented due diligence on the part of Tatanka to preserve cultural resources on private lands that went beyond the requirements of Section 106 of the NHPA.

Conclusions and Recommendations

The contractor (1) was able to avoid all but one cultural resource within the transmission line corridor and wind farm, (2) mitigated the affected portions of the one avoidable site (32DI95) in consultation with the ND SHPO and (3) fulfilled Section 106 of the NHPA. Other than ongoing protection of preserved sites, no corrective actions or follow up efforts appear to be required. We recommend that the existing fence posts that demarcate the boundaries of these sites be left in place to facilitate ongoing avoidance.

4.0 USFWS RIGHT-OF-WAY PERMIT CONDITIONS

The USFWS Right-of-Way Permit did not include any post-construction stipulations or requirements that were not already included in the USFWS SUP.

5.0 U.S. ARMY CORPS OF ENGINEERS (USACE) SECTION 404 PERMITS

Permit Requirements

The North Dakota and South Dakota Regulatory offices of the USACE issued jurisdictional determinations and letters confirming that Section 404 Nationwide Permits (NWPs) 12 and 33 covered the anticipated wetland impacts of the Tatanka Wind Power project. The project activities that generated the need for the NWPs were the placement of temporary fill across an unnamed intermittent drainage for: (1) a crane path between turbines ND03 and ND04 and (2) placement of collector cables within wetlands on the north side of State Line Road between the collection substation and turbine ND5. These were the only aspects of the Tatanka project that involved the discharge of dredged or fill material into waters of the United States. The aforementioned intermittent drainage was found to be jurisdictional because it was tributary to the Elm River. The wetlands along State Line Road are isolated basins that were found to be jurisdictional because they are interstate waters.

The standard conditions applicable to NWPs 12 and 33 respectively require that: (1) temporary fill be removed and affected area restored to pre-construction conditions within three months of placement and (2) areas affected by trenching and backfilling during installation of underground utility lines be restored to pre-construction conditions.

Compliance

During in-field monitoring, Westwood staff visited each of the locations where activities regulated by the USACE were to occur. Based on site observations, the crane crossing of the unnamed intermittent drainage between turbines ND03 and ND04 was accomplished without the use of temporary fill so no removal of such fill was required. As depicted in **Photo 8** in Appendix B, the crane crossing was accomplished during dry conditions in a manner that generated no impacts (likely using construction mats). The underground collector cables along the north side of State Line Road were installed within the road embankment and also avoided any impacts to wetlands. Again, because wetland impacts were avoided in their entirety in this location, no post-installation restoration of wetlands was necessary. **Photo 9** in Appendix B provides documentation of current conditions along the applicable portion of State Line Road.

Conclusions and Recommendations

The contractor was able to totally avoid wetland impacts in the two locations covered by the USACE NWPs. No corrective actions or follow up efforts appear to be required.

6.0 SWPPP AND NPDES PERMITS

Permit Requirements

North and South Dakota each have General Permits for Storm Water Discharges under the National Pollutant Discharge Elimination System (NPDES) program for each state. In accordance with those general permits, individual Storm Water Pollution Protection Plans (SWPPPs) were prepared for the North and South Dakota portions of TWF. These SWPPPs were prepared by HDR Engineering, Inc. and implemented by M. A. Mortenson Construction, the general contractor on the TWF project.

The General NPDES Storm Water Permits for both states that were in place at the time TWF was constructed have expired. North Dakota has reissued its General Permit, effective October 12, 2009. South Dakota has reissued a draft General Permit which will be finalized in November or December 2009. Both permits require that a Notice of Termination (NOT) be filed upon completion of construction and after final stabilization of all disturbed soils has been accomplished. Except on cropland, stabilization is not considered complete until 70 percent vegetative coverage has been achieved as compared to pre-existing vegetation and all temporary erosion control measures have been removed. Cropland needs to be successfully returned to agricultural use to be considered stabilized. The SWPPPs for the portions of the project in each state both indicated that the pre-existing vegetative cover in the areas being disturbed was 100 percent. We believe that this percentage is conservative and that pre-construction vegetative cover was less than 100 percent in some areas. But assuming 100 percent pre-construction coverage, 70 percent vegetative cover would be required on all disturbed soils for the site to be considered stabilized and eligible for the filing of NOTs.

Compliance

Because this compliance review was done post-construction, we did not attempt to determine SWPPP compliance before and during the construction period (i.e. inspections, maintenance of temporary erosion control measures, etc.). However, the remnant erosion and sedimentation control measures we observed at the time of the compliance field review appeared to be in conformance with SWPPP requirements as to their types and locations. None of these measures remain functional. Virtually all silt fences are down and most erosion control blankets we observed was substantially degraded and/or blown away. Erosion control blankets were used on steep slopes and road cuts. Some steeper areas where erosion control blankets were used remain unvegetated due to a lack of topsoil (see **Photo 10** in Appendix B).

It is our understanding that NOTs have not been filed and that the NPDES permits for the project have been extended. Based on our field observations, final stabilization has not been achieved across the TWF project site and filing of NOTs should be delayed until final stabilization has been achieved. As discussed above, many areas have not achieved 70 percent vegetative cover, due primarily to insufficient topsoil. Also, the remnants of temporary erosion control measures remain in place but are non-functional. Despite the non-functionality of remnant erosion control

measures, we observed little erosion and sedimentation on the TWF site. We did observe a few hill cuts on access roads where minor gully erosion had begun in the ditches and sediment plumes had formed (see **Photos 11** and **12** in Appendix B). In most such locations, the contractor or O & M staff had placed rock check dams or linear lines of boulders to retard flow and trap sediment (see **Photos 13** and **14**, respectively, in Appendix B). The boulder lines appeared to be of some benefit but should be built up with additional rock and supplemented with check dams running perpendicular to the direction of flow. Access roads were underlain with geotextile fabric at the time of construction. We observed one location adjacent to Turbine ND 20 where erosion had exposed the underlying fabric. Additional gravel should be applied in this area to reestablish cover over the fabric. As previously stated, none of the erosion or sedimentation issues described above have allowed any impacts to be incurred within waters of the state.

We observed no NPDES issues on temporarily disturbed areas located on cropland. All cropland areas had been properly restored to agricultural use.

Conclusions and Recommendations

The biggest NPDES compliance issue we observed was the inadequacy of vegetative cover due to lack of topsoil. Upon determining that use of a compost and seed mixture is successful on USFWS grassland easement lands, we recommend that the same procedures be applied in other grassland areas of TWF where 70 percent native cover has not been achieved. Once 70 percent cover has been achieved on all native grasslands on the project, NOTs should be filed with the states of North and South Dakota.

7.0 SUMMARY OF RECOMMENDATIONS

1. All permits and licenses obtained for the TWF transmission line should be compiled and a copy of each sent to Jerry Lein at the ND PSC.

2. During the 2010 growing season, a 2 inch layer of compost should be applied to temporarily disturbed areas of USFWS grassland easement land where inadequate topsoil is preventing successful re-vegetation. After compost application, the treated areas should be seeded, fertilized and mulched as described earlier in this report. These areas should be re-visited at the end of the 2010 growing season to confirm successful re-vegetation.

3. If the re-vegetation method used on USFWS grassland easement lands is successful, it should be applied to non-easement grasslands where similar topsoil problems exist.

4. Noxious weed control efforts should be intensified using at least two annual rounds of spot spraying with Glyphosate and/or Picloram as applicable to the species listed in Appendix D. County extension specialists should be consulted by O & M staff to obtain their input on herbicide selection, application rates and timing.

5. Temporary cattle exclusion should be considered and coordinated with underlying landowners if excessive grazing of planted prairie vegetation is observed.

6. Fence posts demarcating cultural resource sites should be left in place to facilitate ongoing impact avoidance.

7. Locations along access roads where boulder lines have been used to minimized gully erosion should be reinforced with rock check dams running perpendicular to the direction of flow.

8. Upon successful re-vegetation of native grasslands (i.e. 70 percent ground cover), NOTs should be prepared and submitted to the states of North and South Dakota to close out the NPDES permit process.

Tatanka Wind Farm
Post-Construction Compliance Monitoring Report And Restoration Management Plan

Dickey and McIntosh Counties, ND
McPherson County, SD

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1.0 INTRODUCTION

Westwood Professional Services, Inc. (Westwood) was retained by Tatanka Wind Power, LLC (Tatanka) to conduct post-construction environmental and cultural resource compliance monitoring for the Tatanka Wind Farm (TWF). The purpose of this effort was to determine whether TWF was in compliance with all post-construction environmental and cultural resource permit conditions and, if not, to provide recommendations for restoration and/or management measures that would bring the project into compliance. Because the monitoring effort took place after construction was completed, we did not endeavor to confirm compliance with permit conditions that were applicable only during the pre-construction or construction phases of the project.

TWF is located in Dickey and McIntosh Counties, North Dakota and McPherson County, South Dakota. Compliance was monitored with regard to provisions and conditions defined in the: (1) the North Dakota Public Service Commission (PSC) transmission line route permit, (2) the U.S. Fish and Wildlife Service (USFWS) Special Use Permit (SUP) and Right-of-Way Permit, (3) U.S. Army Corps of Engineers (USACE) Section 404 permits and (4) National Pollution Discharge Elimination System permits.

In-field compliance monitoring was conducted September 1st through September 3rd, 2009. Ronald P. Peterson, Westwood Director of Environmental Services conducted in-field environmental compliance monitoring. Ryan P. Grohnke, Westwood Cultural Resource Specialist conducted in-field cultural resource compliance monitoring. Annotations from our field observations are provided in the map section contained in **Appendix A**. Representative site photos are provided in **Appendix B**.

The following report details the level of permit compliance observed during the in-field post-construction compliance monitoring and identifies recommended protocols for ongoing monitoring, restoration, and/or maintenance by TWF Operations & Maintenance staff to ensure ongoing compliance.

2.0 PUBLIC SERVICE COMISSION (PSC) ROUTE PERMIT CONDITIONS

The North Dakota PSC has jurisdiction over transmission lines within the state. Tatanka was required to obtain a PSC Certificate of Corridor Compatibility and Transmission Line Route Permit prior to construction of the transmission line in Dickey and McIntosh Counties, ND. The Findings of Fact, Conclusions of Law, and Orders issued by the PSC on March 21, 2007, set forth specific conditions for the Route Permit approval. Based on the field review, Tatanka has complied with all conditions established in the PSC Orders. The Orders specifically addressed here are Orders 5, 9, 13, and 15.

2.1 Other Permits and Licenses: PSC Order 5

Permit Requirements

PSC Order 5 states: "Tatanka shall comply with the rules and regulations of all the agencies having jurisdiction over any phase of its proposed transmission line, and it shall obtain all other necessary licenses and permits; and shall provide copies of all licenses and permits to the Commission which were not included in its application or which have not otherwise been provided to the Commission as of the date of this order prior to the construction of the transmission line."

Compliance

PSC Order 5 represents a pre-construction permit condition. However, coordination was undertaken with Mr. Jerry Lein of the North Dakota Public Service Commission (PSC) staff to confirm that the PSC was satisfied that it had on file copies of all required licenses and permits for the TWF transmission line. Mr. Lein indicated that he had "not tried to review whether all required permits/approvals [had been] received, but if there were any, including SHPO concurrence, road crossing permits, storm water drainage, or other such approvals, then those should have been filed."

Conclusions and Recommendations

It is unclear whether TWF fully complied with PSC Order 5. We recommend that the documents listed by Mr. Lein be compiled and sent to the PSC for filing.

2.2 Cultural Resources: PSC Order 9

Permit Requirements

PSC Order 9 states: "If any cultural resource, paleontological site, archaeological site, historical site, or gravesite is discovered during construction, it shall be marked, preserved and protected from any further disturbance until a professional examination can be made by the State Historical Society, a report of such examination is filed with the Commission, and clearance to proceed is given by the Commission." While PSC Order 9 does not expressly state that previously known cultural resources be avoided and preserved, this was clearly intended and was a commitment made in the route permit application. Since PSC Order 7 required that "Tatanka build and operate the transmission line in the manner described in its application and at the hearing…", ongoing protection of known cultural resources was also required.

Compliance

Coordination was undertaken with Mr. Bill Jackson of M. A. Mortenson Construction and he confirmed that no new cultural resources, paleontological sites, archaeological sites, historical sites or gravesites were encountered during construction. Known archaeological sites 32DI91 and 32DI92, which were identified within the transmission line corridor during the TWF Class

III/Level III cultural resources survey, were visually inspected in the field by Westwood. Both sites were found to have been unaffected by construction of the transmission line and both are far enough from transmission line structures that they should be unaffected by future structure maintenance or replacement activities. Thus PSC Order 9 has been complied with and no future compliance issues are anticipated.

Conclusions and Recommendations

The contractor was able to totally avoid all cultural resources within the transmission line corridor. No corrective actions or follow up efforts appear to be required.

2.3 Reclamation & Re-Seeding: PSC Order 13

Permit Requirements

PSC Order 13 states: "Reclamation, fertilization and reseeding is to be done by Tatanka according to the Natural Resource Conservation Service and County Farm Service Agency recommendations for CRP, native prairie and other lands unless otherwise specified by the landowner and approved by the Commission."

Compliance

No CRP lands were affected by the TWF transmission line. Twenty-five transmission line structures were installed on lands identified as native grassland, of which three were on USFWS grassland easement land. The areas affected by the installation of each structure were limited to the footprints of each pole and entailed so little disturbance that reclamation was unnecessary. We observed no evidence of ancillary disturbance associated with structure installation, equipment movement or the stringing of conductors. These activities were accomplished without any discernable effect on native plant communities. Accordingly, we saw no need for any specific reclamation activities at the structure locations. We also reviewed the substation locations and O & M building area. Impacts in these areas were limited to former cropland acquired by Tatanka. No native grasslands were affected in these locations.

Conclusions and Recommendations

No corrective actions or follow up efforts appear to be required regarding transmission line structures on native grasslands.

2.4 Tree Replacement: PSC Order 15

Permit Requirements

PSC Order 15 states: "Trees and other wooded vegetation must be replaced at a rate of two for every one removed along the route. Landowners shall be given the option of having replacement trees/shrubs planted off the right-of-way on the landowners' property or waiving that requirement in writing and allowing Tatanka to plant replacement trees/shrubs elsewhere. Tatanka shall inspect tree replacements once a year for three years and send a report on or

shortly before October 1 of 2008, 2009, and 2010 to the Commission documenting work completion and condition of woodlands planting. The Commission may order additional plantings if survival rates are less than 75% of the required ratio of two for one."

Compliance

Westwood staff visited the locations considered for tree removal during the in-field monitoring. We did not observe any evidence of trees having been removed during construction of the transmission line. In particular, we examined the tree line east of 66th Ave SE in Section 7 of Albertha Township. In this location, steel monopoles were use used instead of H-frame transmission line structures to avoid tree removal. **Photos 1** and **2** in Appendix B, document that the entire tree line in this location remains intact and that no trees were removed.

Conclusions and Recommendations

Because the contractor was able to totally avoid tree removal within the transmission line corridor, no tree replacement was necessary. No corrective actions or follow up efforts appear to be required.

3.0 USFWS SPECIAL USE PERMIT (SUP) CONDITIONS

3.1 Vegetation Management

Permit Requirements

Stipulation 2 of the Compatibility Determination of the USFWS SUP requires that "[d]isturbed grasslands will be reseeded to weed free native plant species and non-native plants will not be allowed. Sites will be monitored to ensure successful re-vegetation." Westwood Professional Services worked with staff at the Kulm Wetland Management District of the USFWS to arrive at acceptable seeding specifications for use on grassland easement lands. The seeding specifications approved by the USFWS are provided in **Appendix C**. The approved seeding specifications state that the specified seed mix was to be obtained from Chesak Seed House in Bismarck, ND and that these tags were to be submitted to and approved by the project environmental scientist before installation.

Compliance

The seed tags for work done on grassland easement lands by Borneke Construction (the earthwork contractor) and Muth Electric, Inc. (the contractor installing underground collector cables) are included in Appendix C. These seed mixes were in substantial compliance with the seeding specifications with slight variations in percentages and one additional native species (false sunflower) included by Muth Electric. It is unknown whether these tags were submitted to the project environmental scientist prior to installation. Supplemental seeding was performed in May of 2009 by TWF to encourage native prairie re-vegetation. Again, the seed mix used was in substantial compliance with the USFWS-approved specifications.

During the September 2009 field review, it was evident that native seeding had taken place as required in the SUP. Re-vegetation of subsurface collector cable alignments was sufficiently successful that the vegetation along these alignments could not be readily distinguished from the adjacent pre-existing native prairie vegetation. Re-vegetation of temporarily disturbed areas along access roads and aro8und turbine pads within grassland easement lands was less successful. It was readily evident that these areas had been seeded with native plants, as rows of seeded grasses were visible in most locations (see representative **Photos 3** and **4** in Appendix A). However, the only native species visible were western wheatgrass (*Agropyron smithii*) and prairie coneflower (*Ratibida columnifera*) and these were generally very sparse in their growth habit.

It typically takes 3 to 4 years for plantings of native prairie plants to become fully established. Accordingly, full re-vegetation would not be expected after only two growing seasons. However, it is likely that re-vegetation of temporarily disturbed native grassland on grassland easement areas will take much longer, due primarily to the paucity of topsoil. In some locations the planting substrate is so gravelly or stony that full re-vegetation in such locations will likely take decades. Noxious weed competition and cattle grazing of new shoots are also factors that further inhibit native re-vegetation in such areas. However, without an adequate growing medium, controlling noxious weeds and/or excluding cattle would not be sufficient to facilitate successful re-vegetation with native species within a reasonable time frame.

The stipulations set forth in the SUP do not specifically discuss topsoil segregation, re-spreading or amendment. Accordingly, there is no express provision in the SUP that would require TWF to add amend topsoil on grassland easement lands. However, the stipulations in the SUP do require successful re-vegetation of temporarily disturbed areas with native species. For the reasons stated above, compliance with this stipulation is unlikely to be accomplished within any reasonable time frame without topsoil being added or amended.

Non-native plants, including several noxious weed species, were observed in many temporarily disturbed locations on grassland easement lands (as well as many other locations across the overall TWF project). **Table 1** lists the state and local listed noxious weeds that are known to occur in Dickey and McIntosh counties, ND and McPherson County, South Dakota. On USFWS grassland easement lands in both North and South Dakota, noxious weed species that were particularly evident included absinth wormwood (*Artemesia absinthium*) (see **Photo 5** in Appendix B), Canada thistle (*Cirsium arvense*) (see **Photo 6** in Appendix B)and diffuse knapweed (*Centaurea diffusa*). In some locations, noxious weed populations outside of the TWF right-of-way were much higher than within it and it was clear that adjacent rangeland was contributing to the observed infestations. It appeared that some noxious weed control had been undertaken, as some specimens of Canada thistle appeared to have been killed with herbicide.

The stipulations contained in the SUP do not expressly require noxious weed control efforts but such efforts were clearly contemplated by the USFWS as elements of a successful re-vegetation program. Stipulations 2 and 3 emphasize that seed and hauled in materials be weed free and that seed mixtures consist of native species only. Also, while not stated in the SUP, both North and

South Dakota have statutory requirements for noxious weed control. These requirements apply across the entire TWF project and are not limited to USFWS easement lands.

Conclusions and Recommendations

Topsoil Amendment

We recommend the use of a mixture of compost and native seed be applied in areas with little or no topsoil. For several reasons, this option would be preferable to hauling in natural topsoil from off-site. First, sources of natural topsoil are limited in the TWF area (Mick Erickson, USFWS Kulm Wetland Management District, pers. Comm.). Second, ensuring that large quantities of hauled in topsoil are weed free would be very difficult. Third, adding natural topsoil would require the re-installation of silt fencing, erosion control fabric and other applicable erosion control measures in the locations affected. For these reasons, we view hauling in topsoil from off-site as a corrective measure of last resort.

Blower application of a compost and native seed mixture would provide seed, a suitable growth medium and mulch for erosion control all in one procedure. The use of this procedure would obviate the need to re-install silt-fencing and erosion control blankets on affected portions of TWF. An unfertilized compost/seed mixture has been found to facilitate re-vegetation much more rapidly than standard hydromulching. "Terraseeding" is one version of this method:

http://www.expressblower.com/terraseeding.html

A number of state transportation agencies have been using compost in the re-vegetation of roadsides. It does not appear that either the North or South Dakota Departments of Transportation have done so to date. Neither agency has a standard specification for compost use for roadside re-vegetation[1]. However, the Minnesota Department of Transportation (Mn/DOT) has been using compost as a growth medium for some time on highway projects where topsoil is degraded or lacking. Mn/DOT Standard Specification 3890 provides specifications for compost:

http://www.dot.state.mn.us/pre-letting/spec/2005/3835-3973.pdf#compost

A 2 to 3 inch layer of Grade 2 compost, as described in the Mn/DOT Standard Specifications, would be appropriate for use as a growth medium and erosion control measure in areas of TWF where topsoil is lacking. As an initial step in pursuing this approach, we recommend preliminary coordination with the USFWS Kulm and Sand Lake Wetland Management Districts to determine

[1] See http://www.dot.nd.gov/manuals/environmental/2008-Vol01.pdf and http://www.sddot.com/operations/Specifications/specbook_div2_04.htm

whether this approach would be considered an acceptable way to improve re-vegetation on grassland easement lands. A site review with USFWS staff would also be helpful to identify locations of particular concern to them.

If initial coordination with USFWS is favorable, we recommend that further research be undertaken to quantify the area requiring treatment, anticipated material quantities and approximate costs. Assuming this research indicates that this approach would be feasible and desirable, a Request for Proposals (RFP) would be developed and sent to potential compost vendors and applicators.

The Minnesota Department of Transportation (Mn/DOT) has been using compost as a topsoil replacement and has developed a standard specification for compost and its application as a Best Management Practice (BMP). I contacted Dwayne Stenlund, Certified Professional in Erosion & Sediment Control (CPESC) with Mn/DOT's Office of Environmental Services, to obtain information on application rates, methods and success rates. His response to my inquiry is paraphrased below.

Mr. Stenlund indicated that compost is nearly routine as a punchdown BMP when soils will not establish, or when rills occur on slopes that cannot be retilled. Mn/DOT has not applied compost on any projects in the western part of Minnesota, where conditions would be similar to those on TWF. However, for MnDOT projects in the Anoka sand plain area, it is a common BMP. For example, on the new design-build project on Trunk Highway 610 (which started October 26, 2009), 25,000 cubic yards of compost is being required for native plant establishment. Compost has been used for all plant community types and is an EPA approved BMP for erosion control. See also:

http://www.epa.gov/reg5rcra/wptdiv/solidwaste/recycle/compost/roundtable.htm

Mr. Stenlund recommended use of Grade 2 compost as plant feedstock, because few vendors will certify manure or animal feedstock composts. A layer of compost 2 inches thick (270 cubic yards per acre) is applied either by skidsteer placement or blower truck. Compost-amended soils still need water but in the cooler months ryegrass will be up in 3 to 7 days (early cover crop). Typical plant growth is superior with compost and average annual rainfall.

The primary cost in the use of compost is in shipping. Mn/DOT has paid as little as $4 and as much as $12 per cubic yard for compost and up to $25 per cubic yard to haul the material. Similar or higher shipping costs would be likely if compost is used on TWF, due to the project's remote location and distance from potential sources. Mr. Stenlund indicated that Huron and Rapid City, South Dakota both have "really good compost". Mr. Stenlund did not know of any compost sites in North Dakota that could meet the U.S. Composting Council Seal of Testing Assurance (STA) or Mn/DOT specs for 3890.

Mr. Stenlund recommended obtaining the compost using a back haul method with the trucking industry, spread it by any means available and lightly till it in to keep it from blowing. He recommended seeding, then fertilizing with a plant starter (MnDOT Type 4 natural base 12-13-8

at 200 lbs/acre) and then covering with a new BFM with fibers (see Flexterra (Profile) or FlexGuard (Mat Inc.), a 12 month hydromulch).

The as-built survey of TWF was limited to turbine locations and the centerlines of roads and collector cables. The areas actually graded during construction were not quantified in the as-built survey. The Compatibility Determination that is part of the SUP estimated that approximately 25.9 acres of temporary disturbance was to occur (6.7 acres associated with access roads and 19.2 acres associated with turbine pads). We recommend that the actual area of temporary impact caused by grading activity on grassland easement be quantified to facilitate cost estimating for restoration efforts. Assuming the acreages in the Compatibility Determination are reasonable estimates, the application of 2 to 3 inches of compost/seed mixture topsoil would equate to about 7,000 to 10,500 cubic yards of material.

Topsoil amendment as described above would be desirable on other non-easement lands that lack topsoil and have not yet successfully re-vegetated. While such supplementation would not be required under the USFWS SUP, it may be necessary to achieve final stabilization under the NPDES permits for the project (see Section 6.0 below). Assuming compost application is considered cost effective by Tatanka, we recommend that treatment of USFWS grassland easement lands be done as a pilot effort in 2010. If results are favorable, the method could then be applied to other areas of TWF to facilitate successful re-vegetation.

Seeding

Seed would be applied after the compost mixture has been laid down, using the method described above. Seed can be either be drilled with a native seed drill or broadcast seeded. We recommend that the originally approved seed mix be used in this application.

Noxious Weed Control

To facilitate noxious weed control by TWF O & M staff, an illustrated guide to the noxious weed species potentially occurring on the TWF is provided in **Appendix D**. Some species are biennials and have a relatively obscure rosette stage the first year followed by a more noticeable flowering stage the second following year (e.g. thistles, knapweeds, sowthistle, starthistle and yellow toadflax). These species are most vulnerable to herbicide applications during the rosette stage. Most of the listed species can be controlled with Glyphosate (trade names: RoundUp™, Rodeo™, Pond Master™) but Dalmatian toadflax, hoary cress and the knapweed species may be more successfully control using Picloram (trade names: Grazon™ and Tordon™). We recommend that the O & M staff become familiar with all of these species and that a program of spot herbicide applications be integrated with other maintenance activities on TWF. We did not observe leafy spurge in during the field review in September but O & M staff should pay particular attention to this species. Leafy spurge is extremely difficult to control and early detection is critical to preventing it from invading disturbed areas.

A typical noxious weed control program would involve spot treatments in early May followed by a second round in June or July. The second round of treatments would serve to eliminate individuals missed in the first rotation and ensure that these plants do not go to seed. We recommend that county weed control extension specialists be invited to meet with O & M staff to provide their local knowledge on herbicide application rates and dates to maximize treatment efficacy.

Cattle Exclusion

An additional option to consider in re-seeded areas is the temporary exclusion of cattle from access road rights of way by using electric fencing. This method should be used only in areas where heavy grazing is adversely affecting re-vegetation and where approved by the landowner.

3.2 Wetlands

Permit Requirements

Stipulation 5 in the SUP required that all wetlands be avoided on USFWS easement lands, including grassland, wetland and FmHA easements.

Compliance

During our field investigation, no wetland impacts were observed on easement lands. The locations of wetlands on TWF and along the transmission line route are shown in Appendix A.

Conclusions and Recommendations

No corrective actions or follow up efforts involving wetlands on USFWS easement lands appear to be required.

3.3 Cultural Resources

Permit Requirements

Stipulation 7 of the SUP required Tatanka to "comply with Section 106 of the National Historic Preservation Act, including consultation with the North Dakota and South Dakota State Historical Preservation Offices and Native American Tribes historically associated with the project area."

Prior to construction, Westwood coordinated with the Regional Historic Preservation Specialist for the USFWS, who determined that Section 106 of the National Historic Preservation Act (NHPA) applied only to the portions of TWF that lies on USFWS grassland easement land. Notwithstanding this determination, as a matter of due diligence, Tatanka retained Westwood to conduct cultural resource surveys on all transmission structure locations, turbine locations, road alignments and cable routes regardless of whether Section 106 applied. Cultural resource surveys were project-wide and were not limited to USFWS easement lands. Two archaeological

sites potentially eligible for the National register of Historic Places (NRHP) were located on USFWS grassland lands. These sites were avoided in the design of the TWF. One potentially eligible site was located on non-grassland easement land that could not be avoided in the design of the project. While not required under Section 106, Tatanka retained Westwood to conduct a data recovery on this site to mitigate for unavoidable impacts. As lead federal agency, the USFWS conducted the necessary consultations with the North and South Dakota State Historic Preservation Offices and interested Tribes and reviewed the reports prepared by Westwood. In July of 2007, the USFWS issued a "No Effect" determination under Section 106.

Compliance

In order to comply with Section 106 on an ongoing basis, the potentially NRHP eligible archaeological sites on grassland easement land must be preserved in an undisturbed state. Post-construction monitoring by Westwood Staff of cultural resources at TWF in September 2009 revealed that all recommendations as put forth in the Final Class III/Level III Cultural Resource Report for the TWF Project were completely followed. Sites 32DI99 and 32DI45 located on USFWS grassland easement lands were observed in the field by Westwood staff. Both sites were found to have been completely avoided by all construction activities. The posts from protective fencing were still in place and were helpful in locating the boundaries of these sites (see **Photo 7** in Appendix B). We also coordinated with TWF O & M staff members who indicated that they were aware of these cultural resource locations and would continue to protect them. Accordingly, the 2007 "No Effect" determination remains valid and TWF remains in compliance with SUP Stipulation 7.

Finally, all cultural resources that were Westwood recommended be avoided on private lands within the TWF were examined by Westwood Staff and found to have been avoided by construction activities. One site on private land, 32DI95, was impacted by construction; however, the impacted portion of the site had been first mitigated by the data recovery mentioned above. The entire process regarding the mitigation of 32DI95 was undertaken in consultation with the North Dakota State Historic Preservation Office (SHPO). This undertaking represented due diligence on the part of Tatanka to preserve cultural resources on private lands that went beyond the requirements of Section 106 of the NHPA.

Conclusions and Recommendations

The contractor (1) was able to avoid all but one cultural resource within the transmission line corridor and wind farm, (2) mitigated the affected portions of the one avoidable site (32DI95) in consultation with the ND SHPO and (3) fulfilled Section 106 of the NHPA. Other than ongoing protection of preserved sites, no corrective actions or follow up efforts appear to be required. We recommend that the existing fence posts that demarcate the boundaries of these sites be left in place to facilitate ongoing avoidance.

4.0 USFWS RIGHT-OF-WAY PERMIT CONDITIONS

The USFWS Right-of-Way Permit did not include any post-construction stipulations or requirements that were not already included in the USFWS SUP.

5.0 U.S. ARMY CORPS OF ENGINEERS (USACE) SECTION 404 PERMITS

Permit Requirements

The North Dakota and South Dakota Regulatory offices of the USACE issued jurisdictional determinations and letters confirming that Section 404 Nationwide Permits (NWPs) 12 and 33 covered the anticipated wetland impacts of the Tatanka Wind Power project. The project activities that generated the need for the NWPs were the placement of temporary fill across an unnamed intermittent drainage for: (1) a crane path between turbines ND03 and ND04 and (2) placement of collector cables within wetlands on the north side of State Line Road between the collection substation and turbine ND5. These were the only aspects of the Tatanka project that involved the discharge of dredged or fill material into waters of the United States. The aforementioned intermittent drainage was found to be jurisdictional because it was tributary to the Elm River. The wetlands along State Line Road are isolated basins that were found to be jurisdictional because they are interstate waters.

The standard conditions applicable to NWPs 12 and 33 respectively require that: (1) temporary fill be removed and affected area restored to pre-construction conditions within three months of placement and (2) areas affected by trenching and backfilling during installation of underground utility lines be restored to pre-construction conditions.

Compliance

During in-field monitoring, Westwood staff visited each of the locations where activities regulated by the USACE were to occur. Based on site observations, the crane crossing of the unnamed intermittent drainage between turbines ND03 and ND04 was accomplished without the use of temporary fill so no removal of such fill was required. As depicted in **Photo 8** in Appendix B, the crane crossing was accomplished during dry conditions in a manner that generated no impacts (likely using construction mats). The underground collector cables along the north side of State Line Road were installed within the road embankment and also avoided any impacts to wetlands. Again, because wetland impacts were avoided in their entirety in this location, no post-installation restoration of wetlands was necessary. **Photo 9** in Appendix B provides documentation of current conditions along the applicable portion of State Line Road.

Conclusions and Recommendations

The contractor was able to totally avoid wetland impacts in the two locations covered by the USACE NWPs. No corrective actions or follow up efforts appear to be required.

6.0 SWPPP AND NPDES PERMITS

Permit Requirements

North and South Dakota each have General Permits for Storm Water Discharges under the National Pollutant Discharge Elimination System (NPDES) program for each state. In accordance with those general permits, individual Storm Water Pollution Protection Plans (SWPPPs) were prepared for the North and South Dakota portions of TWF. These SWPPPs were prepared by HDR Engineering, Inc. and implemented by M. A. Mortenson Construction, the general contractor on the TWF project.

The General NPDES Storm Water Permits for both states that were in place at the time TWF was constructed have expired. North Dakota has reissued its General Permit, effective October 12, 2009. South Dakota has reissued a draft General Permit which will be finalized in November or December 2009. Both permits require that a Notice of Termination (NOT) be filed upon completion of construction and after final stabilization of all disturbed soils has been accomplished. Except on cropland, stabilization is not considered complete until 70 percent vegetative coverage has been achieved as compared to pre-existing vegetation and all temporary erosion control measures have been removed. Cropland needs to be successfully returned to agricultural use to be considered stabilized. The SWPPPs for the portions of the project in each state both indicated that the pre-existing vegetative cover in the areas being disturbed was 100 percent. We believe that this percentage is conservative and that pre-construction vegetative cover was less than 100 percent in some areas. But assuming 100 percent pre-construction coverage, 70 percent vegetative cover would be required on all disturbed soils for the site to be considered stabilized and eligible for the filing of NOTs.

Compliance

Because this compliance review was done post-construction, we did not attempt to determine SWPPP compliance before and during the construction period (i.e. inspections, maintenance of temporary erosion control measures, etc.). However, the remnant erosion and sedimentation control measures we observed at the time of the compliance field review appeared to be in conformance with SWPPP requirements as to their types and locations. None of these measures remain functional. Virtually all silt fences are down and most erosion control blankets we observed was substantially degraded and/or blown away. Erosion control blankets were used on steep slopes and road cuts. Some steeper areas where erosion control blankets were used remain unvegetated due to a lack of topsoil (see **Photo 10** in Appendix B).

It is our understanding that NOTs have not been filed and that the NPDES permits for the project have been extended. Based on our field observations, final stabilization has not been achieved across the TWF project site and filing of NOTs should be delayed until final stabilization has been achieved. As discussed above, many areas have not achieved 70 percent vegetative cover, due primarily to insufficient topsoil. Also, the remnants of temporary erosion control measures remain in place but are non-functional. Despite the non-functionality of remnant erosion control

measures, we observed little erosion and sedimentation on the TWF site. We did observe a few hill cuts on access roads where minor gully erosion had begun in the ditches and sediment plumes had formed (see **Photos 11** and **12** in Appendix B). In most such locations, the contractor or O & M staff had placed rock check dams or linear lines of boulders to retard flow and trap sediment (see **Photos 13** and **14**, respectively, in Appendix B). The boulder lines appeared to be of some benefit but should be built up with additional rock and supplemented with check dams running perpendicular to the direction of flow. Access roads were underlain with geotextile fabric at the time of construction. We observed one location adjacent to Turbine ND 20 where erosion had exposed the underlying fabric. Additional gravel should be applied in this area to reestablish cover over the fabric. As previously stated, none of the erosion or sedimentation issues described above have allowed any impacts to be incurred within waters of the state.

We observed no NPDES issues on temporarily disturbed areas located on cropland. All cropland areas had been properly restored to agricultural use.

Conclusions and Recommendations

The biggest NPDES compliance issue we observed was the inadequacy of vegetative cover due to lack of topsoil. Upon determining that use of a compost and seed mixture is successful on USFWS grassland easement lands, we recommend that the same procedures be applied in other grassland areas of TWF where 70 percent native cover has not been achieved. Once 70 percent cover has been achieved on all native grasslands on the project, NOTs should be filed with the states of North and South Dakota.

7.0 SUMMARY OF RECOMMENDATIONS

1. All permits and licenses obtained for the TWF transmission line should be compiled and a copy of each sent to Jerry Lein at the ND PSC.

2. During the 2010 growing season, a 2 inch layer of compost should be applied to temporarily disturbed areas of USFWS grassland easement land where inadequate topsoil is preventing successful re-vegetation. After compost application, the treated areas should be seeded, fertilized and mulched as described earlier in this report. These areas should be re-visited at the end of the 2010 growing season to confirm successful re-vegetation.

3. If the re-vegetation method used on USFWS grassland easement lands is successful, it should be applied to non-easement grasslands where similar topsoil problems exist.

4. Noxious weed control efforts should be intensified using at least two annual rounds of spot spraying with Glyphosate and/or Picloram as applicable to the species listed in Appendix D. County extension specialists should be consulted by O & M staff to obtain their input on herbicide selection, application rates and timing.

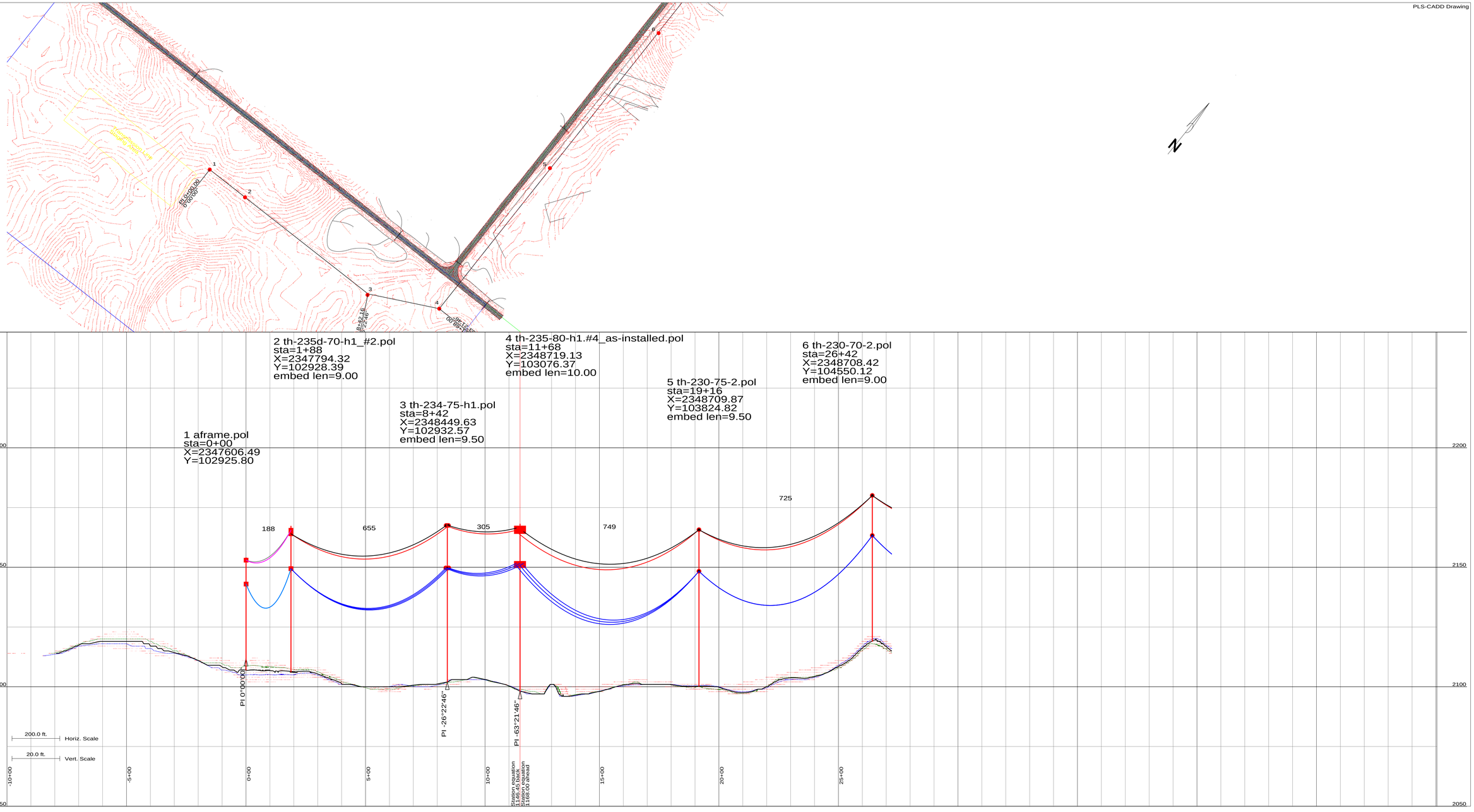
5. Temporary cattle exclusion should be considered and coordinated with underlying landowners if excessive grazing of planted prairie vegetation is observed.

6. Fence posts demarcating cultural resource sites should be left in place to facilitate ongoing impact avoidance.

7. Locations along access roads where boulder lines have been used to minimized gully erosion should be reinforced with rock check dams running perpendicular to the direction of flow.

8. Upon successful re-vegetation of native grasslands (i.e. 70 percent ground cover), NOTs should be prepared and submitted to the states of North and South Dakota to close out the NPDES permit process.

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PROJECT MANAGER	Bill Barnhart
PROJECT NUMBER	48069

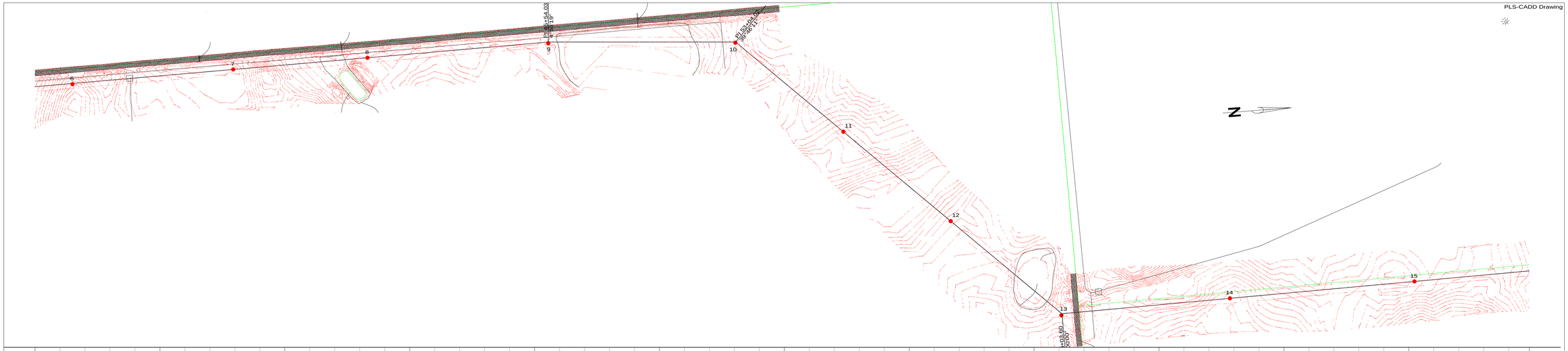
MORTENSON

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TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

SCALE: SEE ABOVE

SHEET
PP-1



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PROJECT MANAGER	Bill Barnhart
PROJECT NUMBER	48069

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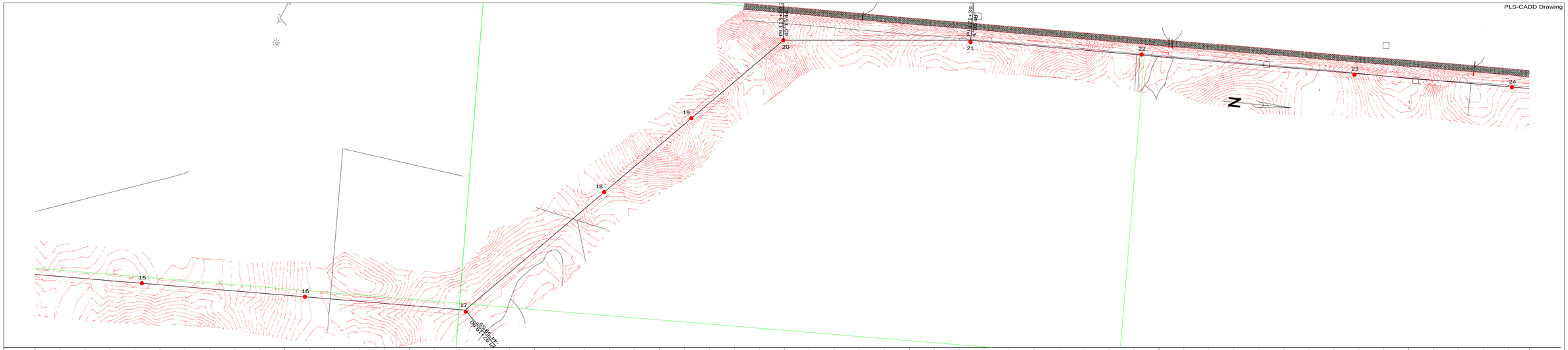
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TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

SCALE: SEE ABOVE

SHEET
PP-2



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PROJECT MANAGER	Bill Barnhart
PROJECT NUMBER	48069

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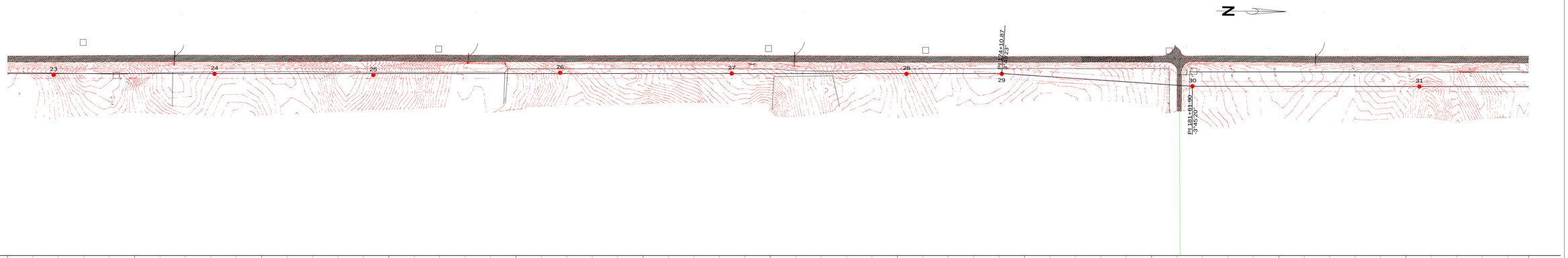
TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

SCALE: SEE ABOVE

SHEET
PP-3

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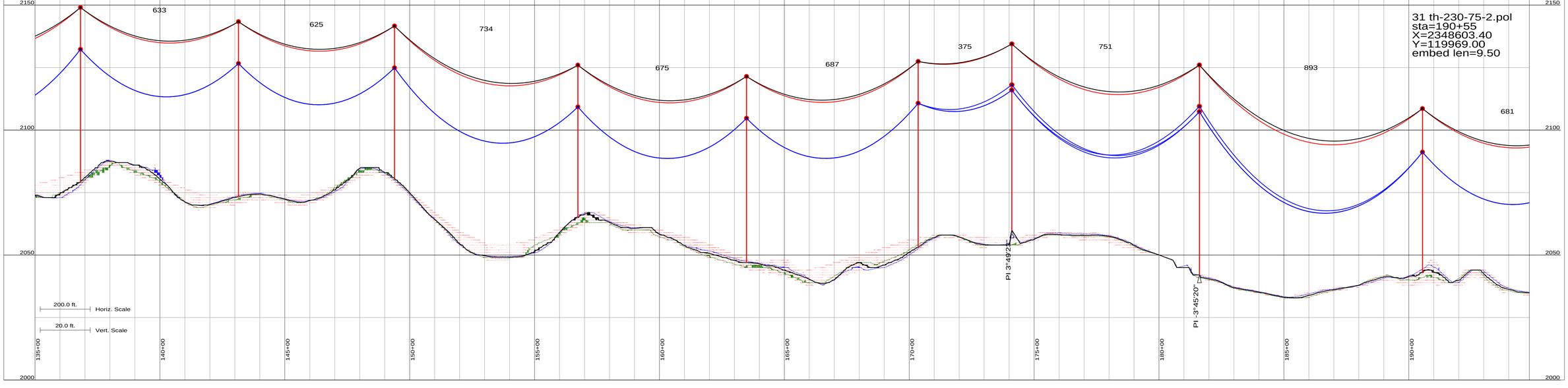
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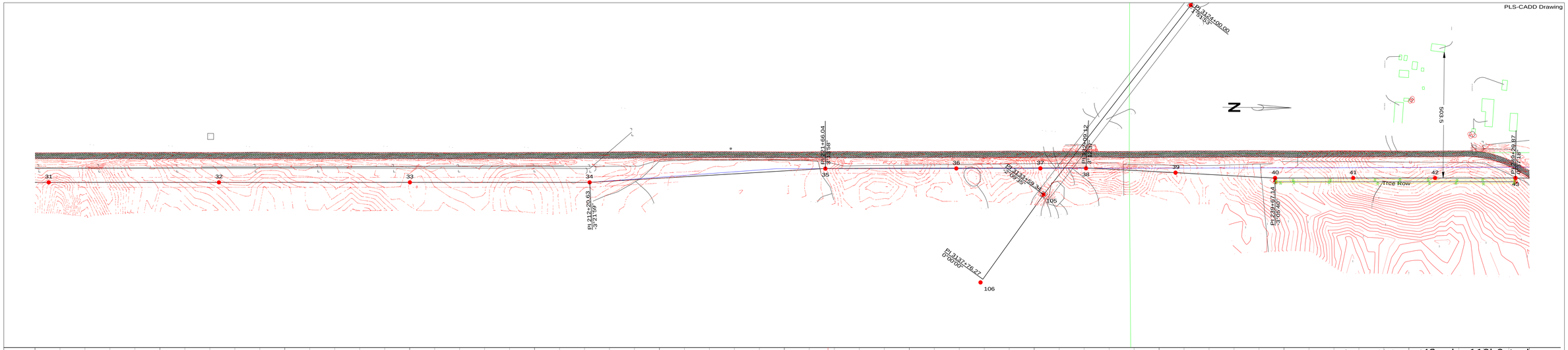
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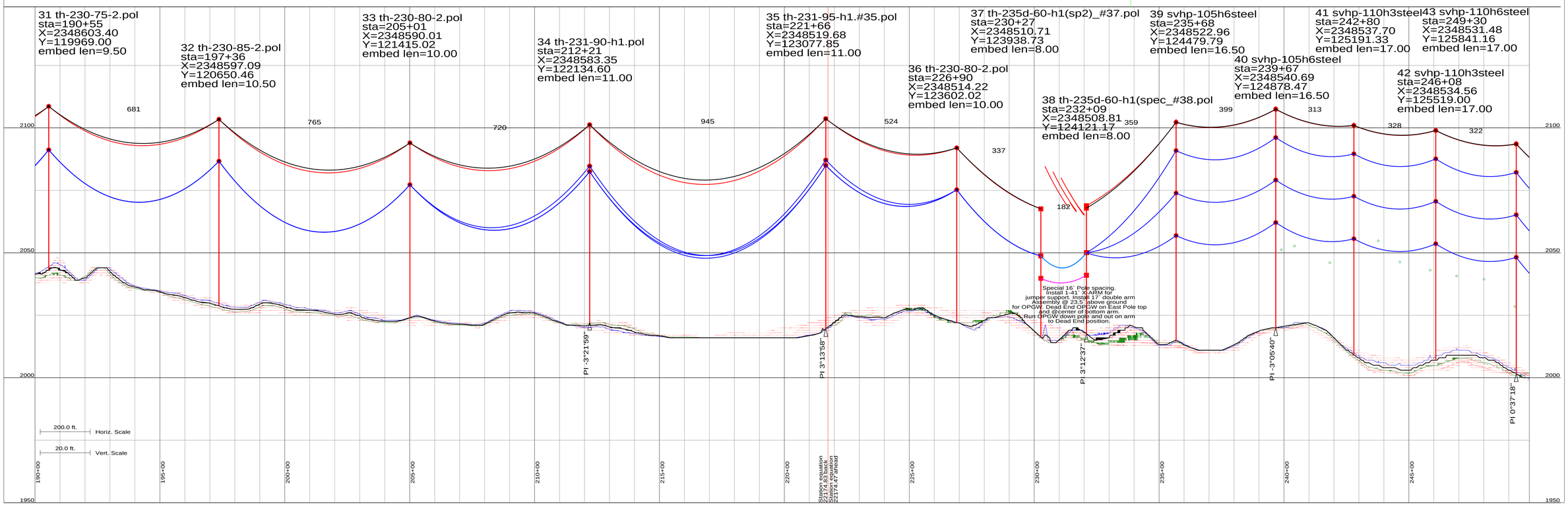
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NORTH DAKOTA

TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

SCALE: SEE ABOVE

SHEET
PP-4





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PROJECT NUMBER	48069

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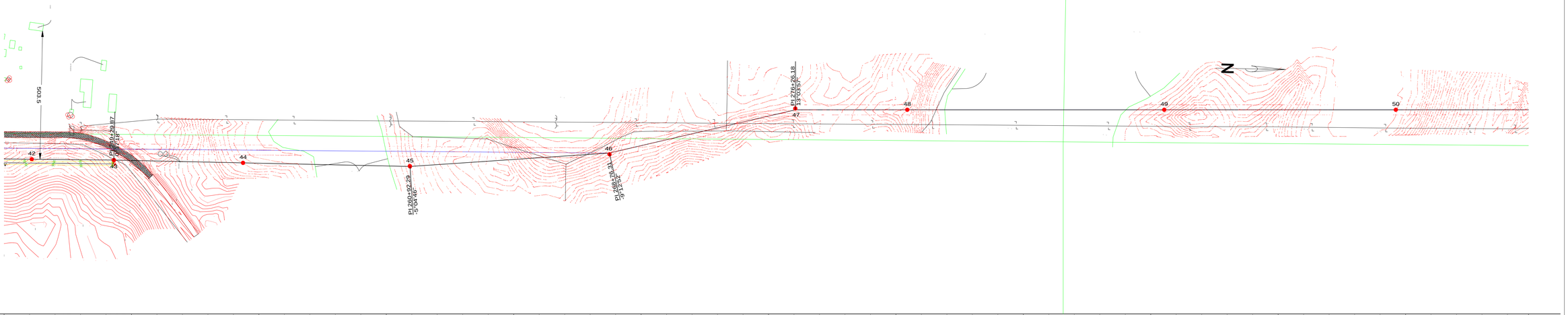
TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

SCALE: SEE ABOVE

SHEET
PP-5

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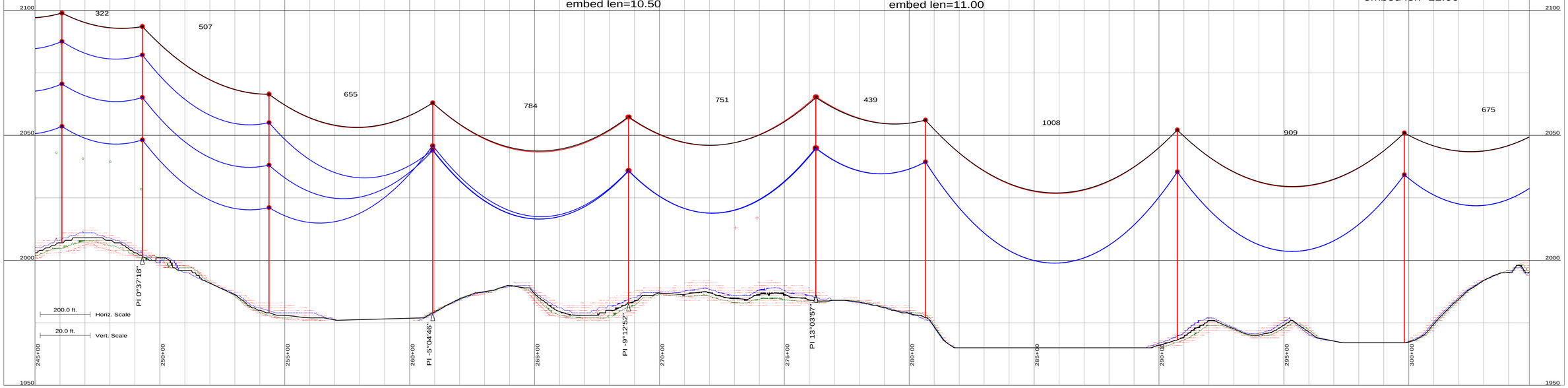
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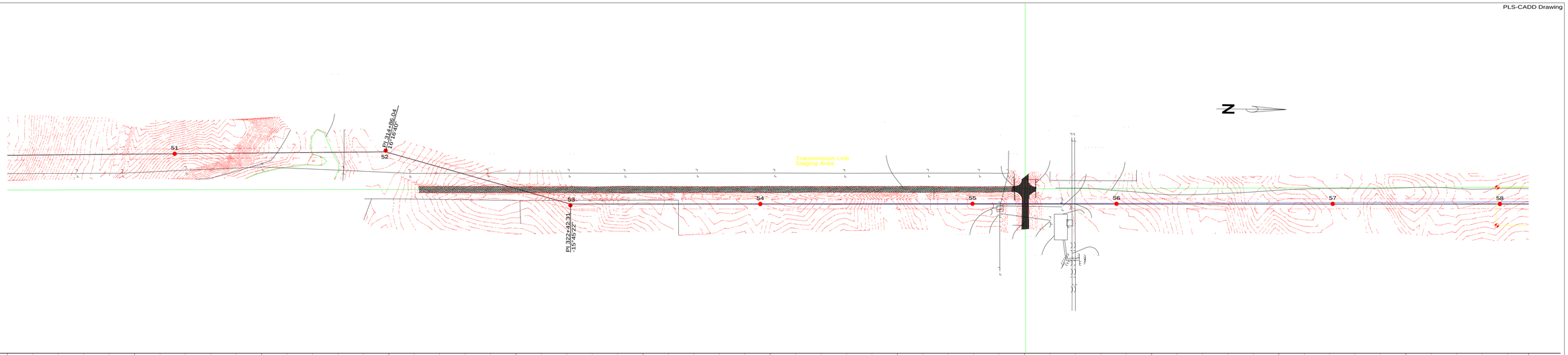
TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

SCALE: SEE ABOVE

SHEET
PP-6

PLS-CADD Drawing



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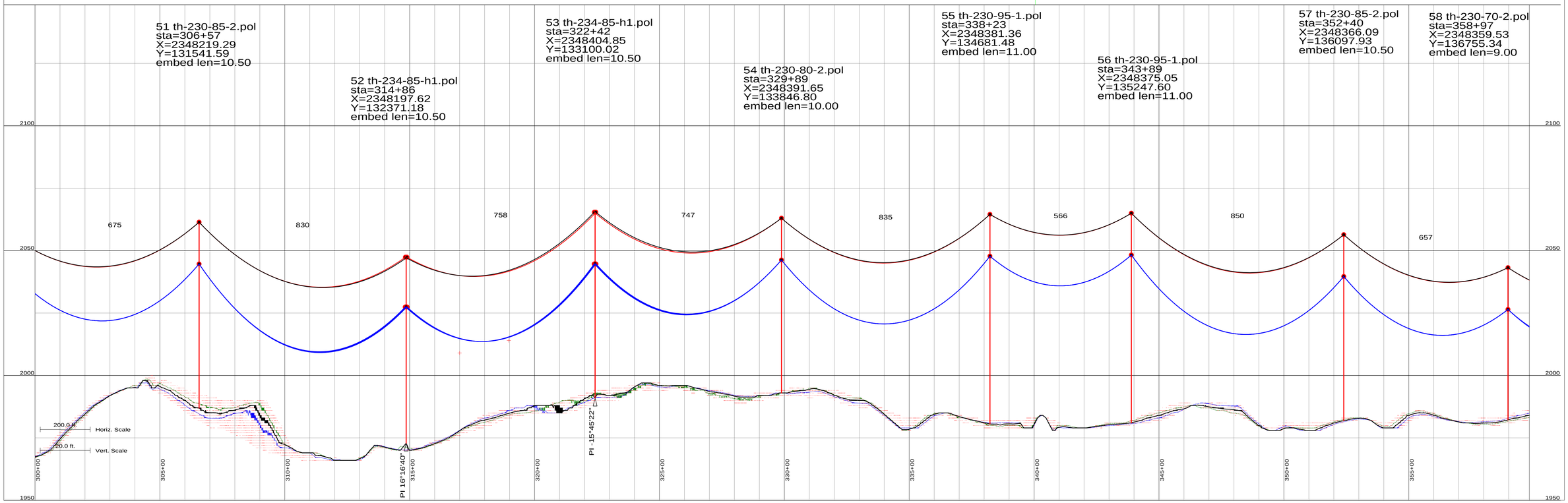
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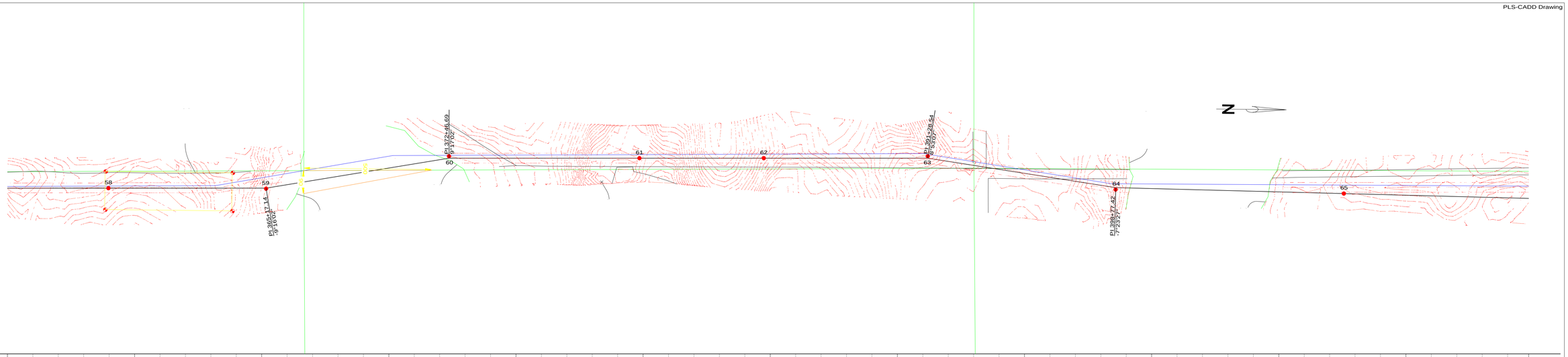
TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

SCALE: SEE ABOVE

SHEET
PP-7

PLS-CADD Drawing



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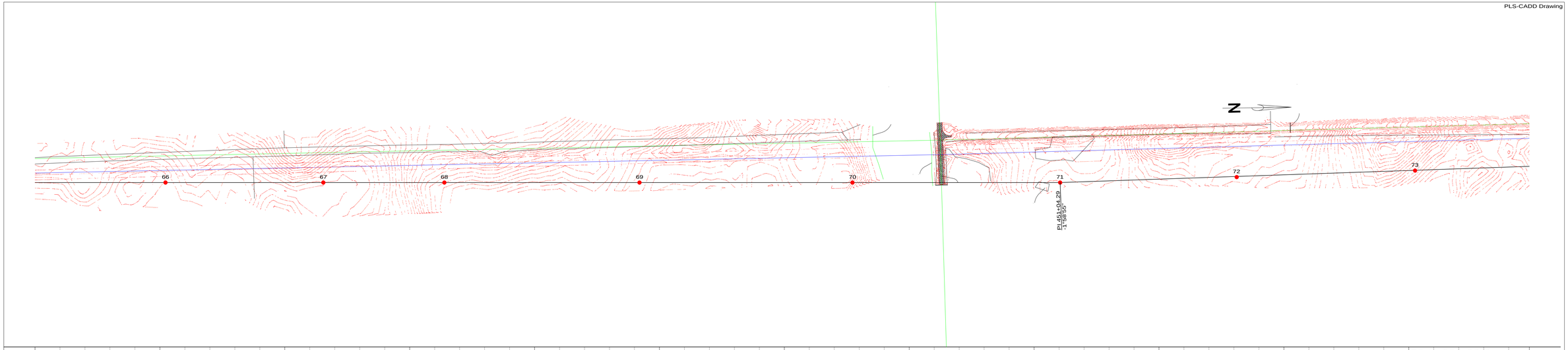
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TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

SCALE: SEE ABOVE

SHEET
PP-8



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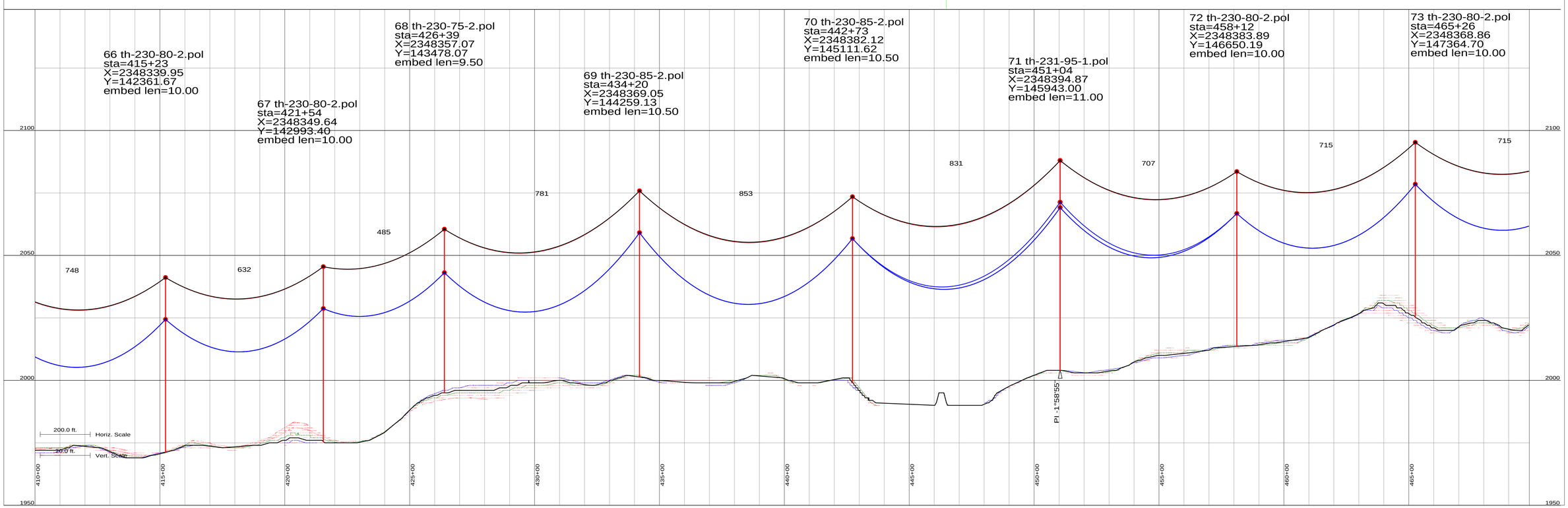
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PROJECT MANAGER	Bill Barnhart
PROJECT NUMBER	48069

MORTENSON

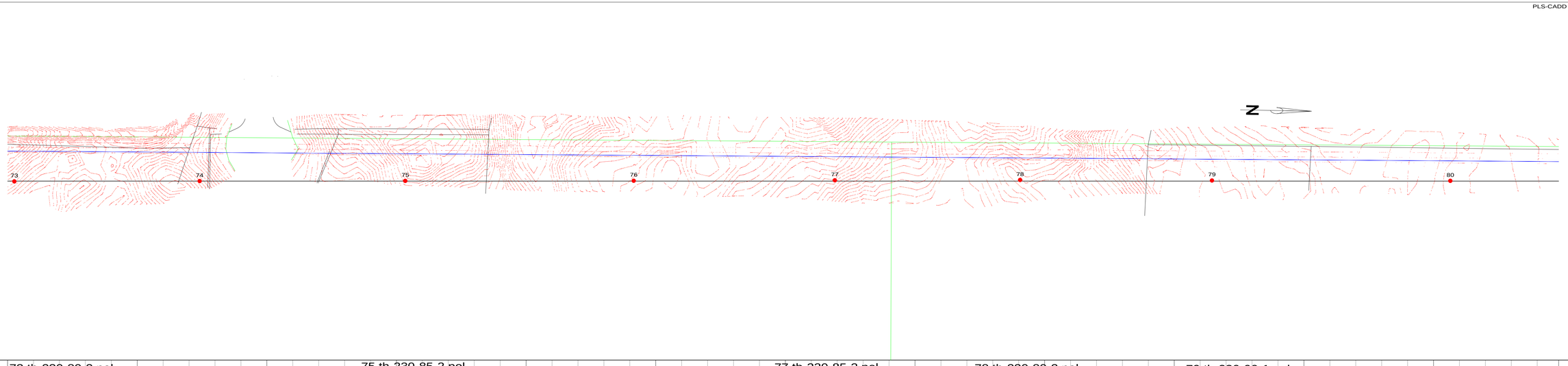
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TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

SCALE: SEE ABOVE

SHEET
PP-9

PLS-CADD Drawing



HDR Engineering, Inc.

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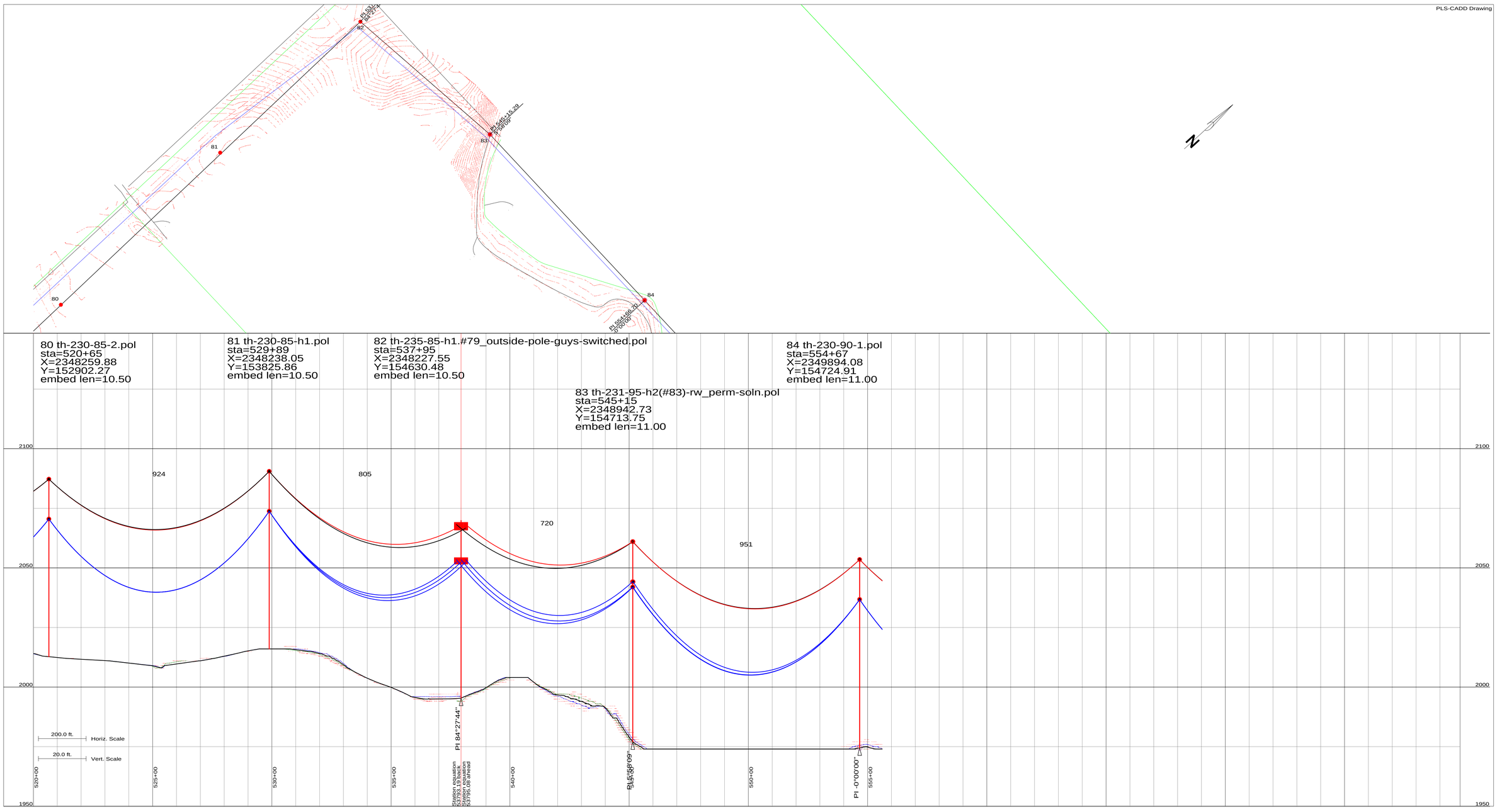
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NORTH DAKOTA

TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

SCALE: SEE ABOVE

SHEET
PP-10



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230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

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PLS-CADD Drawing

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20.0 ft. Vert. Scale

2100 2050 2000 1950

555+00 560+00 565+00 570+00 575+00 580+00 585+00 590+00 595+00 600+00 605+00 610+00

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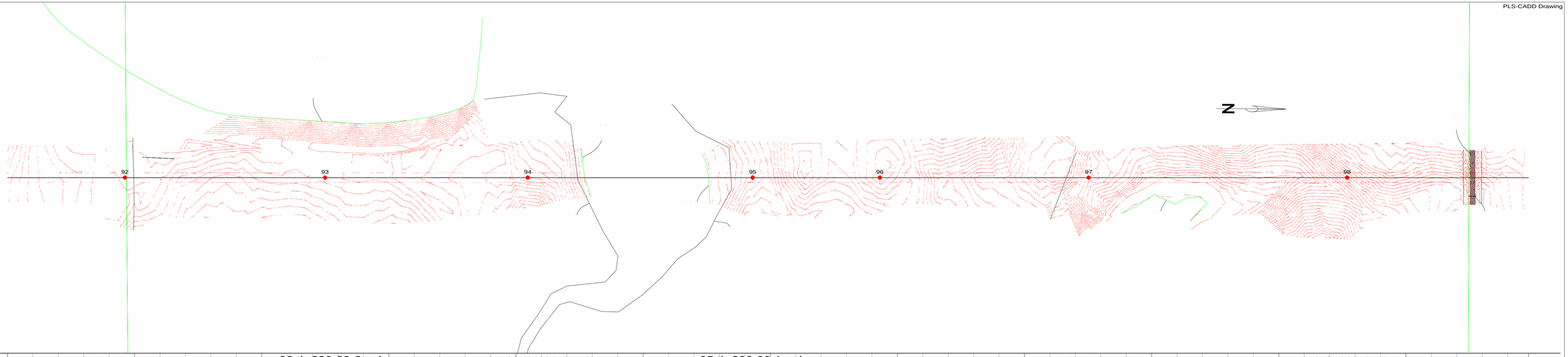
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NORTH DAKOTA

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230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

SCALE SEE ABOVE

SHEET
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PLS-CADD Drawing



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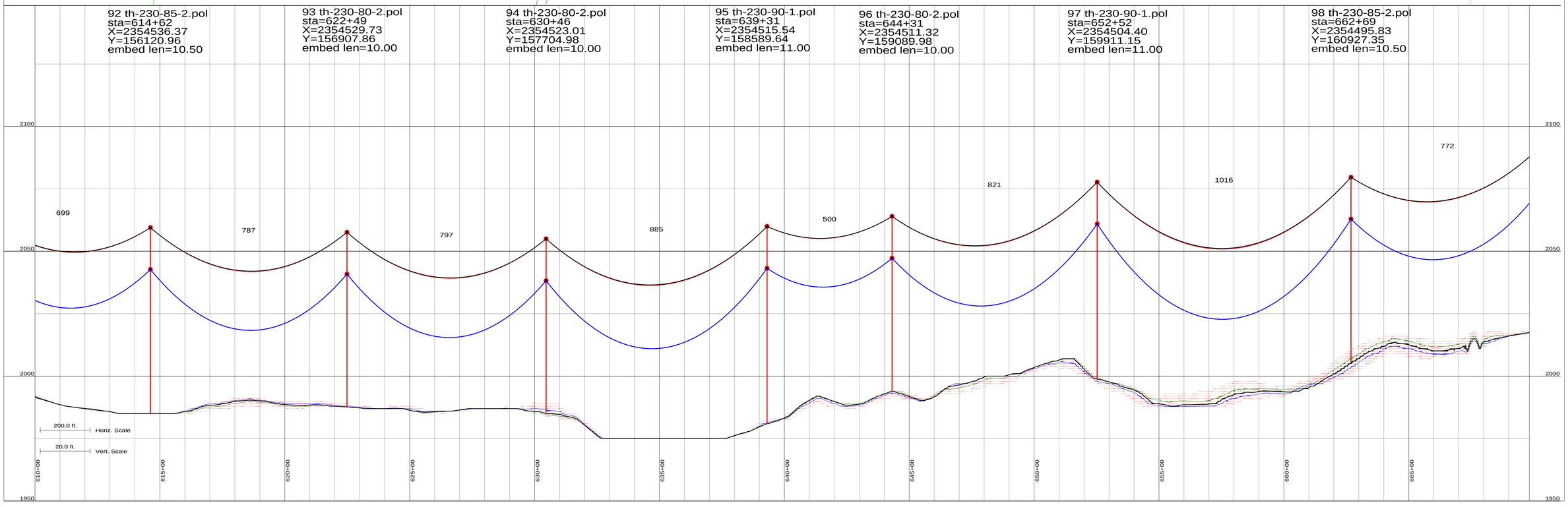
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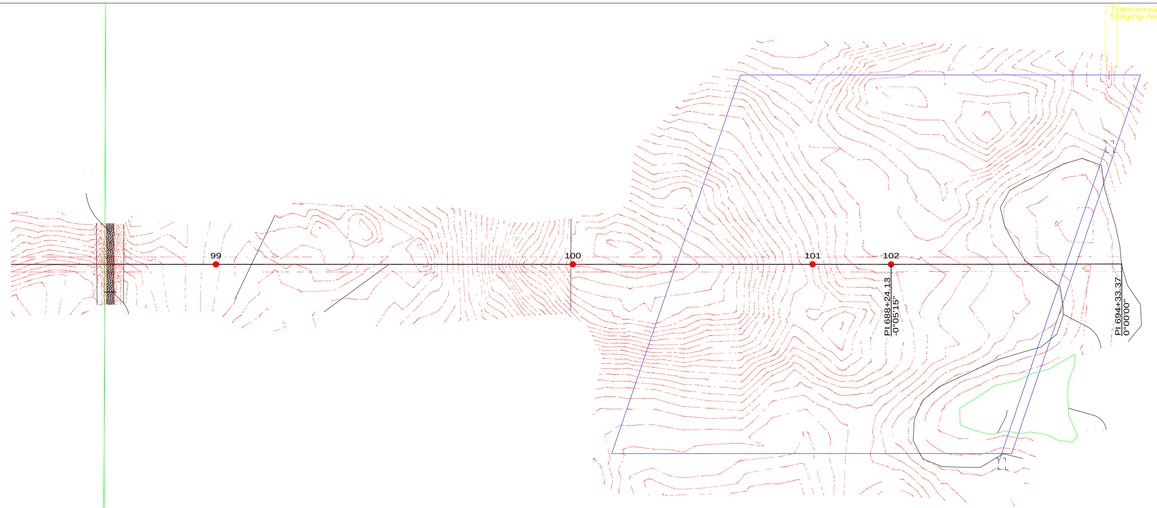
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NORTH DAKOTA

TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

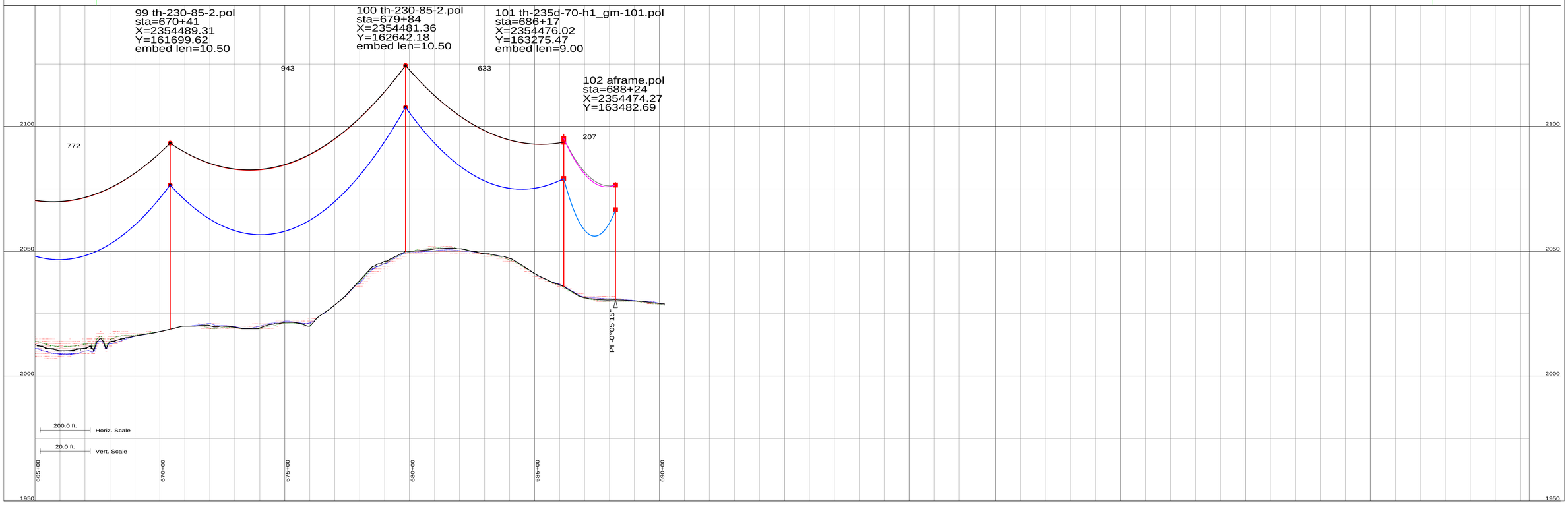
SCALE: SEE ABOVE

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PLS-CADD Drawing





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TATANKA WIND FARM
230kV TRANSMISSION LINE
PLAN AND PROFILE DRAWINGS

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TATANKA WIND FARM

230kV TRANSMISSION LINE

PROJECT DESIGN CRITERIA

1. Project Description

This document describes the technical design criteria for the project and is subject to change with approval from the client.

This project consists of the design of a new 230 kV transmission line thirteen miles in length.

2. Codes and Standards

The design will comply with the requirements of the codes and standards of the National Electrical Safety Code, 2002 Edition and the Rural Utilities Service Bulletin 1724E-200. Where this Design Criteria document differs from the NESC or RUS, this document will govern the design.

3. Supporting Structures

The line shall be constructed using RUS wood H-frame family of structures. The tangent structures will be directly embedded 10% of the pole length plus 2 feet. There are six single steel pole direct embedded tangent structures buried 10% plus 6 feet.

4. Loading Criteria – Grade B Construction

NESC Heavy Loading – Rule 250B

- 0.5 inch radial ice (density 57 lbs/cubic foot)
- 4 psf wind (39.5 mph)
- 0° F, Initial
- Constant K = 0.30 lb/ft

NESC Extreme Wind Loading – Rule 250C

- No ice
- 20.7 psf wind (90 mph)
- 60° F, Initial

5. Conductors

230 kV Transmission Circuit

- T2 - 397.5 kcmil 26/7 ACSR
- Code Name “T2-Ibis”

- Weight: 1.094 lbs/ft.
- Diameter: 1.282 in.
- Rated Tensile Strength (RTS): 32,600 lbs

OHGW

- 3/8" x 7 Strand EHS
- Weight: 0.273 lbs/ft
- Diameter: 0.360 in.
- Rated Tensile Strength (RTS): 15,400 lbs

OPGW

- Fiber AC57/465
- Weight: 0.3 lbs/ft per wire
- Diameter: 0.465 in.
- Rated Tensile Strength (RTS): 16,214 lbs

6. Guys

Guying

- 3/8" EHS 7 Strand Steel
- Rated Tensile Strength (RTS): 15,400 lbs
- Diameter: 0.360"

7. Tension Criteria

1) Conductor

- NESC Heavy loading 50%
- -20° F, initial, no ice, no wind 25%

2) OHGW

- Tension sagged to 80% of the final conductor sag at 60°F

3) OPGW

- Tension sagged to 80% of the final conductor sag at 60°F

8. Air-Gap Criteria

Phase to Structure

- 60° F final, no wind = 71"
- 60° F initial, 6psf wind = 50"
- 60°F final, 12.5psf wind = 20"

9. Clearances

The vertical design clearances shall be based on the transmission conductor's final sag at the maximum design operating temperature (194°F, final) or at the NESC loaded condition, whichever produces the greater sag.

Minimum Design Clearances*

	230kV
• Ground Clearance	24.9 ft
• Over state highways	24.9 ft
• Over railroad tracks	32.9 ft

*Vertical Clearances per RUS Bulletin 1724E-200.

Minimum Design Clearances*

	230kV
• Phases of the same circuit	9.6 ft
• Phase conductors & overhead ground wires	6.4 ft

*Clearance based on RUS Table 6-1- recommended vertical separation between phases on the same structure.

This transmission line was designed based on the RUS Bulletin 1724E-200. Figure E-1 of the RUS bulletin shows the line location in the .5" ice & 60mph wind loading area. There was no additional ice loading applied to the design of the transmission line.

Tatanka Wind Energy

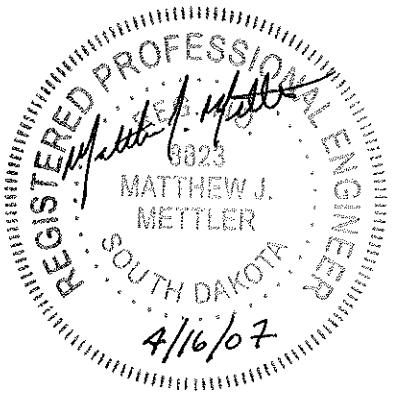
Project Substation

Erection Specification

REV 0: ISSUE FOR CONSTRUCTION

April 13, 2007





TATANKA WIND ENERGY PROJECT SUBSTATION

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03348 CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS
03350 TESTING

DIVISION 5 – METALS

05120 STRUCTURAL STEEL

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

07900 JOINT SEALANTS

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10444 SIGNAGE

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16600 FENCE
16721 SINGLE MODE FIBER OPTIC CABLE

SECTION 03108
FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Formwork requirements for concrete construction.

B. Related Sections include but are not necessarily limited to:
1. Section 03311 - Concrete Mixing, Placing, Jointing, and Curing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. American Concrete Institute (ACI):
   a. 116R, Cement and Concrete Terminology.
   b. 347R, Guide to Formwork for Concrete.
2. Building code:
   a. International Code Council (ICC):
      1) International Building Code and associated standards, 2003 Edition including all amendments, referred to herein as Building Code.

B. Miscellaneous:
1. Design and engineering of formwork, as well as its construction is the responsibility of the Contractor.
2. Design requirements:
   a. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code.
      1) Where conflicts occur between the above two standards, the more stringent requirements shall govern.
   b. Design formwork to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.
3. For slabs not cast on the ground, develop a procedure and schedule for removal of shores and for calculating the loads transferred to the structure during this process.
   a. Perform structural calculations as required to prove that all portions of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus the loads placed thereon.
   b. When developing procedure, schedule and structural calculations, consider the following at each stage of construction:
      1) The structural system that exists.
      2) Effects of all loads during construction.
      3) Strength of concrete.
      4) The influence of deformations of the structure and shoring system on the distribution of dead loads and construction loads.
      5) The strength and spacing of shores or shoring systems used, as well as the method of shoring, bracing, shore removal, and reshoring including the minimum time intervals between the various operations.
      6) Any other loading or condition that affects the safety or serviceability of the structure during construction.

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer and type of proposed form materials.
      d. Manufacturer and type of proposed form ties.
      e. Manufacturer and type of proposed form coating material.

B. Samples:
   1. A 12 IN SQ sample of each of the following form finishes:

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Stay-in-place forms:
      a. Alabama Metal Industries Corporation.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Forms for Surfaces Exposed to View:
   1. Wood forms:
      a. New 5/8 or 3/4 IN 5-ply structural plywood of concrete form grade.
      b. Built-in-place or prefabricated type panel.
      c. 4 x 8 FT sheets for built-in-place type except where smaller pieces will cover entire area.
      d. When approved, plywood may be reused.
   2. Metal forms:
      a. Metal forms excluding aluminum may be used.
      b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.

2.3 ACCESSORIES

A. Form Ties:
   1. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
   2. 3/4 IN minimum to 1 IN maximum diameter cones on both ends.
   3. Embedded portion of ties to be not less than 1-1/2 IN from face of concrete after ends have been removed.

B. Stay-In-Place Forms:
   1. Ribbed expanded metal leave-in-place concrete forms commercially fabricated to provide an intentionally rougher surface.
   2. Hot-dipped galvanized.
   3. Similar to "Stay-Form" by Alabama Metal Industries Corporation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Form Surface Treatment:
   1. Before placing of either reinforcing steel or concrete, cover surfaces of forms with an approved coating material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
      a. A field applied form release agent or sealer of approved type or a factory applied nonabsorptive liner may be used.
   2. Do not allow excess form coating material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

B. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.
   1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 5 FT apart.

C. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.2 ERECTION

A. Install products in accordance with manufacturer's instructions.

B. Tolerances:
   1. Variation from plumb:
      a. In lines and surfaces of columns, piers, walls, and in risers.
         1) Maximum in any 10 FT of height: 1/4 IN.
         2) Maximum for entire height: 1/2 IN.
      b. For control-joint grooves, and other exposed to view lines:
         1) Maximum in any 20 FT length: 1/4 IN.
         2) Maximum for entire length: 1/2 IN.
   2. Variation from level or from grades specified:
      a. In slab, measured before removal of supporting shores.
         1) Maximum in any 10 FT of length: 1/4 IN.
         2) Maximum in any bay or in any 20 FT length: 3/8 IN.
         3) Maximum for entire length: 3/4 IN.
      b. In exposed horizontal grooves, and other exposed to view lines:
         1) Maximum in any bay or in 20 FT length: 1/4 IN.
         2) Maximum for entire length: 1/2 IN.
   3. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 IN.
   4. Variation in thickness of slabs: Maximum of -1/4 IN, +1/2 IN.
   5. Footings and foundations:
      a. Variations in concrete dimensions in plan: -1/2 IN, +2 IN.
      b. Misplacement or eccentricity:
         1) 2 percent of footing width in direction of misplacement but not more than 2 IN.
      c. Thickness:
         1) Decrease in specified thickness: 5 percent.
         2) Increase in specified thickness: No limit except that which may interfere with other construction.

6. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and bench marks to be used for reference purposes to check tolerances.
7. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.
8. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.

C. Make forms sufficiently tight to prevent loss of mortar from concrete.

D. Place 3/4 IN chamfer strips in exposed to view corners of forms to produce 3/4 IN wide beveled edges.

E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 IN.
1. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
2. Where possible, locate juncture of built-in-place wood or metal forms at control joints or at construction joints.

F. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.

G. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.

H. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.

I. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.
1. Securely brace forms against lateral deflection.
2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

J. Stay-In-Place Forms:
1. Support stay-in-place forms as required to maintain the formwork in proper position.
2. Hold the edge of stay-in-place forms back a minimum of 2 IN from all smooth formed concrete surfaces.
3. Stay-in-place forms may be used at the Contractor's option at:
   a. Surfaces that will be backfilled with soil. Maintain a minimum of 3 IN of concrete cover over all reinforcing.
   b. Roughened construction joints.
   c. Other locations approved by Engineer.

3.3 REMOVAL OF FORMS

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads places thereon.

B. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.

1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Section 03311.

D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.

E. Formwork for parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

F. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28-day compressive strength.
   1. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

3.4 RESHORING

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.

B. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.

C. During reshoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs.

E. Tighten reshores to carry their required loads without overstressing.

F. Shoring, reshoring and supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. For floors supporting shores under newly placed concrete leave original supporting shores in place or reshore.
   1. Reshoring system shall have a capacity sufficient to resist anticipated loads.
   2. Locate reshores directly under a shore position above.

H. In multi-story buildings, extend reshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads in such a manner that design superimposed loads of floors supporting shores are not exceeded.

END OF SECTION

SECTION 03208
REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforcing bar requirements for concrete construction.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. SP-66, ACI Detailing Manual.
      b. 318, Building Code Requirements for Structural Concrete.
   2. ASTM International (ASTM):
      a. A185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
      b. A497, Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
      c. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement (Including Supplementary Requirements S1).
      d. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
      e. A775, Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
   3. American Welding Society (AWS):
      a. D1.4, Structural Welding Code - Reinforcing Steel.
   4. Concrete Reinforcing Steel Institute (CRSI):
      a. Manual of Standard Practice.

B. Qualifications:
   1. Welding operators, processes and procedures to be qualified in accordance with AWS D1.4.
   2. Welding operators to have been qualified during the previous 12 months prior to commencement of welding.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Mill certificates for all reinforcing.
      d. Manufacture and type of proprietary rebar mechanical splices.
      e. Manufacturer and type of rebar adhesive anchor including installation instructions.
   2. Qualifications of welding operators, welding processes and procedures.
   3. Rebar number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and rebar supports.
   4. Sufficient rebar details to permit installation of reinforcing.
   5. Rebar details in accordance with ACI SP-66.
   6. Locations where proprietary rebar mechanical splices are required or proposed for use.
   7. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.

a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Support and store all reinforcing above ground.

B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

C. Handling of Epoxy-Coated Rebar:
   1. Use padded or nonmetallic slings and padded straps to protect coated reinforcement from damage.
   2. Handle bundled bars to prevent sagging that could damage the coating.
   3. Do not drop or drag rebars.
   4. Store on wooden cribbing.
   5. Coated rebars subject to rejection by Engineer if rebar coating has been damaged.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

A. Subject to compliance with Contract Documents, the following Manufacturers are acceptable:
   1. Rebar adhesive anchors:
      a. HIT-HY150 System by HILTI FASTENING SYSTEMS, INC.
      b. Epcon Adhesive Anchoring System by ITW Ramset/Red Head.
      c. Power-Fast by Powers Fastening, Inc.
   2. Rebar mechanical splices:
      a. Lenton Rebar Splicing by Erico, Inc.
      b. Richmond dowel bar splicer system by Richmond Screw and Anchor Co., Inc.
      c. Bar-Grip Systems by Barsplice Products, Inc.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Reinforcing Bars: ASTM A615, grade 60, deformed.

B. Reinforcing Bars to be Welded: ASTM A706.

C. Welded Wire Fabric: ASTM A185 or ASTM A497.

D. Smooth Dowel Bars: ASTM A615, grade 60 with metal end cap to allow longitudinal movement equal to joint width plus 1 IN.

E. Epoxy-Coated Rebars: ASTM A775 and A615, Grade 60, meeting Annex A1 for epoxy coating.

F. Epoxy-Coated Rebar Patching Material:
   1. Compatible with the coating material.
   2. Inert in concrete.
   3. Meet requirements of Annex A1 of ASTM A775.
   4. Obtained from the manufacturer of the epoxy resin that was used to originally coat the rebars.

G. Proprietary Rebar Mechanical Splices: To develop in tension and compression a minimum of 125 percent of the yield strength of the rebars being spliced.

H. Welding Electrodes:
1. E90 meeting requirements of AWS D1.4.

I. Rebar Adhesive Anchors:
1. Manufactured for the specific purpose of embedding and developing the yield strength of rebars in hardened concrete.

2.3 ACCESSORIES

A. Metal Chairs, Runners, Bolsters, Spacers, Hangers, and Other Rebar Supports:
1. Plastic-coated tips in contact with forms.
2. Plastic coating meeting requirements of CRSI Manual of Standard Practice.

B. Protective plastic caps at mechanical splices.

2.4 FABRICATION

A. Tolerances:
1. Sheared lengths: +1 IN.
2. Overall dimensions of stirrups, ties and spirals: +1/2 IN.
3. All other bends: +0 IN, -1/2 IN.

B. Minimum diameter of bends measured on the inside of the rebar to be as indicated in ACI 318 Paragraph 7.2.

C. Ship rebars to jobsite with attached plastic or metal tags.
1. Place on each tag the mark number of the rebar corresponding to the mark number indicated on the Shop Drawing.
2. Mark numbers on tags to be so placed that the numbers cannot be removed.
3. For epoxy-coated rebars, use only plastic tags secured to rebars by nylon or plastic ties.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Tolerances:
1. Rebar placement:
a. Clear distance to formed surfaces: +1/4 IN.
b. Minimum spacing between bars: -1/4 IN.
c. Top bars in slabs:
1) Members 8 IN deep or less: +1/4 IN.
2) Members between 8 IN and 2 FT deep: -1/4 IN, +1/2 IN.
3) Members more than 2 FT deep: -1/4 IN, +1 IN.
d. Crosswise of members: Spaced evenly within +1 IN.
e. Lengthwise of members: +2 IN.
2. Minimum clear distances between rebars:
a. Slabs: Distance equal to rebar diameter, maxiumum aggragate size or 1 IN, whichever is greater.
b. Slab rebars shall be threaded through the slab vertical rebars without displacing the slab vertical rebars and still maintaining the clear distances required for the slab rebars.

B. Minimum concrete protective covering for reinforcement: As shown on Drawings.

C. Unless indicated otherwise on Drawings, provide splice lengths for reinforcing as follows:
1. For rebars: Class B splice meeting the requirements of Paragraph 12.15 of ACI 318.

2. For welded wire fabric: Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than 1 spacing of cross wires plus 2 IN, nor less than 1.5 x development length nor less than 6 IN. Development length shall be as required for the yield strength of the welded wire fabric in accordance with Paragraph 12.8 of ACI 318.
3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Drawings.

D. Welding:
1. Obtain approval by the Engineer prior to welding reinforcing.
2. Perform welding of rebars in accordance with requirements of AWS D1.4.
3. Have each welder place an approved identifying mark near each completed weld.

E. Placing Rebars:
1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.
2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM specification that governs for the rebar supplied.
3. Rebar support:
   a. Uncoated rebar:
      1) Support rebars and fasten together to prevent displacement by construction loads or placing of concrete.
      2) On ground, provide supporting concrete blocks or metal bar supports with bottom plate.
         a) Do not use concrete blocks to support slab-on-grade reinforcing.
      3) Over formwork, provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other rebar support. Only tips in contact with the forms need to be plastic coated.
   b. Coated rebar:
      1) Support coated rebars and fasten together to prevent displacement.
      2) Use plastic or nylon ties to hold rebars rigidly in place.
      3) Support rebars by use of plastic or plastic-coated chairs, runners, bolsters, spacers, hangers and rebar supports as required.
4. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, rebars in the upper layers shall be placed directly above rebars in the bottom layer with clear distance between layers to be 1 IN. Place spacer rebars at 3 FT maximum centers to maintain the required 1 IN clear distance between layers.
5. Extend reinforcement to within 2 IN of concrete perimeter edges. If perimeter edge is formed by earth or stay-in-place forms, extend reinforcement to within 3 IN of the edge.
6. To assure proper placement, furnish templates for all column vertical bars and dowels.
7. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer. Do not bend reinforcing by means of heat.
8. Do not tack weld reinforcing.
9. Embed rebars into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:
   a. Drill hole in concrete with diameter and depth as required to develop 125 percent of the yield strength of the bar according to manufacturer's requirements.
   b. Place adhesive in drilled hole.
   c. Insert rebar into hole and adhesive in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. Reinforcement Congestion and Interferences:
   1. Notify Engineer whenever the specified clearances between rebars cannot be met.
   2. Do not place any concrete until the Engineer submits a solution to rebar congestion problem.
   3. Rebars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
   4. If rebars are moved more than one bar diameter, obtain Engineer's approval of resulting arrangement of rebars.
   5. No cutting of rebars shall be done without written approval of Engineer.

B. Inspection of Epoxy-Coated Rebars:
   1. Coated rebars will be inspected on the jobsite for handling defects, coating abrasion, coating thickness and continuity of coating.
   2. Engineer may defer final inspection of rebar coating integrity and repairs until the rebars have been erected and all handling is completed.
   3. Repair coated areas as directed by Engineer. Do not place concrete until all repairs to coatings have been completed.

C. Patching of Epoxy-Coated Rebar:
   1. Patching and repair to be performed in accordance with the instructions of patching material manufacturer.
   2. Patching material to provide a minimum film thickness of 5 mils over the bare area. Thickness of area adjacent to patched area not to exceed 15 mils.
   3. Areas to be patched to be clean and free of surface contaminants. Treat areas in accordance with patching material manufacturer's instructions before oxidation occurs.
   4. Total surface area covered by patching material not to exceed 2 percent of total surface area of the rebar.
   5. Rebar welds and adjacent bare rebar areas to also be patched after welding is completed.

D. Employ a testing laboratory to perform and report following:
   1. Review and approve Contractor proposed welding procedures and processes for conformance with AWS D1.4.
   2. Qualify welders in accord with AWS D1.4.
   3. Test three samples of each bar size and each type of weld in accord with AWS D1.4. The tensile strength of each test shall be not less than 125 percent of the required yield strength of the rebar tested.
   4. Conduct nondestructive field tests (radiographic or magnetic particle) on not less than one random sample for each 10 welds. In addition if any welds are found defective, test five previous welds performed by same welder.
   5. Visually inspect each weld for presence of cracks, undercuts, inadequate size and other visible defects.

END OF SECTION

SECTION 03308
CONCRETE, MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete materials, strengths and proportioning for concrete work.
   2. Grouting:
      a. Base plates for columns and equipment.
      b. Dowels and anchors into concrete.
      c. Patching cavities in concrete.
      d. As specified and indicated in the Contract Document.

B. Related Sections include but are not necessarily limited to:
   1. Section 03350 - Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
      b. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
      c. 212.3R, Chemical Admixtures for Concrete.
      d. 318, Building Code Requirements for Structural Concrete.
      e. 350, Code Requirements for Environmental Engineering Concrete Structures.
   2. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
      c. C94, Standard Specification for Ready-Mixed Concrete.
      d. C150, Standard Specification for Portland Cement.
      e. C157, Standard Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete.
      f. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
      g. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
      h. C494, Standard Specification for Chemical Admixtures for Concrete.
      i. C595, Standard Specification for Blended Hydraulic Cements.
      j. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
   3. Corps of Engineers(COE):
      a. CRD-C621, Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (NonShrink).

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's instructions.
      c. Concrete mix designs as required by Section 03350.
      d. Manufacture and type of proposed admixtures.
      e. Manufacturer and type of proposed non-shrink grout and grout cure/seal compound.
   2. Certifications:
      a. Certification of standard deviation value in psi for ready mix plant supplying the concrete.
      b. Certification that the fly ash meets the quality requirements stated in this Section, and fly ash supplier's certified test reports for each shipment of fly ash delivered to concrete supplier.
      c. Certification that the class of coarse aggregate meets the requirements of ASTM C33 for type and location of concrete construction.
      d. Certification of aggregate gradation.
   3. Test reports: Cement mill reports for all cement to be supplied.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:
   1. Store cement and pozzolan in weathertight buildings, bins, or silos which will exclude moisture and contaminants.
   2. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
   3. Allow natural sand to drain until it has reached a relatively uniform moisture content before use.
   4. Store admixtures in such a manner as to avoid contamination, evaporation, or damage.
      a. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure thorough distribution of ingredients.
      b. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics and performance.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Non-shrink grout:
      a. BASF Admixtures, Inc.
      b. Euclid Chemical Company.
      c. U. S. Grout.
      d. Upco.
      e. Set Products, Inc.
      f. L & M Construction Chemicals, Inc.
      g. Sika Corporation
   2. Epoxy grout:
      a. Ceilcote.
      b. Exxon Chemical Company.
      c. Sika Corporation.
      d. U. S. Grout.

e. Euclid Chemical Company.

2.2 MATERIALS

A. Cement:
1. ASTM C150, Type II modified or Type V.
2. Cement type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

B. Fly Ash:
1. ASTM C618, Class F or Class C.
2. Non-staining.
3. Suited to provide hardened concrete of uniform light gray color.
4. Maximum loss on ignition: 4 percent.
5. Compatible with other concrete ingredients and having no deleterious effects on the hardened concrete.
6. Produced by source approved by the State Highway Department in the state where the project is located for use in concrete for bridges.
7. Cement and fly ash type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

C. Admixtures:
1. Air entraining: ASTM C260.
2. Water reducing, retarding, and accelerating: Conform to ASTM C494, Types A through E, and provisions of ACI 212.3R.
3. High range water reducers (superplasticizers): Conform to ASTM C494, Types F or G.
4. Admixtures to be chloride free.
   a. Do not use calcium chloride.
5. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.

D. Water:
1. Potable.
2. Clean and free from deleterious substances.
3. Free of oils, acids and organic matter.

E. Aggregates for Normal Weight Concrete:
1. ASTM C33.
2. Fine and coarse aggregates to be regarded as separate ingredients.
3. Fine aggregates to be natural, not manufactured.
4. Coarse aggregate sieve analysis:
   a. For lean concrete, concrete topping, and integral wearing course: ASTM C33, size number 7 (maximum 1/2 IN).
   b. For all other concrete: ASTM C33, size number 57 (maximum 1 IN).
5. Provide aggregates approved for bridge construction by the State Highway Department in the State where the Project is located.
6. Pozzolan or other additives shall not be used to compensate for alkali reactivity of aggregates.

F. Maximum total chloride ion content for concrete mix including all ingredients measured as a weight percent of cement:
1. 0.06 for prestressed concrete.
2. 0.10 for all other concrete.

G. Sand Cement Grout:
1. Approximately 3 parts sand, 1 part Portland cement, 6 ±1 percent entrained air and water to produce a slump which allows grout to completely fill required areas and surround adjacent reinforcing.
a. Provide sand in accordance with requirements for fine aggregate for concrete.
2. Minimum 28-day compressive strength: 4000 psi.

H. Non-shrink Grout:
1. Non-shrink, non-metallic, non-corrosive, and non-staining.
2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.
3. Grout to produce a positive but controlled expansion.
a. Mass expansion shall not be created by gas liberation or by other means.
4. Minimum 28-day compressive strength: 6500 psi.
5. BASF Admixtures, Inc. "Masterflow, 713 Plus"; Euclid Chemical "NS Grout"; Sauereisen Cements "F-100 Level Fill Grout"; U. S. Grout "Five Star Grout"; Set Products, Inc. "Set Non-Shrink Grout"; The Upco Corp "Upcon"; L & M "Crystex"; Sika Corporation "Sika Grout 212"; or equal.
6. In accordance with COE CRD-C621.

I. Epoxy Grout:
1. Three-component epoxy resin system:
a. Two (2) liquid epoxy components.
b. One (1) inert aggregate filler component.
2. Adhesive:
a. BASF "Masterflow 648 CP".
b. Exxon Chemical Company "Escoweld 2505."
c. Sika "Sikadur Hi-Mod."
d. U. S. Grout "Five Start Epoxy Grout."
e. Euclid Chemical "E3-G."
f. Or equal.
3. Aggregate:
a. BASF "Masterflow 648 CP".
b. Exxon Chemical Company "Escoweld 2510."
c. Sika aggregate.
d. U. S. Grout aggregate.
e. Euclid Chemical "Euclid aggregate."
f. Or equal.
4. Aggregate manufacturer shall be the same as the adhesive manufacturer.
5. The aggregate shall be compatible with the adhesive.
6. Each component furnished in separate package for mixing at jobsite.

2.3 MIXES

A. General:
1. Provide concrete capable of being placed without aggregate segregation and, when cured, of developing all properties specified.
2. Ready-mixed concrete shall conform to ASTM C94.
3. All concrete to be normal weight concrete, weighing approximately 145 to 150 LBS per cubic foot at 28 days after placement.

B. Minimum 28-Day Compressive Strengths:

Normal weight concrete fill	3000 psi
Normal weight lean concrete	3000 psi

Normal weight concrete topping	4000 psi
Normal weight all other concrete	4000 psi
Normal weight and lightweight precast concrete	5000 psi
Normal weight concrete pavements	4000 psi
Normal weight concrete integral wearing course	6000 psi

C. Air Entrainment:
   1. Provide air entrainment in all concrete resulting in a total air content percent by volume as follows:
      a. 1-1/2 IN maximum aggregate size: 4-1/2 to 6-1/2 percent total air content.
      b. 1 IN maximum aggregate size: 5 to 7 percent total air content.
      c. 3/4 IN maximum aggregate size: 5 to 7 percent total air content.
      d. 1/2 IN maximum aggregate size: 5-1/2 to 8 percent total air content.
      e. Interior slabs and mats with power trowel finish: Maximum 3 percent total air content.

D. Slump:
   1. 4 IN maximum, 1 IN minimum measured at point of discharge into the concrete construction member.
   2. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
   3. Provide additional water or water reducing admixture at ready mix plant for concrete that is to be pumped to allow for slump loss due to pumping.
      a. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified and the maximum specified water-cement ratio is not exceeded.

E. Proportioning:
   1. General:
      a. Proportion ingredients to produce a mixture which will work readily into corners and angles of forms and around reinforcement by methods of placement and consolidation employed without permitting materials to segregate or excessive free water to collect on surface.
      b. Proportion ingredients to produce proper placability, durability, strength and other required properties.
   2. Normal weight concrete minimum cement contents and maximum water cement ratios:

SPECIFIED STRENGTH (PSI)	MINIMUM CEMENT (LBS/CY)	MAXIMUM WATER CEMENT RATIO BY WEIGHT
3000	517*	0.45
4000	564*	0.45
4500	611*	0.42
5000	611*	0.45
6000	658*	0.45

* If fly ash is proposed for use, the weight of fly ash plus weight of Portland cement shall equal these values.

   3. Fly ash:
      a. For cast-in-place concrete only, a maximum of 25 percent by weight of Portland cement content per cubic yard may be replaced with fly ash at a rate of 1 LB fly ash for 1 LB cement.

b. If fly ash is used, the water to fly ash plus cement ratio not to exceed the maximum water cement ratio specified in this Section.
c. Concrete containing fly ash shall not be used in the construction of the precast concrete units specified.

4. Water reducing, retarding, and accelerating admixtures:
   a. Use in accordance with manufacturer's instructions.
   b. Do not use unless required by these specifications or approved for use by Engineer.
5. High range water reducers (superplasticizers):
   a. Use in accordance with manufacturer's instructions.
   b. Do not use unless required by these Specifications or approved for use by Engineer.
6. Concrete mix proportioning methods for normal weight concrete:
   a. Method 1:
      1) Used when combination of materials proposed is to be evaluated and proportions selected to be on a basis of trial mixes.
      2) Produce mixes having suitable proportions and consistencies based on ACI 211.1, using at least three (3) different water cement ratios or cement contents which will produce a range of compressive strengths encompassing the required average strength.
      3) Design trial mixes to produce a slump within 0.75 IN of maximum specified, and for air entrained concrete, air content within 0.5 percent specified.
      4) For each water cement ratio or cement content, make at least four (4) compression test cylinders for specified test age, and cure in accordance with ASTM C192.
         a) Test for strength at 28 days in accordance with ASTM C39.
      5) From results of these tests, plot a curve showing relationship between water cement ratio or cement content and compressive strength.
      6) From this curve select water cement ratio or cement content to be used to produce required average strength.
      7) Use cement content and mixture proportions such that maximum water cement ratio is not exceeded when slump is maximum specified.
      8) Base field control on maintenance of proper cement content, slump, air content and water cement ratio.
      9) See paragraph hereafter for definition of required average strength.
   b. Method 2:
      1) In lieu of trial mixes, field test records for concrete made with similar ingredients may be used.
      2) Use of proposed concrete mix proportions based on field test records subject to approval by Engineer based on information contained in field test records and demonstrated ability to provide the required average strength.
      3) Field test records to represent materials, proportions and conditions similar to those specified.
         a) Changes in the materials, proportions and conditions within the test records shall have not been more restricted than those for the proposed concrete mix.
         b) Field test records shall meet the requirements of ACI 318 Paragraph 5.3.1.
      4) Required concrete proportions may be established by interpolation between the strengths and proportions of two (2) or more test records each of which meets the requirements of this Section.
7. Required average strength to exceed the specified 28-day compressive strength by the amount determined or calculated in accordance with Paragraph 5.3 of ACI 318 using the standard deviation of the proposed concrete production facility as described in Paragraphs 5.3.1 and 2 of ACI 318.

F. Allowable Shrinkage: 0.048 percent per ASTM C157.

2.4 SOURCE QUALITY CONTROL

A. To assure stockpiles are not contaminated or materials are segregated, perform any test for determining conformance to requirements for cleanness and grading on samples secured from aggregates at point of batching.

B. Do not use frozen or partially frozen aggregates.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Perform concrete tests per Section 03350.

B. Perform strength test on any concrete to which water has been added at the jobsite.

END OF SECTION

SECTION 03311
CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Mixing, placing, jointing, and curing of concrete construction.

B. Related Sections include but are not necessarily limited to:
   1. Section 03108 - Formwork.
   2. Section 03208 - Reinforcement.
   3. Section 03308 - Concrete, Materials and Proportioning.
   4. Section 03348 - Concrete Finishing and Repair of Surface Defects.
   5. Section 03350 - Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
      b. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
      c. 304.2R, Placing Concrete by Pumping Methods.
      d. 305R, Hot Weather Concreting.
      e. 306R, Cold Weather Concreting.
      f. 308, Standard Practice for Curing Concrete.
      g. 309R, Guide for Consolidation of Concrete.
   2. ASTM International (ASTM):
      a. C94, Standard Specification for Ready-Mixed Concrete.
      b. C171, Standard Specification for Sheet Materials for Curing Concrete.
      c. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      d. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
      e. D1056, Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber.
      f. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-Extruding and Resilient Bituminous Types).
   3. Corps of Engineers (COE):
      a. CRD-C572, Specifications for Polyvinylchloride Waterstops.
   4. National Ready Mixed Concrete Association (NRMCA):
      a. Checklist for Certification of Ready Mixed Concrete Production Facilities.

B. Qualifications:
   1. Ready Mixed Concrete Batch Plant: Certified by NRMCA.

1.3 DEFINITIONS

A. Words and terms used in this Specification are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
         1) Procedure for adding high-range water reducer at the jobsite.
      c. Scaled (minimum 1/8 IN per foot) drawings showing proposed locations of construction joints and joint keyway dimensions.
      d. Manufacturers and types:
         1) Joint fillers.
         2) Curing agents.
         3) Construction joint bonding adhesive.
         4) Pressure relief valves.
         5) Waterstops.
   2. Certifications:
      a. Ready mix concrete plant certification.
      b. Waterstops: Products shipped meet or exceed the physical properties specified.

B. Miscellaneous:
   1. Copies of concrete delivery tickets.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery:
   1. Concrete:
      a. Prepare a delivery ticket for each load of ready mixed concrete.
      b. Truck operator shall hand ticket to Contractor at the time of delivery.
      c. Ticket to show:
         1) Mix identification.
         2) Quantity delivered.
         3) Amount of material in each batch.
         4) Outdoor temperature in the shade.
         5) Time at which cement was added
         6) Time of delivery.
         7) Time of discharge.
         8) Amount of water added.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Neoprene Expansion Joint Fillers:
   1. Manufacturers:
      a. Permaglaze.
      b. Rubatex.
      c. Williams Products.
   2. Materials:
      a. Closed cell neoprene.
      b. ASTM D1056, Class SC, 2 to 5 psi compression deflection, Grade SCE-41.

B. Asphalt Expansion Joint Fillers:
   1. Manufacturers:
      a. W R Meadows.
      b. J and P Petroleum Products.

2. Materials: ASTM D994.

C. Fiber Expansion Joint Fillers:
1. Materials: ASTM D1751.

D. Waterstops, Bulb Type:
1. Manufacturers:
   a. Greenstreak Plastics Products.
   b. W R Meadows.
2. Materials:
   a. Virgin polyvinyl chloride compound not containing any scrap or reclaimed materials or pigment.
   b. Standard: COE CRD-C572.
3. In expansion joints:
   a. 9 IN wide x 3/8 IN thick tear web type waterstop.
   b. 2 IN minimum horizontal movement without rupturing.
   c. Similar to Greenstreak Plastic Products Style #700.
4. In all other joints:
   a. 6 IN wide x 3/8 IN thick bulb type.
   b. Similar to Greenstreak Plastics Products Style #705.
5. Provide hog rings or grommets at maximum 12 IN OC along the length of the waterstop.
6. Provide factory-made waterstop fabrications at all changes in direction, intersections and transitions, leaving only straight butt splices for the field.

E. Waterstops, Preformed - Strip Type:
1. Manufacturers:
   a. Hydrotite CJ by Greenstreak Plastics, Inc.
   b. Synko Flex.
   c. Volclay Waterstop Rx.
2. Materials:
   a. Hydrophilic type waterstop manufactured solely for the purpose of preventing water from traveling through construction joints.
   b. Hydrotite type CJ-0725-3K or approved equal.

F. Sand cement grout, non-shrink grout and epoxy grout: See Section 03308.

PART 3 - EXECUTION

3.1 PREPARATION

A. General:
1. Complete formwork.
   a. See Section 03108.
2. Remove earth, snow, ice, water, and other foreign materials from areas that will receive concrete.
3. Secure reinforcement in place.
   a. See Section 03208.
4. Position expansion joint material, anchors and other embedded items.
5. Obtain approval of reinforcement erection and placement prior to placing concrete.
6. Do not place concrete during rain, sleet, or snow, unless adequate protection is provided and approval is obtained.
   a. Plan size of crews with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
   b. Do not allow rainwater to increase mixing water nor to damage surface finish.

7. Coat all construction joints with an approved bonding material, before new concrete is placed.
    a. Apply proprietary bonding adhesive in accordance with manufacturer's instructions.
8. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.
9. Provide slabs of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
    a. For slabs on grade, slope top of subgrade to provide slab of required uniform thickness.

B. Preparation of Subgrade for Slabs On Ground:
1. Subgrade drained and of adequate and uniform load-bearing nature.
2. Obtain approval of subgrade compaction density prior to placing slabs on ground.
3. Maintain subgrade at a temperature above 32 DegF before concrete placing begins for a sufficient amount of time to remove frost.
4. Moisten subgrade to eliminate absorption.
    a. Keep subgrade moist at time of concreting.
    b. Allow no free-standing water on subgrade or soft or muddy spots when concrete is placed.

C. Edge Forms and Screeds:
1. Set accurately to produce designated elevations and contours of finished surface.
2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
3. Use strike off templates, or approved vibrating type screeds, to align concrete surfaces to contours of screed strips.

3.2 CONCRETE MIXING

A. General:
1. Provide all concrete from a central plant conforming to Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
2. Batch, mix, and transport in accordance with ASTM C94.

B. Control of Admixtures:
1. Charge admixtures into mixer as solutions.
    a. Measure by means of an approved mechanical dispensing device.
    b. Liquid considered a part of mixing water.
    c. Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.
2. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.
3. Complete addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.

C. Tempering and Control of Mixing Water:
1. Mix concrete only in quantities for immediate use.
2. Discard concrete which has set.
3. Discharge concrete from ready mix trucks within time limit and drum revolutions stated in ASTM C94.
4. Addition of water at the jobsite:
    a. See Section 03308 for specified water cement ratio and slump.
    b. Do not exceed maximum specified water cement ratio or slump.
    c. Incorporate water by additional mixing equal to at least half of total mixing required.
    d. Perform strength test on any concrete to which water has been added at the jobsite.
        1) See Section 03350.

3.3 PLACING OF CONCRETE

A. General:
   1. Comply with ACI 304R and ACI 304.2R.
   2. Deposit concrete:
      a. Continuously to avoid cold joints.
      b. In layers of 12 to 18 IN.
   3. Locate construction joints at locations approved by Engineer.
      a. Plan size of crews with due regard for effects of concrete temperature and atmosphere conditions to avoid unplanned cold joints.
   4. Place concrete at such a rate that concrete, which is being integrated with fresh concrete, is still workable.
   5. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
   6. Spreaders:
      a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
      b. Embedded:
         1) Obtain approval of Engineer.
         2) Materials: Concrete or metal.
         3) Ends of metal spreaders coated with plastic coating 2 IN from each end.
   7. Do not begin placing of concrete in supported elements until concrete previously placed in supporting members is no longer plastic and has been in place at least a minimum of 2 HRS.
   8. Deposit concrete as nearly as practicable in its final position to avoid segregation.
      a. Maximum free fall: 4 FT.
      b. Free fall exceeding 4 FT:
         1) Place concrete by means of hopper, elephant trunk or tremie pipe extending down to within 4 FT of surface placed upon.
   9. Perform the following operations before bleeding water has an opportunity to collect on surface:
      a. Spread.
      b. Consolidate.
      c. Straightedge.
      d. Darby or bull float.

B. High-Range Water Reducers (Superplasticizers):
   1. Add superplasticizer to the concrete in the truck mixer at the jobsite.
   2. Perform concrete slump test at the jobsite both prior to and after addition of the admixture to the concrete.

C. Cold Weather Concrete Placement:
   1. Comply with ACI 306R.
   2. Do not place concrete on substrates that are below 32 DegF or contain frozen material.
   3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
   4. Temperature of concrete when discharged at site:

AIR TEMPERATURE DEGF	MINIMUM CONCRETE TEMPERATURE, DEGF FOR SECTIONS WITH LEAST DIMENSION LESS THAN 12 IN	MINIMUM CONCRETE TEMPERATURE, DEGF FOR SECTIONS WITH LEAST DIMENSION 12 IN OR GREATER
30 to 45	60	55
0 to 30	65	55
below 0	70	60

5. Heat subgrade, forms, and reinforcement so the temperature of the subgrade, forms, and reinforcement will be between 45 and 70 DegF, when temperature of surrounding air is 40 DegF or below at time concrete is placed.
    a. Remove all frost from subgrade, forms and reinforcement before concrete is placed.
6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 DegF.
7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 DegF.
8. Do not place slabs on ground if temperature is below 40 DegF or if temperature surrounding the slab will be below 40 DegF before structure is enclosed and heated.

D. Hot Weather Concrete Placement:
1. Comply with ACI 305R.
2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
3. Temperature of concrete when placed:
    a. Not to exceed 90 DegF.
    b. Not so high as to cause:
        1) Shrinkage cracks.
        2) Difficulty in placement due to loss of slump.
        3) Flash set.
4. Temperature of forms and reinforcing when placing concrete:
    a. Not to exceed 90 DegF.
    b. May be reduced by spraying with water to cool below 90 DegF.
        1) Leave no standing water to contact concrete being placed.

E. Consolidating:
1. Consolidate in accordance with ACI 309R except as modified herein.
2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
    a. Eliminate:
        1) Air or stone pockets.
        2) Honeycombing or pitting.
        3) Planes of weakness.
3. Internal vibrators:
    a. Minimum frequency of 8000 vibrations per minute.
    b. Insert and withdraw at points approximately 18 IN apart.
        1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
    c. Size of vibrators shall be in accordance with Table 5.1.5 of ACI 309R.
4. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other approved means.
5. Do not use vibrators to transport concrete within forms.
6. Provide spare vibrators on jobsite during all concrete placing operations.
7. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
8. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
9. Prevent construction equipment, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.

F. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.
   1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94.
   2. Horizontal belt conveyors:
      a. Mount at a slope which will not cause segregation or loss of ingredients.
      b. Protect concrete against undue drying or rise in temperature.
      c. Use an arrangement at discharge end to prevent segregation.
      d. Do not allow mortar to adhere to return length of belt.
      e. Discharge conveyor runs into equipment specially designed for spreading concrete.
   3. Metal or metal lined chutes:
      a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
      b. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
      c. Provide end of each chute with a device to prevent segregation.
   4. Pumping or pneumatic conveying equipment:
      a. Designed for concrete application and having adequate pumping capacity.
      b. Control pneumatic placement so segregation is avoided in discharged concrete.
      c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1-1/2 IN.
      d. Do not convey concrete through pipe made of aluminum or aluminum alloy.
      e. Provide pumping equipment without Y sections.

3.4 JOINTS AND EMBEDDED ITEMS

A. General - Construction Joints:
   1. Locate joints as indicated on Contract Drawings or as shown on approved Shop Drawings.
      a. Where construction joint spacing shown on Drawings exceeds the joint spacing indicated in Paragraph B below, submit proposed construction joint location in conformance with the Specification.
   2. Unplanned construction joints will not be allowed.
      a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
   3. In general, locate joints near middle of spans of slabs.
   4. Locate joints in slabs and at tops of foundations unless shown otherwise.
      a. At Contractor's option, beam pockets may be formed into concrete walls.
      b. Size pockets to allow beam reinforcing to be placed as detailed on Drawings.
   5. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
   6. Provide roughened construction joints at all construction joints unless indicated otherwise on Drawings.
      a. Clean the previously hardened concrete interface and remove all laitance.
      b. Intentionally roughen the interface to a full amplitude of 1/4 IN.
      c. Provide recessed flat surface as required to install strip type waterstops.
   7. Provide continuous keyways at all construction joints.
      a. Construction joint keyways shall have the following dimensions, unless shown otherwise on Drawings or directed otherwise by Engineer.
      b. Construction joint keyways in footings, foundations, base slabs, and structural or elevated slabs:
         1) Keyway height not less than 1/3 and not more than 1/2 the footing or slab thickness.
         2) Keyway depth not less than 1-1/2 IN.
         3) Keyway in footing or slab center unless shown otherwise on Drawings.

8. Allow a minimum of 48 HRS before placement of adjoining concrete construction.

B. Construction Joints - Spacing:
   1. General - Structures not intended to contain liquid:
      a. Base slab and floor construction joints:
         1) Placements to be approximately square and not to exceed 3500 SF.
         2) Maximum side dimension of a slab pour to be 80 FT.
   2. Structures intended to contain liquids:
      a. Base slab and floor construction joints:
         1) Placements to be approximately square and not to exceed 2000 SF.
         2) Maximum side dimension of a slab pour to be 60 FT.

C. Bonding at Construction Joints:
   1. Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance from construction joints.
      a. Before new concrete is placed, all construction joints shall be coated with epoxy adhesive, cement grout, or dampened.
      b. General:
         1) Use cement grout or dampening for all construction joints.
         2) At tanks, and structures designed to contain liquids:
            a) Cover the hardened concrete of horizontal joints with a coat of cement grout of similar proportions to the concrete, except substitute fine aggregate for coarse aggregate.
            b) Place grout as thick as possible on vertical surfaces.
            c) Place 1 IN layer of grout in bottoms of wall or column lifts immediately before placing concrete and at least 1/2 IN thick on other horizontal surfaces.
            d) Vibrate grout and first layer of concrete simultaneously.
            e) Place fresh concrete before the grout has attained its initial set.
   2. At other locations:
      a. Roughen the surface of the concrete to expose the aggregate uniformly.
      b. Remove laitance, loosened particles of aggregate or damaged concrete at the surface, or at the Contractor's option, use an approved chemical retarder which delays but does not prevent setting of the surface of the mortar in accordance with the manufacturer's recommendations.
         1) Retarded mortar shall be removed within 24 HRS after placing to produce a clean exposed aggregate bonding surface.
      c. Dampen the hardened concrete (but do not saturate) immediately prior to placing of fresh concrete or grout.

D. Locate control joints in slabs on grade as indicated on Drawings.
   1. Time cutting properly with set of concrete, if saw cut joints are required or permitted.
      a. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw.
      b. Complete before shrinkage stresses become sufficient to produce cracking.

E. Expansion Joints:
   1. Do not permit reinforcement or other embedded metal items bonded to concrete (except smooth dowels bonded on only one side of joint) to extend continuously through an expansion joint.
   2. Use neoprene expansion joint fillers, unless noted otherwise on Drawings.
   3. Seal expansion joints as shown on Drawings.
      a. See Section 07900 for requirements.

F. Waterstops:
   1. Preformed strip type:

a. Install on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.
b. Waterstop to be continuous with splices in accordance with manufacturer's instructions.
c. Use in joints against existing concrete and where indicated on Drawings.

2. Bulb type:
a. Position waterstop accurately in forms.
b. Secure waterstops in correct position using hog rings or grommets spaced along the length of waterstop and tie wire to adjacent reinforcing.
c. Hold horizontal waterstops in place with continuous supports.
d. Install according to manufacturer's instructions.
1) Do not displace reinforcement from required location.
e. Waterstops to be continuous.
f. Splice ends with perpendicular butt splice using electrical splicing iron in accordance with manufacturer's instructions.
g. Unless otherwise noted, use for all construction joints in new construction for all structures indicated on Drawings.

G. Other Embedded Items:
1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.
2. Do not place electrical conduit, drains, or pipes in or thru concrete slabs, foundations, or other structural members unless approved by Engineer.

H. Placing Embedded Items:
1. Position expansion joint material, waterstops, and other embedded items accurately.
2. Support against displacement.
3. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
4. Provide adequate means for anchoring waterstop in concrete.
a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.
b. Work concrete under the waterstops by hand, so as to avoid the formation of air and rock pockets, when placing roof and floor slab concrete around waterstops.

3.5 FINISHING

A. See Section 03348.

B. Coordinate mixing and placing with finishing.

3.6 INSTALLATION OF GROUT

A. Grout Schedule of Use:
1. Sand cement grout:
a. Fill keyways if precast HCU.
b. General use.
2. Non-shrinking non-metallic grout:
a. Filling form tie holes.
b. Other uses indicated on the Drawings.
3. Epoxy grout:
a. Patching cavities in concrete.
b. Grouting of dowels and anchor bolts into existing concrete.
c. Other uses indicated on the Drawings.

B. Grout Installation:
1. Sand cement grout:

a. Fill keyways between precast concrete hollow core slabs with sand cement grout.
b. Consolidate grout by rodding or by other means to assure complete filling of keyways.
c. Cure grout by one of methods specified.

2. Non-shrink non-metallic grout:
   a. Clean concrete surface to receive grout.
   b. Saturate concrete with water for 24 HRS prior to grouting.
   c. Mix in a mechanical mixer.
   d. Use no more water than necessary to produce flowable grout.
   e. Place in accordance with manufacturer's instructions.
   f. Provide forms where base plates and bed plates do not confine grout.
   g. Where exposed to view, finish grout edges smooth.
   h. Except where a slope is indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
   i. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.

3. Epoxy grout:
   a. Mix and place in accordance with manufacturer's instructions.
   b. Apply only to clean, dry, sound surface.
   c. Completely fill all cavities and spaces around dowels and anchors without voids.
   d. Grout base as specified for non-shrinking, non-metallic grout.
   e. Obtain manufacturer's field technical assistance as required to assure proper placement.

3.7 CURING AND PROTECTION

A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
   1. Follow recommendations of ACI 308 except as modified herein.

B. Apply one of the following curing procedures immediately after completion of placement and finishing, for concrete surfaces not in contact with forms.
   1. Ponding or continuous sprinkling.
   2. Application of absorptive mats or fabric kept continuously wet.
   3. Application of sand kept continuously wet.
   4. Continuous application of steam (not exceeding 150 DegF) or mist spray.
   5. Application of waterproof sheet materials, conforming to ASTM C171.
   6. Application of other moisture retaining covering as approved.
   7. Application of a curing compound conforming to ASTM C309.
      a. Apply curing compound in accordance with manufacturer's recommendations immediately after any water sheen which may develop after finishing has disappeared from concrete surface.
      b. Do not use on any surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.
      c. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two coats of the curing compound.
         1) Apply the first coat of curing compound to a vertical surface immediately after form removal.
         2) The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
         3) Allow the preceding coat to completely dry prior to applying the next coat.
         4) A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.

C. Curing Concrete In Contact with Forms:

1. Minimize moisture loss from and temperature gain of concrete placed in forms exposed to heating by sun by keeping forms wet and cool until they can be safely removed.
2. After form removal, cure concrete until end of time prescribed.
   a. Use one of methods listed above.
3. Forms left in place shall not be used as a method of curing in hot weather.
4. The term "hot weather," where used in these specifications, is defined in ACI 305R.
5. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete.

D. Continue curing for at least 7 days for all concrete except high early strength concrete for which period shall be at least 3 days.
   1. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is 1 day old, provided concrete is not permitted to become surface dry during transition.

E. Cold Weather:
   1. Follow recommendations of ACI 306R.
   2. Maintain temperature of concrete between 50 and 70 DegF for required curing period, when outdoor temperature is 40 DegF, or less.
   3. Use heating, covering, insulating, or housing of the concrete work to maintain required temperature without injury due to concentration of heat.
   4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
   5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.

F. Hot Weather:
   1. Follow recommendations of ACI 305R.
   2. Make provision for cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
   3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.

G. Rate of Temperature Change:
   1. Keep changes in temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing period.
   2. Do not exceed a temperature change of 5 DegF in any 1 HR or 50 DegF in any 24 HR period.

H. Protection from Mechanical Injury:
   1. Protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
   2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
   3. Do not load self supporting structures in such a way as to overstress concrete.

3.8 FIELD QUALITY CONTROL

A. Tests in accordance with Section 03350.
   1. Perform a strength test on all concrete to which water or superplasticizer, in addition to the amount stated in the concrete mix design, has been added at the jobsite.
      a. Perform strength test after water or superplasticizer has been added and additional mixing has been performed.

B. Field samples of fabricated waterstop fittings (crosses, tees, etc.) will be selected at random by the Engineer for testing by a laboratory at the Owner's expense.
   1. When tested, they shall have a tensile strength across the joints equal to at least 600 psi.

1 **END OF SECTION**

SECTION 03348
CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete finishing and repair of surface defects.

B. Related Sections include but are not necessarily limited to:
   1. Section 03108 - Formwork.
   2. Section 03002 - Concrete.
   3. Section 03308 - Concrete, Materials and Proportioning.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
   2. ASTM International (ASTM):
      a. C150, Standard Specification for Portland Cement.
      b. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

1.3 DEFINITIONS

A. Vertical Surface Defects:
   1. Any void in the face of the concrete deeper than 1/8 IN, such as:
      a. Tie holes.
      b. Air pockets (bugholes).
      c. Honeycombs.
      d. Rock holes.
   2. Scabbing:
      a. Scabbing is defect in which parts of the form face, including release agent, adhere to concrete.
   3. Foreign material embedded in face of concrete.
   4. Fins 1/16 IN or more in height.

B. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

C. Other words and terms used in these Specifications are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   2. Certifications:
      a. Certification of aggregate gradation.

b. Certification that products being used will not interfere with bonding of future floor or wall finishes.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations and requirements for materials used.

1.6 WARRANTY

A. Provide warranty equal to specified manufacturer's standard warranty for all products used.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Chemical sealer:
      a. L & M Construction Chemicals, Inc.
      b. Euclid Chemical Co.
      c. Dayton Superior.
   2. Bonding agents:
      a. Euclid Chemical Co.
      b. BASF Admixtures, Inc.
      c. L & M Construction Chemicals Inc.

2.2 MATERIALS

A. Chemical Floor Sealer:
   1. Colorless low VOC water-based solution containing acrylic copolymers.
      a. ASTM C1315, Class B, minimum 30 percent solids.
   2. Similar to L & M Construction Chemicals Inc. Dress & Seal WB 30.

B. Bonding Agent:
   1. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
   2. Euclid Chemical Co. "Flex-Con."
   3. BASF Admixtures, Inc. "Acryl-Set."
   4. L & M Construction Chemicals "Everbond."
   5. Thoro System Products "Acryl 60."

C. Cement:
   1. ASTM C150, Type II Portland for areas exposed to sewage.
   2. ASTM C150, Type IV Portland elsewhere.

D. Aggregate:
   1. Sand: Maximum size #30 mesh sieve.
   2. For exposed aggregate finish surfaces: Same as surrounding wall.

E. Water: Potable.

2.3 MIXES

A. Bonding Grout:
   1. One part cement to one part aggregate.
   2. Mix cement and aggregate.
   3. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.

4. Add bonding agent/water mixture to cement/aggregate mixture.
5. Mix to consistency of thick cream.
6. Bonding agent itself may be used as bonding grout if approved by manufacturer and Engineer.

B. Patching Mortar:
1. One part cement to two and one-half parts aggregate by damp loose volume.
   a. Substitute white Portland cement for a part of gray Portland cement to produce color matching surrounding concrete.
2. Mix cement and aggregate.
3. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
4. Add only enough bonding agent/water mixture to cement/aggregate mixture to allow handling and placing.
5. Let stand with frequent manipulation with a trowel, until mix has reached stiffest consistency to allow placement.

PART 3 - EXECUTION

3.1 PREPARATION

A. Repair surface defects within 24 HRS after removal of forms.
1. Chip, wire brush or abrasive blast to completely open defects down to sound concrete.
   a. If chipping is necessary, make edges perpendicular to surface or slightly undercut.
   b. No featheredges will be permitted.

B. Repairing Surface Defects:
1. Fill and repair using patching mortar mix specified in Article 2.3.
2. Clean surfaces to remove dust, dirt, laitance, form oil, grease, or other contaminants.
   a. If required by bonding agent manufacturer, etch surfaces with a muriatic acid solution followed by a thorough rinse with clean water.
   b. Test concrete to determine pH level and continue flushing with clean water until surface pH is within acceptable limits.
3. Dampen area to be patched and an area at least 6 IN wide surrounding it prior to application of bonding grout.
4. Brush bonding grout into the surface after the surface water has evaporated.
5. Allow bonding grout to set for period of time required by bonding agent manufacturer before applying premixed patching mortar.
6. Fill tie holes and areas where honeycombed or defective concrete has been removed.
   a. Fill tie holes in liquid containing structures with non-shrink non-metallic grout. See Section 03308.
   b. Fill all other defects with patching mortar.
   c. Consolidate grout or mortar into place and strike off so as to leave patch slightly higher than surrounding surface.
7. Leave undisturbed for at least 60 minutes before finishing level with surrounding surface.
   a. Do not use metal tools in finishing a patch in a formed wall which will be exposed or coated with other materials.
8. Keep areas damp for 7 days or in accordance with bonding agent manufacturer's directions.

3.2 INSTALLATION AND APPLICATION

A. Do not repair surface defects or apply wall or floor finishes when temperature is or is expected to be below 50 DegF.
1. If necessary, enclose and heat area to between 50 and 70 DegF during repair of surface defects and curing of patching material.

B. Chemical Floor Sealer (Type '1') Application:
   1. Apply to floor areas indicated on the Drawings in accordance with manufacturer's recommendations.
   2. Apply at rate recommended by manufacturer.
   3. After final coat of material is applied, remove surplus in accordance with manufacturer's recommendations.
   4. Do not apply sealer to floors scheduled to receive epoxy floor finish.

C. Concrete Finishes for Vertical Wall Surfaces:
   1. General: Give concrete surfaces finish as specified below after removal of formwork and repair of surface defects.
   2. Finish #1 - As cast rough form finish:
      a. Selected forming materials are not required.
      b. Prepare surface in accordance with Paragraph 3.1A. and repair the following surface defects:
         1) Tie holes.
         2) Honeycombs deeper than 1/4 IN.
         3) Air pockets deeper than 1/4 IN.
         4) Rock holes deeper than 1/4 IN.
      c. Chip or rub off fins exceeding 1/4 IN in height.
      d. Use at unexposed surfaces such as foundations and backfilled surfaces of walls not to be waterproofed.
   3. Finish #2 - NOT USED:
   4. Finish #5 - Grout cleaned finish:
      a. Form facing material shall produce a smooth, hard, uniform texture. Use forms specified for surfaces exposed to view in accordance with Section 03108.
      b. Prepare surface in accordance with Paragraph 3.1A and repair all surface defects.
      c. All contiguous surfaces to be finished shall be completed and accessible before finishing operation begins.
      d. Mix one part Portland Cement and one and one-half parts fine sand with sufficient bonding agent/water mixture to produce a grout with the consistency of thick paint.
         1) White Portland cement shall be substituted for gray Portland cement to produce a color that matches color of surrounding concrete as determined by trial patch for areas not to be painted.
      e. Wet surface of concrete to prevent absorption of water and uniformly apply grout.
      f. Immediately after applying grout mix, scrub the surface with a cork float or stone to coat surface and fill remaining air holes, etc.
      g. While grout is still plastic, remove all excess grout by working surface with rubber float or sack.
      h. After the surface whitens from drying, rub vigorously with clean burlap.
      i. Keep final finish damp for a minimum of 36 HRS after final rubbing.
      j. Provide this finish on all surfaces which are to remain as grout cleaned finish.

D. Related Unformed Surfaces (Except Slabs):
   1. Strike smooth tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
   2. Float surface to a texture consistent with that of formed surfaces.
      a. If more than one finish occurs immediately adjacent to unformed surface, provide surface with most stringent formed surface requirement.
   3. Continue treatment uniformly across unformed surfaces.

E. Concrete Finishes for Horizontal Slab Surfaces:
   1. General: Screed with straightedge, eliminate high and low places, bring surface to required finish elevations; slope uniformly to drains. Dusting of surface with dry cement or sand during finishing processes not permitted.

2. Unspecified slab finish: When type of finish is not indicated, use following finishes as applicable:
    a. Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
    b. All slabs to receive a floated finish before final finishing.
3. Scratched slab finish: After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, roughen surface with stiff brushes or rakes before final set.
4. Floated finish:
    a. After concrete has been placed, consolidated, struck off, and leveled, do no further work until ready for floating.
    b. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operations. Use wood or cork float.
    c. During or after first floating, check planeness of entire surface with a 10 FT straightedge applied at not less than two different angles.
    d. Cut down all high spots and fill all low spots to produce a surface with Class B tolerance throughout.
    e. Refloat slab immediately to a uniform texture.
5. Troweled finish:
    a. Float finish surface to true, even plane.
    b. Power trowel, and finally hand trowel.
    c. First troweling after power troweling shall produce a smooth surface which is relatively free of defects, but which may still show some trowel marks.
    d. Perform additional trowelings by hand after surface has hardened sufficiently.
    e. Final trowel when a ringing sound is produced as trowel is moved over surface.
    f. Thoroughly consolidate surface by hand troweling.
    g. Leave finished surface essentially free of trowel marks, uniform in texture and appearance and plane to a Class A tolerance.
    h. On surfaces intended to support floor coverings, remove any defects that would show through floor covering by grinding.
6. Broom or belt finish: Immediately after concrete has received a float finish as specified, give it a transverse scored texture by drawing a broom or burlap belt across surface.
7. Underside of concrete slab finish: Match finish as specified for adjacent vertical surfaces.
    a. If more than one finish occurs immediately adjacent to underside of slab surface, provide surface with most stringent formed surface requirement.

3.3 FIELD QUALITY CONTROL

A. Horizontal slab finishes will be accepted provided:
    1. Applicable specification requirements are satisfied.
    2. Water does not pond in areas sloped to drain.
    3. Gap between a 10 FT straightedge placed anywhere and the finished surface does not exceed:
        a. Class A tolerance: 1/8 IN.
        b. Class B tolerance: 1/4 IN.
        c. Class C tolerance: 1/2 IN.
    4. Accumulated deviation from intended true plane of finished surface does not exceed 1/2 IN.

B. Unacceptable finishes shall be replaced or, if approved in writing by Engineer, may be corrected provided strength and appearance are not adversely affected. High spots to be removed by grinding and/or low spots filled with a patching compound or other remedial measures to match adjacent surfaces.

3.4 PROTECTION

A. All horizontal slab surfaces receiving applied toppings or sealer compound shall be kept free of traffic and loads for minimum of 10 days following installation of topping or compound.

END OF SECTION

SECTION 03350
TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Materials and concrete testing as required to establish concrete mix design.
   2. Testing of concrete during construction for compliance with Contract Documents.
   3. In-place testing of concrete, if required.

B. Related Sections include but are not necessarily limited to:
   1. Section 03208 - Reinforcement.
   2. Section 03308 - Concrete, Materials and Proportioning.
   3. Section 03311 - Concrete Mixing, Placing, Jointing, and Curing.

1.2 RESPONSIBILITY AND PAYMENT

A. Owner and Contractor each provide and pay for certain testing services:
   1. Owner shall retain the services of a qualified Testing Agency to perform testing services for the following:
      a. Testing of concrete produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
   2. Contractor shall retain the services of a qualified Testing Agency to perform testing services for the following:
      a. Testing of materials and mixes proposed by the Contractor for compliance with the Contract Documents and retesting in the event of changes.
      b. Additional testing or retesting of concrete or other cement-containing products occasioned by their failure, by test or inspection, to meet requirements of the Contract Documents.
      c. Strength testing on any concrete to which water has been added at the jobsite.
      d. In-place testing of concrete as may be required by Engineer when strength of structure is considered potentially deficient.
      e. Other testing services needed or required by Contractor such as:
         1) Field curing of test specimens and testing of specimens for determining when forms, form shoring, or reshoring may be removed.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. T260, Standard Method of Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials.
   2. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete.
   3. ASTM International (ASTM):
      a. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
      b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
      c. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

d. C138, Standard Method of Test for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
e. C143, Standard Test Method for Slump of Hydraulic Cement.
f. C172, Standard Practice for Sampling Freshly Mixed Concrete.
g. C173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
h. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
i. C567, Standard Test Method for Unit Weight of Structural Lightweight Concrete.
j. C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
k. C1019, Standard Test Method for Sampling and Testing Grout.
l. E329, Standard Specifications for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

B. Qualifications:
1. Testing Agency:
a. Meeting requirements of ASTM E329.
b. Provide evidence of recent inspection by Cement and Concrete Reference Laboratory of National Bureau of Standards, and correction of deficiencies noted.

1.4 DEFINITIONS

A. Testing Agency: An independent professional testing firm or service hired by Contractor or by Owner to perform testing and analysis services on materials, mixes, structures, and other items as directed, and as provided in the Contract Documents.

1.5 SUBMITTALS

A. Shop Drawings:
1. Product technical data including:
a. Concrete materials and concrete mix designs proposed for use. Include results of all testing performed to qualify materials and to establish mix designs. Place no concrete until approval of mix designs has been received in writing. Submittal for each concrete mix design to include:
1) Sieve analysis and source of fine and coarse aggregates.
2) Test for aggregate organic impurities.
3) Proportioning of all materials.
4) Type of cement with mill certificate for the cement.
5) Brand, quantity and class of fly ash proposed for use along with other submittal data as required for fly ash by Section 03308.
6) Unit weight of fresh and dry lightweight concrete.
7) Slump.
8) Splitting tensile strength for proposed lightweight concrete mix.
9) Brand, type and quantity of air entrainment and any other proposed admixtures.
10) Total chloride ion content per cubic yard of concrete determined in accordance with AASHTO T260.
11) 28-day compression test results and any other data required by Section 03308 to establish concrete mix design.
2. Certifications:
a. Testing Agency qualifications.
3. Test results:
a. Strength test results on concrete placed during construction including slump, air content, and concrete temperature.
b. Strength test results on concrete core samples of in-place construction if required.

c. Results of load testing in-place concrete construction when load testing is required.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.1 TESTING SERVICES TO BE PERFORMED BY CONTRACTOR'S TESTING AGENCY

A. Review and test Contractor's proposed materials for compliance with the Contract Documents.

B. Review and test Contractor's proposed concrete mix design(s).

3.2 OTHER TESTING SERVICES TO BE PERFORMED BY CONTRACTOR'S TESTING AGENCY AS NEEDED

A. Following services to be performed by Contractor's Testing Agency when necessary at no additional cost to Owner:
   1. Additional testing and inspection required because of changes in materials or proportions requested by Contractor.
   2. Additional testing of materials or concrete occasioned by their failure, by test or inspection, to meet Specification requirements.
   3. Perform strength test on any concrete to which water has been added at the jobsite.
   4. Other testing services needed or required by Contractor, such as; field cured test specimens for determining when forms, form shoring or reshoring may be removed.
      a. An extra strength test is required for concrete subject to either live load or shore removal prior to 28 days after placing concrete.

B. The above services to be performed by the Contactor's Testing Agency may be performed by the Owner's Testing Agency provided these services are performed at no additional cost to the Owner.

3.3 DUTIES AND AUTHORITIES OF TESTING AGENCY

A. Testing Agency to inspect, sample and test materials and production of concrete as required by these Contract Documents and by Engineer. When it appears that any material furnished or work performed by Contractor fails to fulfill requirements of the Contract Documents, Testing Agency to report such deficiency to Engineer and Contractor.

B. Testing Agency to report all test and inspection results to Engineer and Contractor immediately after they are performed. All test reports to include exact location in the work at which batch represented by a test was deposited. Reports of strength tests to include detailed information on storage and curing of specimens prior to testing.

C. Limited Authority of Testing Agency: Any Testing Agency or agencies and their representatives retained by Contractor or Owner for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve or accept any portion of the Work.

3.4 RESPONSIBILITIES AND DUTIES OF CONTRACTOR

A. Provide necessary testing services for qualification of proposed materials and establishment of concrete mix design(s).

B. Use of Testing Agency and approval by Engineer of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

C. To facilitate testing and inspection, perform the following:
   1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
   2. Provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 HRS as required by ASTM C31.

D. Notify Engineer and Owner's Testing Agency sufficiently in advance of operations (minimum of 24 HRS) to allow completion of quality tests for assignment of personnel and for scheduled completion of quality tests.

3.5 EVALUATION OF CONCRETE OR GROUT TEST RESULTS

A. Test results for standard molded and cured test cylinders to be evaluated separately for each mix design. Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards. For evaluation of potential strength and uniformity, each mix design shall be represented by at least three strength tests. A strength test shall be the average of two cylinders from the same sample tested at 28 days.

B. Acceptance:
   1. Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:
      a. Average of all sets of three consecutive strength tests equal or exceed the required specified 28-day compressive strength.
      b. No individual strength test falls below the required specified 28-day compressive strength by more than 500 psi.

3.6 TESTING OF CONCRETE-IN-PLACE

A. In-place testing of concrete may be required by Engineer when strength of structure is considered potentially deficient as specified in Paragraph 3.7D.

B. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer to determine relative strengths at various locations in the structure or for selecting areas to be cored. Such tests shall not be used as a basis for acceptance or rejection.

C. Core Tests:
   1. Where required, obtain and test cores in accordance with ASTM C42. If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 DegF, relative humidity less than 60 percent) for 7 days before test then test dry. If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 HRS and test wet. Testing wet or dry to be determined by Engineer.
   2. Take three representative cores from each member or area of concrete in place that is considered potentially deficient. Location of cores shall be determined by Engineer so as least to impair strength of structure. If, before testing, one or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.
   3. Concrete in area represented by a core test will be considered adequate if average strength of three cores is equal to at least 85 percent of specified strength and no single core is less than 75 percent of specified strength.
   4. Fill core holes with nonshrink grout and finish to match surrounding surface when exposed in a finished area.

3.7 ACCEPTANCE

A. Completed concrete work which meets applicable requirements will be accepted without qualification.

1. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.
2. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents. In this event, modifications may be required to assure that concrete work complies with requirements. Modifications, as directed by Engineer, to be made at no additional cost to Owner.

B. Dimensional Tolerances:
1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Engineer.
2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.
3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.
4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected. Repair or remove and replace if required.
5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.

C. Appearance:
1. Concrete surfaces exposed to view with defects which, in opinion of Engineer, adversely affect appearance as required by specified finish shall be repaired by approved methods.
2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Engineer, the defects impair the strength or function of the member.

D. Strength of Structure:
1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure, including but not necessarily limited to following:
    a. Low concrete strength as specified in Article 3.5.
    b. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Section 03208 or requirements of the Contract Drawings or approved Shop Drawings.
    c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
    d. Curing time and procedure not meeting requirements of these Specifications.
    e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
    f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
    g. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength.
2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.
3. Core tests may be required when strength of concrete in place is considered potentially deficient.

4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with Chapter 20 of ACI 318.
5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Engineer, at Contractor's expense.
6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

END OF SECTION

SECTION 05120
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Finish steel structure package with fasteners, anchor bolts, and hardware necessary to complete all support stands as shown on drawings. Structure types and quantities are designated on the Steel Drawings.

B. The following drawings are hereby made part of this specification (Drawings to be determined):
   1. TWESD-SS-01: Structural Steel – 230kV Switch Stands
   2. TWESD-SS-02: Structural Steel – 230kV Bus Supports
   3. TWESD-SS-03: Structural Steel – 230kV Misc. Steel
   4. TWESD-SS-04: Structural Steel – Termination Stand Sheet 1 of 2
   5. TWESD-SS-05: Structural Steel – Termination Stand Sheet 2 of 2
   6. TWESD-SS-06: Structural Steel – Equipment Supports
   7. TWESD-SS-07: Structural Steel – Transformer Grating
   8. TWESD-SM-01: Static Mast – 230kV Dead End Tower

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Institute of Steel Construction (AISC):
      a. Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
      b. Code of Standard Practice for Steel Buildings and Bridges dated March 7, 2000.
      c. Quality Certification Program for Fabricators
      d. Erector Certification Program.
      e. Manual of Steel Construction.
   2. American National Standards Institute (ANSI):
      a. B18.22.1, Plain Washers.
   3. American Society of Civil Engineers (ASCE).
   4. ASTM International (ASTM):
      a. A2, Standard Specification for Carbon Steel Girder Rails of Plain, Grooved, and Guard Types.
      b. A6, Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use.
      c. A36, Standard Specification for Carbon Structural Steel.
      d. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      e. A108, Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.
      f. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      g. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
      h. A325, Standard Specification of Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
      i. A354, Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
      j. A490, Standard Specification for Heat-Treated Steel Structural Bolts.

k. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
l. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
m. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
n. A582, Standard Specification for Free-Machining Stainless Steel Bars.
o. F436, Standard Specification for Hardened Steel Washers.
p. F593, Standard Specification for Stainless Steel Bolts, Hex Caps Screws and Studs.
q. F959, Standard Specification for Compressible Washer Type Direct Tension Indicators for Use with Structural Fasteners.
r. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

5. Specification for Structural Joints using ASTM A325 or A490 Bolts as approved by the Research Council on Structural Connections (RCSC) of the Engineering Foundation (referred to herein as Specification for Structural Joints).
6. American Welding Society (AWS):
   a. A5.1, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. A5.5, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
   c. A5.17, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   d. A5.18, Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding.
   e. A5.20, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   f. A5.23, Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding.
   g. A5.28, Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding.
   h. A5.29, Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding.
   i. D1.1, Structural Welding Code - Steel (referred herein as AWS Code).
   j. Steel stud connectors and their installation to comply with requirements of AWS Code.
7. Specification for the Design, Fabrication, and Erections of Structural Steel for Buildings contained in Steel Construction Manual of the American Institute of Steel Construction.
8. National Electric Safety Code (Standard C2), American National Standards Institute.
9. Where conflicts are present between referenced codes and standards, the code or standard establishing more stringent requirements shall be followed.

B. Qualifications:
1. Steel fabricator: Minimum of 5 years experience in fabrication of structural steel and shall be certified under AISC Quality Certification Program.
   a. Use a professional engineer on fabrication staff.
2. Steel erector: Minimum of 5 years of experience in erection of structural steel.
   a. With an active and enforced quality assurance program in place, as described in the Code.
3. Qualify welding procedures and welding operators in accordance with AWS.

1.3 SUBMITTALS

A. Shop Drawings:
1. Shop drawing submittals shall be sent to the Engineer.

HDR Engineering, Inc.
Attn: Bill Barnhart, Sr., P.E.
2913 Millennium Circle
Billings, MT 59102-7444

a. The standard size drawing size for shop drawings shall be 22" x 34". Drawings shall be laid out in legible, organized manner, with uniformity in appearance, style, contents, and dimensional proportions. Material lists shall be included on the shop drawings.
b. Reproducible drawings to be supplied shall be matte finish, black line on Mylar or high quality vellum, capable of producing high quality drawing prints. Mylar drawings with excessively dark background will be rejected.
c. Electronic files of all shop drawings shall be Autocad "DWG" files and shall include all reference files that will enable the Engineer and Owner to view and generate plot files that will result in an exact match of the submitted hard copy.

2. Fabrication and/or layout drawings:
   a. Prepare Shop Drawings under National Institute of Steel Detailing Quality Procedures Program certification.
   b. Complete Shop Drawings for all of the work showing clearly all pieces, sizes, dimensions, details, connections materials and shop coatings.
      1) All Shop Drawings must be checked and signed "approved" before submittal.
      2) Show all cuts, copes, and holes.
      3) Indicate all shop and field bolts.
      4) Indicate all shop and field welds using AWS symbols.
      5) Be reviewed and sealed by a professional engineer retained by Contractor to verify conformance with design criteria stipulated in the Contract Documents.
   c. Prepare complete erection drawings showing the location and marks of all pieces.
      1) Copies of up-to-date erection drawings shall accompany the Shop Drawings. Use match marks on the erection drawings to indicate the sheet number on which each particular member is detailed.
   d. Correct any incorrect or unacceptable material or fabrication due to incorrect detailing, shop work, or erection, without additional charge.
3. Approval Drawings:
   a. Provide three (3) sets of drawings prior to fabrication. The Engineer will return to the Supplier, within two weeks after receipt, one set of drawings marked "No Exceptions Taken", "Furnish as Corrected", "Revise and Resubmit", or "Rejected" as the case might be.
   b. In the last case, all revisions will be clearly shown on the returned set, which shall be considered as an approved set.
   c. Design revisions, in accordance with corrections shown thereon, may be considered as ready for fabrication.
   d. Corrections or revisions shown on "resubmit" set shall be made, and two revised sets furnished to the Engineer for his approval.
   e. Drawings shall be returned two weeks after notice of requiring resubmittal.
4. Construction Drawings:
   a. Furnish six (6) sets of structural steel shop drawings for construction purposes.
5. "As-Built" Drawings
   a. Supplier shall furnish four (4) sets of "Released for Construction" prints, one (1) set of "Released for Construction" Mylar reproducibles, and an electronic file on CD of all Supplier-furnished structural steel shop drawings.
6. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Detailed supplemental specification relating to load indicator washers or high-strength bolts - alternate design for approval of Engineer (submitted at Contractor's option if desired by Contractor for use).
   d. Source and certification of quality for high-strength bolts, nuts and washers.
7. Certifications:

a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
b. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
c. Welder qualification data and prequalified procedures.

8. Test reports:
a. Certified copies of mill tests.
b. Manufacturer's load test and temperature sensitivity data for expansion anchor bolts and adhesive anchor bolts.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Steel structure, with all associated hardware and fasteners, shall be shipped in one complete shipment.

B. Handle and store steel members above ground on skids or other supports.
1. Keep free of dirt and other foreign material and protect against corrosion.

C. Anchor bolts shall be shipped F.O.B. 6 weeks ARO.

D. Delivery shall be made F.O.B. job site. Project Substation is located in McPherson County, South Dakota near the North Dakota border.. Latest acceptable delivery date for steel structures is 20 weeks ARO.

1.5 DEFINITION

A. Code: AISC Code of Standard Practice for Steel Buildings and Bridges.

B. Owner: May mean the Owner's Designated Representative for Construction as defined by the Code.

C. Galvanizing: Hot-dipped galvanizing per ASTM A153 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. High-strength bolts:
a. Bethlehem Steel Corporation.
b. Lewis Bolt & Nut Company.
c. Nucor Fasteners.
d. St. Louis Screw and Bolt Company.
2. Load indicator washers for high-strength bolts:
a. Bethlehem Steel Corporation.
b. Mid-South Bolt and Screw Co., Inc.
c. J and M Turner, Inc.
3. Alternate design high-strength bolts:
a. T. C. Bolt Corporation.
b. Construction Fastener Systems Division of Bristol Machine Company.
c. LeJuene Bolt Co.
4. Headed studs and deformed bar anchors:
a. Nelson Stud Welding Division, TRW, Inc.
b. Stud Welding Products, Inc.

B. Acceptable Fabricators:
1. Distran Products, Inc.
2. Falcon Steel
3. Galvinizers, Inc.
4. Meyer T&B Industries
5. Valmont/Tulsa

2.2 MATERIALS

A. Steel, Structural Shapes and Plate (unless noted otherwise on Drawings):
1. All W-shapes and WT-shapes: ASTM A572, Grade 50.
a. Provide ASTM A572, Grade 50 with special requirements per AISC Technical Bulletin #3, New Shape Material, dated March 3, 1997.
b. ASTM A992 may be used in lieu of ASTM A572, Grade 50.
2. All other plates and rolled shapes: ASTM A36.

B. Wide Flange Beams: ASTM A992 (Fy=50 KSI)

C. Plate and Bar: ASTM A36 (Fy=36 KSI).

D. Pipe: ASTM A53, Grade B (Type E or S) (Fy=35 KSI).

E. Hollow Structural Sections (HSS):
1. Round: ASTM A500, Grade B (Fy=42 KSI)
2. Square or rectangular: ASTM A500, Grade B (Fy=46 KSI)

F. High-Strength Bolts, Nuts and Washers, ASTM A325 with A563 Type DH specifications:
1. High-strength bolts:
a. Provide two ASTM F436 washers for all bolts.
b. Provide beveled washers at connections of sloped/tapered sections.
2. High-strength bolts with load indicating devices, ASTM F959, Type 325.
a. Provide at Contractor's option and subject to approval of Engineer.
3. Alternate high-strength design:
a. Provide at Contractor's option and subject to approval of Engineer.

G. Bolts and Nuts, Unfinished: ASTM A307, Grade A.

H. Washers, Plain (Unfinished Bolts): ANSI B18.22.1, Type B.

I. Welding Electrodes (AWS):
1. Shielded metal arc: AWS A5.1 or AWS A5.5, E70XX or E801X-X.
2. Submerged arc: AWS A5.17 or AWS A5.23, F7XX-EXXX or F8XX-EXXX-XX.
3. Gas metal arc: AWS A5.18, E70S-X or E70U-1 or AWS A5.28, ER805-XX, E80C-XXX.
4. Flux cored arc: AWS A5.20, E7XT-X (except 2, 3, 10, GS), AWS A5.29, E7XT-X or E8XTX-X, E8XTX-XM.

J. Anchor Rods and Bolts:
1. ASTM F1554, Grade 55 with weldability supplement S1 or ASTM A36for threaded rods
2. ASTM A307, Grade A for headed bolts {galvanized}.
3. ASTM F593 type 304 or 316 stainless steel with matching nut and washer.

K. Headed Studs and Deformed Bar Anchors:
1. Studs: ASTM A108, complying with AWS Code Section 7, Type B; minimum yield strength 50,000 psi, minimum tensile strength 60,000 psi.
a. Uniform diameter.
b. Heads: Concentric and normal to shaft.
c. Weld end: Chamfered and solid flux.

2. Deformed anchor bars: ASTM A496, complying with AWS Code Section 7 Type C. Minimum yield strength 70,000 psi. Minimum tensile strength 80,000 psi.
   a. Straight, unless indicated otherwise.
   b. Solid flux.
3. After welding, remove ceramic ferrules and maintain free from any substance which would interfere with function, or prevent bonding to concrete.

2.3 FABRICATION

A. Structure:
1. Steel structures shall be fabricated as shown on the Drawings.
2. Supplier shall assume responsibility as noted.
3. Supplier shall verify all dimensions to verify proper fit up of structure connections prior to fabrication.
4. Any deviation in dimension or materials from that shown on the drawings shall be submitted to the Engineer for his written approval prior to fabrication. Such submittals shall be in form of shop fabrication drawings, per Section 1-3 of this specification.

B. Materials:
1. Prior to being worked in any manner, structural materials shall be cleaned of all rust and foreign particles.
2. Material shall be straight within the tolerance allowed by ASTM Specification A6.
3. If straightening is necessary, it may be done by mechanical means or by application of a limited amount of localized heat. Straightening shall be done in a manner that will not injure the material.

C. Punching and drilling shall be done accurately:
1. Center to center distance between holes of a piece shall not vary more than 1/16 inch from the specified dimension.
2. Holes other than those shown on the drawings and those required for the galvanizing process shall be approved by the Engineer. Burrs caused by drilling or punching shall be removed prior to galvanizing.

2.4 GALVANIZING

A. All structural members, hardware and locknuts shall be hot dip galvanized, in accordance with ASTM A123, A143, A153, A384, A385, A386.

B. Steel to be galvanized shall be clean and free from welding slag.

C. All burrs and sharp edges shall be ground smooth.

D. Material on which the galvanizing has been damaged may be redipped, unless damage is local and can be satisfactorily repaired by applying two coats of zinc base paint. Any member which has the galvanized coat damaged after being dipped twice shall be rejected.

E. In order to accommodate the galvanizing process:
1. All tubular column baseplates and closed tubular beam end plates shall have vent holes for pressure relief and drainage or as detailed on the drawings.
2. All gussets shall be cropped on inside corners.
3. All tubular columns with welded top plates shall semi-circular holes cut into the top of the tube.
4. All tubular columns with baseplates to be grouted shall have semi-circular holes cut into the bottom of the tube to serve as weep holes, unless otherwise indicated on the drawings.

2.5 WELDING

A. Comply with AWS Code, and other requirements indicated herein, for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.
   1. Qualify joint welding procedures or test in accordance with AWS qualification procedures.

B. Test and qualify welders, welding operators and tackers in compliance with AWS Code for position and type of welding to which they will be assigned.
   1. Conduct tests in presence of approved testing agency.
   2. Certification within previous 12 months will be acceptable, provided samples of the welder's work are satisfactory.

C. Before Starting Welding:
   1. Carefully plumb and align members in compliance with specified requirements.
   2. Fully tighten bolts.
   3. Comply with Section 5 of AWS Code for assembly and surface preparation.
   4. Preheat base metal to temperature stated in AWS Code.
      a. When no preheat temperature is given in AWS Code and base metal is below 50 DegF, preheat base metal to at least 70 DegF.
      b. Maintain temperature during welding.
      c. Preheat surface of all base metal within distance from point of welding equal to thickness of thicker part being welded or 3 IN, whichever is greater, to specified preheat temperature.
      d. Maintain this temperature during welding.
   5. Each welder shall use identifying mark at welds.

D. Make flange welds before making web welds.

E. Where groove welds have back-up plates, make first three passes with 1/8 IN round electrodes.
   1. Use backup plates in accordance with AWS Code, extending minimum of 1 IN either side of joint.

F. Flame cut edges of stiffener plates at shop or field butt weld. Do not shear.

G. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.

H. Low Hydrogen Electrodes: Dry and store electrodes in compliance with AWS Code.

I. Do not perform welding when ambient temperature is lower than 0 DegF or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.

J. Headed Studs and Deformed Bar Anchors:
   1. Automatically end welded in accordance with the AWS Code and manufacturer's recommendations.
   2. Fillet welding of headed studs and deformed bar anchors is not allowed unless approved by Engineer.

K. Test in-place studs in accordance with requirements of AWS Code to ensure satisfactory welding of studs to members.
   1. Replace studs failing this test.

L. When headed stud-type shear connectors are to be applied, clean top surface of members to receive studs in shop to remove oil, scale, rust, dirt, and other materials injurious to satisfactory welding. Do not shop paint or galvanize metal surfaces to receive field applied studs.

2.6 SOURCE QUALITY CONTROL

A. OWNER pays for inspection and testing:

B. Responsibilities of Testing Agency:
   1. Inspect shop and field welding in accordance with Section 6 of AWS Code including the following non-destructive testing:
      a. Visually inspect all welds.
      b. In addition to visual inspection, test 50 percent of full penetration welds and 20 percent of fillet welds with liquid dye penetrant.
      c. Test 20 percent of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
   2. Inspect high-strength bolting in accordance with Section 9 of the Specification for Structural Joints.
      a. Verify proper pretension for slip-critical bolted connection.
      b. Verify direct tension indicator gaps.
   3. Inspect structural steel which has been erected.
   4. Inspect stud welding in accordance with Article 7.8, AWS Code.
   5. Prepare and submit inspection and test reports to Engineer. Assist Engineer to determine corrective measures necessary for defective work.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor is solely responsible for safety. Construction means and methods and sequencing of work is the prerogative of the Contractor. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, bracing or rigid connections are installed.
   1. Partially complete structural members shall not be loaded without an investigation by the Contractor.
   2. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, furnished, and installed by the Contractor for the partially complete structure.

B. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including wind, construction activities, and operation of equipment is the responsibility of the Contractor.
   1. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
   2. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
   3. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades. If not obvious from experience or from the Drawings, the Contractor shall confer with the Engineer to identify those structural steel element that must be complete before the temporary bracing system is removed.
   4. Remove and dispose of all temporary work and facilities off-site.

C. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work. Report defects in work-in-place which may influence satisfactory completion of the work. Absence of such notification will be construed as acceptance of work-in-place.

D. Field Measurement: Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings. Contractor responsible for the accurate fit of the work.

E. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection. Notify Engineer of any errors or deviations found by such checking.

3.2 ERECTION

A. Framing member location tolerances after erection shall not exceed the frame tolerances listed in Article 3.3.

B. Erect plumb and level; introduce temporary bracing required to support erection loads.

C. Use light drifting necessary to draw holes together. Drifting to match unfair holes is not allowed.

D. Welding:
   1. Conform to AWS D1.1 and requirements of this Specification.
   2. When joining two sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.

E. Shore existing members when unbolting of common connections is required.
   1. Use new bolts for rebolting connections.

F. Clean stored material of all foreign matter accumulated during erection period.

G. Clean bearing and contact surfaces before assembly.

H. Set beam and column base and bearing plates accurately, as indicated, on nonshrink grout.
   1. Set and anchor each base plate to proper line and elevation.
   2. Use metal wedges, shims or setting nuts as required and tighten anchor bolts.
      a. Use same metal as base plate.
      b. Cut off protrusions of wedges and shims flush with edge of base plate.
   3. Fill sleeves around anchor bolts with nonshrink grout.
   4. Pack grout solidly between bottom of plate and bearing surface.

I. Anchor Bolts:
   1. Anchor bolt location tolerance per Section 7.5 of the Code.
   2. Tie anchor bolts in position to embedded reinforcing steel using wire.
   3. Welding or tack welding is prohibited.
   4. Provide steel templates for locating anchor bolts.
   5. Coat bolt threads and nuts with heavy coat of clean grease.

J. Install high strength bolts with hardened washers. Install and tighten in accordance with Section 8 of Specifications for Structural Joints.
   1. Coordinate installation with inspection. Do not start installation until coordination with Testing Agency is complete.
   2. Bearing-type connections: High-strength bolts shall be tightened to snug-tight condition.
   3. Slip-critical connections: Perform calibration testing for all methods of installation of high-strength bolts in accordance with Section 8(b) of Specification for Structural Joints, using ASTM A325 or A490 bolts.
      a. Turn-of-nut tightening: Torque wrenches shall be used only by laboratory personnel.
      b. Calibrated wrench tightening: Calibrate on a daily basis.

c. Direct tension indicator tightening: If previously approved by Engineer.
d. Installation of alternate design bolts: If previously approved by Engineer.

4. In the event any bolt in a connection is found to be defective, check and retighten all bolts in the connection.

K. Do not use gas cutting to correct fabrication errors. In case members do not fit or holes do not match, ream out the holes and insert the next larger size bolt. If the connections require new holes, then drill new holes. Make no such corrections without prior approval of the Engineer.

1. Burning of holes: Not permitted.

L. Prior to making field connections to existing structural steel, remove completely all paint from existing steel which will be in contact with new steel and new welds.

M. Tighten and leave in place erection bolts used in welded construction.

N. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1 in 20 with a plane normal to bolt axis.

O. After bolts are tightened, upset threads of A307 unfinished bolts and anchor bolts to prevent nuts from backing off.

P. After erection, grind smooth all sharp surface irregularities resulting from field cutting or welding; power tool clean welds, bolts, washers and abrasions to shop coat removing all rust and foreign matter.

3.3 FIELD QUALITY CONTROL

A. Testing Agency responsibilities are described in Article 2.6.

B. Erected Frame Tolerance (Unless noted otherwise on the Drawings):

1. Overall finished dimensions shall not exceed cumulative effect of rolling, fabrication and erection tolerance.
2. Erection tolerances are defined relative to member working points and working lines as follows:
   a. Actual centerline of top flange or surface at each end for horizontal members.
   b. Actual center of member at each end for all other members.
   c. Other points may be used, providing they are based on these definitions.
   d. Working line is straight line connecting member working points.
3. Tolerances on position and alignment are as specified in the Code, unless otherwise modified. "Adjustable items" such as lintels, wall supports, curb angles, window mullions and similar members shall be provided with adjustable connections to supporting structural frame.
4. Steel erector shall certify the location of erected structural steel is acceptable for plumbness, level and aligned within tolerances specified. Such certification can be provided upon completion of any part of work and shall be done prior to start of work by other trades that may be supported, attached or applied to structural steel work.

3.4 CLEANING AND REPAIR OF SHOP PRIMER PAINT

A. After erection, clean all steel of mud or other foreign materials, and repair any damage. Touchup coatings to comply with Section 09905.

END OF SECTION

SECTION 07900
JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sealant work.

B. Work included consists of but is not necessarily limited to:
   1. Sealing all joints which will permit penetration of dust, air or moisture, unless sealing work is specifically required under other sections.
      a. Work may include the following:
         1) Flashing reglets and retainers.
         2) Isolation joints.
         3) Concrete construction.
         4) Sawed joints in interior concrete slabs.
         5) Joints at penetrations of floors and other services and equipment.
         6) Sealing around conduit penetrations through floors.
         7) Other joints where calking, sealant, expanding foam sealant or compressible sealant is indicated.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 302.1R, Guide for Concrete Floor and Slab Construction.
   2. ASTM International (ASTM):
      a. C834, Standard Specification for Latex Sealants.
      b. C920, Specification for Elastomeric Joint Sealants.
   3. National Sanitation Foundation International (NSF).
   4. Underwriters Laboratories, Inc., (UL).

B. Qualifications: Sealant applicator shall have minimum 5 years experience using products specified on projects with similar scope.

C. Mock-Ups:
   1. Before calking work is started, a sample of each type of joint shall be calked where directed by the Engineer.
      a. The approved samples shall show the workmanship, bond, and color of calking materials as specified or selected for the work and shall be the minimum standard of quality on the entire project.

1.3 DEFINITIONS

A. "Caulk(ing)," "calk(ing)," and "sealant": Joint sealant work.

B. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

C. Finish sealant: Sealant material per this specification applied over face of compressible sealant or expanding foam sealant specified, to provide a finished, colored sealant joint.

D. Defect(ive): Failure of watertightness or airtightness.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's recommendations for joint cleaner, primer, backer rod, tooling and bond breaker.
   2. Warranty.
   3. Certification from sealant manufacturer stating product being used is recommended for and is best suited for joint in which it is being applied.
   4. Certification of applicator qualification.

B. Samples:
   1. Cured sample of each color for Engineer's color selection.
   2. Color chart not acceptable.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver material in manufacturer's original unopened containers with labels intact: Labels shall indicate contents and expiration date on material.

1.6 WARRANTY

A. Material and Labor Warranty:
   1. Sealant work free of defects for a period of 3 years from date of final acceptance.
   2. Remove any defective work or materials and replace with new work and materials.
   3. Warranty signed jointly by Applicator and sealant manufacturer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Polyurethane sealants:
      a. Pecora.
      b. Sika Chemical Corp.
      c. Sonneborn - Rexnord.
      d. Tremco.
   2. Silicone sealants:
      a. General Electric.
      b. Dow Corning Corp.
      c. Tremco.
   3. Backer rod, compressible filler, primer, joint cleaners, bond breaker: As recommended by sealant manufacturer.

2.2 MATERIALS

A. Sealants - General:
   1. Provide colors matching materials being sealed.
   2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
   3. Nonsagging sealant for vertical and overhead horizontal joints.

B. Polyurethane Sealant:
   1. One or two components.
   2. Paintable.
   3. Meet ASTM C920 Type S or Type M, Grade NS or P, Class 25, Use NT, T, M, A and O.
      a. Pecora Dynatrol-IXL, Dynatrol II, Urexpan NR-200, NR-201.
      b. Sika Chemical Corporation Sikaflex-1a, Sikaflex-2C NS/SL.
      c. Sonneborn Sonolastic NP-1, NP-II, SL-1 SL-2.
      d. Tremco Dymonic or Dymeric, Vulkem 116,227,45,245.

C. Silicone Sealant:
   1. One component.
   2. Meet ASTM C920, Type S, Grade NS, Class 25, Use NT, G, A, O.
      a. General Electric: Silpruf, Silglaze II.
      b. General Electric: Sanitary 1700 sealant for sealing around plumbing fixtures.
      c. Dow Corning: 786 for sealing around plumbing fixtures.
      d. Dow Corning: 790, 795.
      e. Tremco: Spectrem 1, Spectrem 3, Tremsil 600.
   3. Mildew resistant for sealing around plumbing fixtures.

D. Sealant Backer Rod and/or Compressible Filler:
   1. Closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, nonbituminous material recommended by sealant manufacturer to:
      a. Control joint depth.
      b. Break bond of sealant at bottom of joint.
      c. Provide proper shape of sealant bead.
      d. Serve as expansion joint filler.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before use of any sealant, investigate its compatibility with joint surfaces, fillers and other materials in joint system.

B. Use only compatible materials.

C. Where required by manufacturer, prime joint surfaces.
   1. Limit application to surfaces to receive calking.
   2. Mask off adjacent surfaces.

D. Provide joint depth for joints receiving polyurea joint filler in accordance with manufacturer's recommendations.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions and UL requirements.

B. Clean all joints.

C. Make all joints water and airtight.

D. Make depth of sealing compounds, except expanding foam and polyurea sealant, not more than one-half width of joint, but in no case less than 1/4 IN nor more than 1/2 IN unless recommended otherwise by the manufacturer.

E. Provide correctly sized backer rod, compressible filler or compressible sealant in all joints to depth recommended by manufacturer:
   1. Take care to not puncture backer rod and compressible filler.

2. Provide joint backer rod as recommended by the manufacturer for polyurea joint filler.

F. Apply bond breaker where required.

G. Tool sealants using sufficient pressure to fill all voids.

H. Upon completion, leave calking with smooth, even, neat finish.

3.3 SCHEDULE

A. Furnish sealant as indicated for the following areas:
1. Exterior areas: Polyurethane, Silicone.

END OF SECTION

SECTION 10444
SIGNAGE

GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Warning signs.
   2. Equipment identification signs.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. C2, National Electrical Safety Code (NESC).

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   2. Schedule of all signs indicating text and graphics.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Safety signs:
      a. Electromark.
      b. Premax.
      c. Or Approved Equal.

2.2 MATERIALS

A. Safety Signs:
   1. Exterior: Plexiglass or 18 gauge steel.

2.3 FABRICATION

A. Warning High Voltage Warning Signs
   1. Provide four (4) "Warning High Voltage" signs.
   2. Signs shall be standard design, colored red, black, and white.

B. Phase Identification Signs
   1. Phase identifications signs shall be located under each phase at the following locations:
      a. At both ends of the 230kV main bus, two (2) sets of signs.
   2. Signs shall be approximately six inches by six inches.
   3. Phases shall be identified by A, B, and C.

C. Switch Signs

1. Switch signs shall be approximately 12 x 16 inches.

D. Transformer and Power Circuit Breaker Signs
   1. Signs shall be approximately 12 x 16 inches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Safety Signs:
   1. Sign mounting shall be accomplished with self-tapping washer head screws.
   2. Signs larger than 6" x 6" shall be mounted with galvanized channel (B-line B-22 or equivalent) full length across top and bottom of back.
   3. Provide safety markers including guard posts and connecting rope or chain as specified below.

B. Warning High Voltage Warning Signs:
   1. Sign shall be centered along each fence side at a height of 5'-0".
   2. Signs shall be mounted on the outside of the fence, facing outward, as shown on the drawings.

END OF SECTION

SECTION 16121
MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Single conductor #1/0 AWG, 250kcmil, 500kcmil and 1000 kcmil copper, 35kV primary underground cable. The cable shall be suitable for use in wet and dry locations in conduit, underground duct, direct burial and aerial riser installation.
      b. 35kV cable elbows, modules, splices, riser terminations and miscellaneous accessories.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Association of Edison Illuminating Companies (AEIC).
      a. CS8, Extruded Dielectric, Shielded Power Cables Rated 5 Through 46kV.
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 48, Alternating-Current Cable Terminations 2.5kV Through 756kV.
      b. 386, Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
      c. 404, Cable Joints for use with Extruded Dielectric Cable Rated 5000 - 138,000V and Cable Joints for use with Laminated Dielectric Cable Rated 2500 - 500,000V.
      d. 510, High-Voltage and High-Power Testing.
   3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. WC 74/S-93-639, 5-46kV Shielded Power Cable for Use in the Transmission & Distribution of Electric Energy.
      b. WC74/S-97-682, 5-46kV Standard for Utility Shielded Power Cable.
   4. InterNational Electrical Testing Association (NETA):
      a. Acceptance Testing Specifications For Electrical Power Distribution Equipment and Systems.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 70E, Electrical Safety Requirements for Employee Workplaces.
   6. Occupational Safety and Health Standards (U.S. Department of Labor) (OSHA).
   7. Underwriters Laboratories, Inc. (UL):
      a. 1072, Medium Voltage Power Cables.

B. Qualifications:
   1. Cable technician:
      a. Three years experience in handling, terminating and splicing medium voltage cables.
      b. Specifically trained by a factory representative on the terminations and splices to be used on the project. If not trained on the products to be used, on-site training by the factory representative shall be preformed before any terminations or splices are made.
   2. Cable testing :
      a. The independent testing organization shall have been engaged in full practice in the final inspection, testing, calibration, and adjusting of electrical distribution systems, for a minimum of five years.

b. The independent testing organization shall have a calibration program with accuracy traceable every six months in an unbroken chain, to the National Institute of Standards and Technology (NIST).

c. The independent testing organization shall have a designated safety representative on the project. The standards followed shall include OSHA, NFPA 70E and IEEE 510.

d. Inspection, testing, and calibration shall be performed by an engineering technician, certified by a national organization, such as the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies, with a minimum of five years experience inspecting, testing, and calibrating electrical equipment, systems and devices. Information on the certified engineering technician shall be submitted to the Engineer for approval prior to the start of work.

e. The qualifications of the independent testing organization shall be submitted to the Engineer for approval prior to the start of testing. Full membership to the InterNational Electrical Testing Association constitutes proof of meeting all of the above requirements.

1.3 SUBMITTALS

A. Shop Drawings:
   1. 35kV primary underground cable.

B. Miscellaneous:
   1. Cable Technician qualifications.
   2. Independent testing organization qualifications.
   3. Engineering Technician qualifications.
   4. Cable test reports signed by the engineering technician including the following information:
      a. Summary of Project.
      b. Description of equipment/components tested.
      c. Visual inspection report.
      d. Description of tests.
      e. Test results including appropriate test forms.
      f. Conclusions and recommendations.
      g. Identification of test equipment used.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Ship cable with removable watertight end seals, and store in dry place.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Wire and cable:
      a. The Okonite Company.
      b. Prysmian Cables & Systems
      c. Nexans Canada, Inc.
      d. Southwire
   2. Lugs, connectors, dead break elbows, insulated protective caps, bushing adapters, lightning arresters and terminations:
      a. Raychem.
      b. Elastimold.
      c. Joslyn.
      d. RTE.

e. Cooper Power Systems.
f. 3M.

2.2 MEDIUM VOLTAGE CABLES

A. Ratings:

1. 35kVPrimary Underground Cable. Single conductor #1/0 AWG, 250kcmil, 500 kcmil and 1000 kcmil copper suitable for use in wet and dry locations in conduit, underground duct, direct burial and aerial riser installations.

2. Cable shall be rated 90°C for normal operation, 130°C for emergency overload conditions and 250°C for short circuit conditions.

B. Standards:

1. WC 74/S-93-639, 5-46kV Shielded Power Cable for Use in the Transmission & Distribution of Electric Energy.
2. WC74/S-97-682, 5-46kV Standard for Utility Shielded Power Cable.
3. CS8, Extruded Dielectric, Shielded Power Cables Rated 5 Through 46kV.
4. UL 1072, Medium Voltage Power Cables

C. Conductor Material:

1. Conductor shall be uncoated bare copper conductor with strand filling compound, stranded in accordance with ICEA standards, class B stranding.

D. Insulation:

1. Insulation shall be a cross linked polyethylene compound with tree retardant additive (XLP-TR), or ethylene propylene rubber (EPR) and shall be extruded and cured with the conductor and insulation screens. The minimum average insulation thickness shall be 345 mils (100% insulation level).

E. Shielding:

1. Conductor shield shall be an extruded layer of semi-conducting compound with volume resistivity not in excess of 50,000 ohm-cm at 90°C. Screen shall be free stripping from the conductor and firmly bonded to the insulation.

F. Insulation Shield or Concentric Neutral:

1. Insulation Shield: Insulation shield shall be an extruded layer of semi-conducting thermosetting compound with volume resistivity not in excess of 50,000 ohm-cm at 90°C. The shield shall be extruded directly over the insulation. Insulation shield shall be printed in ink "semi-conducting – remove when splicing or terminating." Over this layer shall be applied a helically wrapped copper tape with 25% overlap, or a concentric serve of annealed solid bare copper wires over which shall be applied a lapped non-metallic tape. Shield shall be sized for 11,000 amps available L-G short circuit current for 30 cycles.
2. Concentric Neutral: Solid copper wires shall be spirally applied to provide rating equal to the cable conductor current rating for the 500kcmil cable and 1/6 of the cable conductor current rating for the 1000kcmil cable.

G. Jackets:

1. Overall jacket shall be insulating PVC or LLDPE. The jacket shall be applied in such a manner that neutral wires are not displaced and voids between neutral wires and the jacket are negligible.

H. Identification:

1. Cables shall be permanently marked with the manufacturer, year of manufacture, sequential footage numbers, cable type, insulation thickness, conductor size and type and rated voltage.

I. Factory Tests:

1. Reports of factory tests shall be provided at the time of shipment. Tests shall include:
   a. High voltage Ac and DC
   b. Conductor resistance
   c. Corona discharge
2. Tests shall be conducted on shipping lengths.

2.3 CABLE ACCESSORIES

A. Lugs and Connectors:
   1. Lugs:
      a. Compression type.
      b. Standard: UL 486B for aluminum and copper cables.
      c. Voltage rating: Up to 35 kV.
      d. Current rating: Continuous operation at the rating of the cable.
      e. Material: Aluminum with bronze underplating, tin outerplating and aluminum anti-oxide paste.
      f. Number of holes: Two
   2. Aerial stem connectors:
      a. Same as lug type, except with a 6 IN copper stem.
   3. Splice connectors:
      a. Standard: UL 486B for aluminum and copper cables.
      b. Voltage rating: Up to 35kV.
      c. Current rating: Continuous operation at the rating of the cable.
      d. Material: Aluminum with bronze underplating, tin outerplating and aluminum anti-oxide paste.

B. Terminations:
   1. End caps:
      a. Cold or hot shrink.
      b. Used to environmentally seal and mechanically protect exposed cable ends.
   2. Cold shrink kits:
      a. Standard: IEEE 48, Class 1 termination.
      b. Voltage rating: Same as the cable rating.
      c. Current rating: Continuous operation at the rating of the cable.
      d. One piece design, where high-dielectric constant stress control is integrated within a skirted insulator made of silicone rubber.
      e. Suitable of contaminated indoor and outdoor locations.
   3. Molded rubber kit:
      a. Standard: IEEE 48.
      b. Voltage rating: Same as the cable rating.
      c. Current rating: Continuous operation at the rating of the cable.
      d. One piece design or modular with stress cone and skirts, where high-dielectric constant stress control is integrated within a skirted insulator made of EPDM rubber.
      e. Suitable of contaminated indoor and outdoor locations.

C. Splices:
   1. Cold shrink kits:
      a. Standard: IEEE 404.
      b. Voltage rating: Same as the cable rating.
      c. Current rating: Continuous operation at the rating of the cable.
      d. One piece design, comprised of an insulation shield, insulation layer and a silicone rubber body.
      e. Suitable for indoor, direct burial or submersible applications.
   2. Molded rubber kit:
      a. Standard: IEEE 386 or 404.

b. Voltage rating: Same as the cable rating.
c. Current rating: Continuous operation at the rating of the cable.
d. One or multi piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
e. Suitable for indoor, direct burial or submersible applications.

3. Modular separable molded rubber:
a. Standard: IEEE 386.
b. Voltage rating: Same as the cable rating.
c. Current rating: 600A.
d. One piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
e. Deadfront, deadbreak type.
f. Components: T-body, insulating plug with cap, insulating plug with cap and stud, and connecting plug.
g. Suitable for submersible applications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not install cable during wet conditions.
1. Prior to pulling cables, drain or pump low points of trench if standing water is present.
2. Blow out conduits with dried compressed air if moisture is present in conduits.
3. Install end caps immediately on all cut ends of cable prior to pulling, and maintain end caps while pulling in cable.
a. If end caps are damaged, remove and install new end caps.
b. Do not remove end caps until ready to terminate or splice cable.

B. Do not install conductors when ambient temperature is near minimum as recommended by manufacturer for installation of the type of conductor insulation.

C. Provide voltage rated prefabricated terminations at each shielded cable termination.
1. Select correct termination to match cable diameter and construction.
2. Form and install terminations in strict accordance with instructions of cable manufacturer and termination manufacturer.

D. Splices:
1. Provide components in kit form, complete with instructions, supplied by a single approved manufacturer and suitable for the type of cable being used. Prepare cable ends, provide materials and follow all application steps in accordance with manufacturer's instructions.
a. As a minimum requirement:
1) The cable ends shall be cut squarely.
2) The insulation shall be free from nicks or burrs after removal of jacket.
3) The conductors shall be cleaned and an oxide inhibitor applied.
4) For splices, connector indents shall be filled with insulating putty to eliminate voids.
5) Attach grounding lead to system ground.

2. Splices shall be avoided whenever possible.
a. No more than one splice is permitted between termination points.
b. No splices are permitted in runs less than 100 FT long.
c. Do not pull splices into ductbanks or conduits or leave them under tension.
d. All splice points shall be GPS located and properly documented.
e. Contractor shall supply cable splicing schedule for engineering review and approval prior to cable installation.

3.2 FIELD QUALITY CONTROL

A. After all terminations and splices have been made, and prior to connections to equipment, provide the following acceptance tests:
   1. Shield continuity test.
   2. DC high-potential test.

B. The acceptance tests shall be performed per NETA's Acceptance Testing Specifications For Electrical Power Distribution Equipment and Systems.

END OF SECTION

SECTION 16122
ELECTRICAL BUS AND OVERHEAD STATIC WIRE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Electrical Bus (Pipe).
      b. Electrical Bus (Cable).
      c. Overhead Static Wire.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronic Engineers/American National Standards Institute (IEEE/ANSI):
   2. American Society for Testing and Materials (ASTM):
      a. B187/B197M-03, Standard Specification for Copper, Bus Bar, Rod, and Shapes.
      b. B188-02, Standard Specification for Seamless Copper Bus Pipe and Tube.
      c. B1, Standard Specification for Hard-Drawn Wire.
      d. B232/B-232M, Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR).
   3. National Fire Protection Association (NFPA):
      a. 70B, National Electrical Code (NEC).

1.3 DEFINITIONS

A. Bus (Pipe): An extruded tubular product used to convey electricity.

B. Alloy: A substance composed of two or more metals.

C. Bus (Cable): Used to convey electricity.

D. Overhead Static Wire: Wire used for the protection of equipment from lighting strikes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Bus (Pipe):
      a. Alcoa.
      b. Or Approved Equal.
   2. Bus (Cable):
      a. South Wire.
      b. Or Approved Equal.
   3. Overhead Static Wire:
      a. Okonite.
      b. Or Approved Equal.

2.2 MANUFACTURED UNITS

A. Bus (Pipe):
   1. Alloy to be 6063.
   2. Temper to be type T6.
   3. Bus to be 3½" and 5" IPS Schedule 40 Al.
   4. Bus to have smooth surface Industry Class IV finish.

B. Bus (Cable):
   1. 1272 KCM AAC, 61 Strand.
   2. 397.5 KCM AAC, 19 Strand.

C. Overhead Static Wire:
   1. 3/8" H.S.S.

PART 3 - EXECUTION

3.1 INSTALLATION

A. CONTRACTOR to carefully inspect to assure pipe is free of any mars, burrs, rough welds or any defect likely to cause high values of corona discharge.

B. Bus conductor which cannot be suitably repaired shall be rejected.

C. Bus conductor shall be cleaned using emery cloth or other approved means, to a finish that is uniform in appearance and free of discoloration.

D. All tube splices shall be welding-type and designed to insure that maximum strength is retained in the tube section.

E. All bus conductor shall be cut to the proper length and terminated in a manner to insure that mechanical stresses are not transferred to insulators, bushings, or other power equipment.

F. All sections of tubular conductor longer than eight feet between supports shall have damping conductor installed.

G. Damping conductor shall be cut to length approximately four inches shorter than the tubular section and shall be free to move inside the tube.

H. Refer to drawings for Damping conductor size.

I. Buss connectors are specified on the drawings. The "Or Equal" clause will apply to all Contractor furnished connectors where a specific manufacturer part number or type is listed.

J. For equipment rated 600 amps and below, use NEMA 2-hole pads.

K. For equipment rated 1200 and 1600 amps, use NEMA 4-hole, 3"x3" pads

L. Bolted connections shall be fastened with stainless steel bolts.

M. On copper-to-aluminum and aluminum-to-aluminum connections, each bolt shall be furnished with one Belleville and two flat washers.

N. On copper-to-copper connections use one flat and one lock washer.

O. Copper and copper alloy composition connectors shall have tinned contact surfaces where used for copper-to-aluminum connections.

P. Stainless steel Bellville washers shall be a minimum of 7/64" thick by 1-1/16" diameter with a 5000 pound load required to flatten the washer.

Q. Stainless steel flat washers shall be a minimum of 0.125" thick and shall be 1 5/8" diameter.

R. All bolts shall be sized to extend completely through nuts, with a minimum of ⅛" and a maximum of ¼" thread reveal when properly torqued.

S. All bus bolts shall be tightened with a torque wrench to the following specifications, Fastener Material / Diameter / Torque (Ft-Lbs):
   1. Bronze & Stainless Steel / ½" / 40.
   2. Bronze & Stainless Steel / ⅝" / 55.
   3. Lubricated Aluminum / ½" / 25.
   4. Lubricated Aluminum / ⅝" / 40.
   5. Unlubricated Aluminum / ½" / 35.
   6. Unlubricated Aluminum / ⅝" / 50.

T. Using a torque-limiting wrench set at 50% of the recommended value, tighten all bolts in sequence.

3.2 OVERHEAD STATIC WIRE

A. Installation and material requirements for all static wire shall be as shown on the drawings. Installation shall be accomplished in a manner acceptable to the Engineer, with equipment specifically designed for the purpose. Stringing shall be accomplished by means of pulleys or other devices to avoid damage from cable tensioning equipment gripping attachments. No splices in static wire will be allowed.

END OF SECTION

SECTION 16275
DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Two (2) distribution pad-mounted transformers.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI) and Institute of Electronic and Electrical Engineers (IEEE).
      a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V.
      b. 592, Standard for Exposed Semiconducting Shields on High-Voltage Cable Joints and Separable Insulated Connectors.
      c. C57.12.00, General Requirements for Liquid-immersed Distribution, Power, and Regulating Transformers.
      d. C57.12.26, Standard for Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors.
      e. C57.12.28, Pad-Mounted Equipment – Enclosure Integrity.
      f. C57.12.70, Terminal Markings and Connections for Distribution and Power Transformers.
      g. C57.12.80, Terminology for Distribution and Power Transformers.
      h. C57.12.90, Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.
      i. C62.11, Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits.
   2. National Electrical Manufacturers Association (NEMA).

1.3 SUBMITTALS

A. Shop Drawings (By OWNER):
   1. Product technical data:
      a. Technical Data.
      b. Nameplate drawing.
   2. Test reports:
      a. Factory tests.

PART 2 - PRODUCTS

2.1 THREE PHASE TRANSFORMER

A. General:
   1. Transformer to be designed and constructed in accordance with ANSI Standard C57.12.00, C57.12.26, C57.12.70, C57.12.80.
   2. "Unit residential" type padmount transformers are not acceptable.
   3. Manufacturer shall be aware that transformers will be utilized for lighting and auxiliary loads within substation. As such, the transformers will be used in a step down configuration.

4. Unit shall be shipped completely filled with non-PCB insulating oil. Provide certification of PCB tests of each unit.

B. Ratings:
1. Type: Outdoor, pad-mounted, liquid-immersed, self-cooled, compartmental type.
2. Operation and application: Step-down operation.
3. Voltage Ratings:
   a. Primary Voltage: 34,500 Delta Volts, 200 BIL
   b. Secondary Voltage: 480 Volts, grounded Y/277 V, 30kV BIL.
4. kVARatings: 750kVA, 3-Phase, Class ONAN, 65°C rise.
5. Number of phases: Three (3).
6. ANSI Standard impedance 5%, plus tolerance in accordance with ANSI C57,12.00.
7. Frequency: 60 Hz.
8. Polarity: ANSI standard.
9. Connections:
   a. Primary: 200 amp deadbreak bushings.
   b. Secondary: NEMA standard 10 hole spade bushing per ANSI C57,12.26.

C. Components:
1. Windings: Copper.
2. Tank:
   a. Sealed-tank construction with welded main cover and bolted tamper-resistant handhole.
   b. Steel divider between high-voltage and low-voltage compartments.
   c. No exposed screws, bolts, or other fastening devices that are externally removable.
   d. No openings through which foreign objects such as sticks, rods, or wires may contact live parts.
   e. 24 IN deep cabinet (minimum)
   f. One-inch upper fill plug.
   g. One-inch drain valve with sampling device.
   h. Automatic pressure relief device.
   i. Oil level gauge and oil temperature gauge.
   j. Stainless steel NEMA 2-hole ground pads.
   k. Oil sampling device.
3. Door:
   a. Each compartment will have removable, three-point latching hinged doors equipped for latching in the open position.
   b. Provide door extenders as required to provide clearance for 200 Amp T-OPII terminator with ground elbows installed when enclosure doors are closed.
   c. The high-voltage compartment door will have a fastening device that is accessible only through the low-voltage compartment.
   d. The hinge assemblies made of corrosion-resistant material. Provide stainless-steel hinge pins of 3/8 IN minimum diameter.
   e. Both compartment doors capable of securing with a single padlock having a maximum 1/2 IN DIA shackle.
   f. Provide 7" x 10" caution warning signs on exterior of all access doors.
4. Unit protection:
   a. Provide unit protection with a partial-range current limiting fuse on each primary phase (under oil, factory replaceable only).
   b. High voltage fuse assembly shall have minimum interrupting rating of 10,000 Amps.
   c. Provide an expulsion-type, bayonet fuse (under oil, user serviceable) in series with the current limiting fuse. Hook stick operable, rated for load break operation. Current sensing fuse elements shall be installed. One (1) spare fuse element for each bayonet fuse shall be provided. Oil drip tray for each bayonet fuse shall be provided.

5. Finish:
   a. Manufacturer's standard corrosion protection system.
   b. Dark "padmount" green.
6. Permanently affix nameplate to outside of tank stamped "Non PCB".
7. Accessories:
   a. Liquid level indication.
   b. Dial-type thermometer.
   c. Provisions for pressure vacuum gage.
   d. Stainless steel or laser-scribed anodized aluminum nameplate, with date of manufacturer.
   e. Provide a minimum of two, welded, ground lug attachment points on lower front of transformer tank. Ground lugs shall accommodate 1/0 str. Cu ground conductor

2.2 SOURCE QUALITY CONTROL

A. Factory Tests: Test transformers in accordance with ANSI C57.12.90.

2.3 MAINTENANCE MATERIALS

A. Touch-up paint, two separate one quart containers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install on pad as detailed on Drawings and in accordance with manufacture's instructions.

B. Transformer locations as shown on drawings are intended to be used as a guide. Field conditions may affect actual transformer location. Coordinate final location with Owner.

END OF SECTION

SECTION 16341
35KV METALCLAD SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Design, fabricate and deliver, F.O.B. jobsite, Two (2) 35kV indoor switchgear.
   2. Checkout and field testing, prior to bus connections.
   3. On-site services of factory-trained service representative for technical direction, inspections, and testing.

B. Work by Others:
   1. CONTRACTOR will provide the following:
      a. Receiving and Unloading.
      b. Placement and assembly at jobsite.
      c. Connection to OWNER's bus.

C. The following drawings are hereby made part of this specification:
   1. TWESD-OL-01: Relay One Line Diagram.
   2. TWESD-TL-01: Three Line Diagram.
   3. TWESD-TL-02: Three Line Diagram.
   4. TWESD-TL-03: Three Line Diagram.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. C2, National Electrical Safety Code (NESC).
      b. C37.04, IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
      c. C37.06, AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities.
      d. C37.09, Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (Includes Supplements IEEE C37.09a, IEEE C37.09c, IEEE C37.09e, and IEEE C37.09g).
      e. C37.11, Requirements for Electrical Control for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis or a Total Current Basis.
      f. C37.21, Control Switchboards
      g. C37.20.7, Guide for Testing Medium-Voltage Metal-Enclosed Switchgear for Internal Arcing Faults.
      h. C37.23, Metal-Enclosed Bus and Calculating Losses in Isolated-Phase Bus
      i. C37.20.2, IEEE Standard for Metal-Clad and Station-Type Cubicle Switchgear.
      j. C62.11, Metal-Oxide Surge Arresters for Alternating Current Power Circuits.
      k. C57.13, Requirements for Instrument Transformers.
      l. C57.90, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
   2. National Electrical MANUFACTURERS Association (NEMA):
      a. ICS 6, Industrial Control and Systems: Enclosures
      b. SG2, High Voltage Fuses
      c. SG4, Alternating – Current High Voltage Circuit Breaker
      d. SG 5, Power Switchgear Assemblies
      e. NEMA SG4, Alternating Current High Voltage Circuit Breakers.
   3. American Society of Civil Engineers (ASCI)
      a. ASCE 7; Minimum Design Loads for Buildings and Other Structures.

4. American Institute of Steel Construction (AISC)
   a. Manual of Steel Construction, 9th Edition; Specification for Structural Steel Buildings – Allowable Stress Design.
5. American Iron and Steel Institute (AISI)
   a. Cold-Formed Steel Design Manual; Specification for the Design of Cold-Formed Steel Structural Members.
6. American Society for Testing and Materials (ASTM)
   a. A 123, Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A 143, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   c. A 153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   d. A 36, Standard Specification for Carbon Structural Steel.
   e. A 370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
   f. A 384, Standard Practice for Safeguarding Against Warpage and Distortion during Hot-Dip Galvanizing of Steel Assemblies.
   g. A 572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   h. A 6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   i. E 23, Standard Test Methods for Notched Bar Impact Testing of Metallic Materials.
7. UL 508 – Industrial Control Equipment.

B. Qualifications:
   1. History of satisfactory service in similar applications for a minimum of 5 years.

C. Product/Material Tests:
   1. Make certified reports of all design tests available upon request.
   2. Perform all routine or production tests specified or required by the referenced standards.

1.3 SYSTEM DESCRIPTION

A. The equipment will operate with two (2), 230,000 Grd/Y Volt – 34,500 Grd/Y Volt, 60/80/100 MVA substation power transformers.

B. Functional Description:
   1. The switchgear provides service for the distribution feeders serving Acciona Wind Turbine Collection System.

1.4 SUBMITTALS

A. Proposal Data:
   1. Furnish the following equipment and supplier information for each metalclad switchgear line-up with proposal. Failure to submit all items may be cause for rejection of proposal:
   2. Switchgear Assembly:
      a. General Information:
         1) Manufacturer.
         2) Assembly location.
         3) Nearest service location.
         4) Contact name, telephone, e-mail for technical questions.
      b. Physical Data:
         1) Overall dimensions, length, height and width.
         2) Total weight with circuit breakers.
         3) Largest single piece shipping dimensions.
         4) Largest single piece shipping weight.
   3. Circuit Breakers:
      a. General Information:
         1) Manufacturer.

2) Model.
3) Catalog Number.
4) Weight.

4. MANUFACTURER, model number, and product specifications for the following:
   a. Protective Relays.
   b. Communication hardware.
   c. Instrument transformers.
5. Itemized list section number of any exceptions taken to this specification. To be valid, all exceptions must be explicitly listed for consideration during proposal evaluation. Exceptions implied or described directly or indirectly in bills of material or other literature submitted with proposal without being explicitly listed will not be valid, VENDOR shall remain obligated to compliance.

B. Product Data: MANUFACTURER's specifications and technical data modified for this project, clearly indicating options to be provided including performance, construction and fabrication.
   1. Submit for OWNER approval prior to fabrication product technical data:
      a. Nameplate data for all equipment.
      b. Complete ratings and specifications.
      c. Bills of material.
      d. Instrument transformer performance curves and data.
      e. Mounting, loading and reaction data for foundation design.
      f. Installation instructions and procedures.
   2. Test reports:
      a. Certified reports of all factory production tests.
      b. Results of all field tests.
   3. Calculated DC power requirements, steady state and peak.

C. Shop Drawings:
   1. Submit for OWNER approval prior to fabrication.
   2. Factory generated and identified for this project.
   3. The equipment naming convention shown on the drawings will be used on the shop drawings.
   4. General arrangement drawings.
   5. Dimensioned outline drawings, locating all connections and indicating weights.
   6. Cross-section drawings showing bus and equipment arrangements.
   7. Elevations indicating actual arrangement of devices, equipment, and meters.
   8. Detailed drawings of cable terminal compartments and method of connection.
   9. Complete single-line and three-line diagrams.
   10. Complete control schematics.

D. Wiring Diagrams.
   1. Submit for information prior to shipment.
   2. Internal wiring diagrams, showing point-to-point connections, within each assembly or line-up. Internal wiring is defined as any system wiring that is contained within any separate equipment or component, (factory wired).
   3. External wiring diagrams, showing point-to-point connections, between assemblies or line-ups. External wiring is defined as any connection that requires field wiring by the installing electrician at the project site.
   4. MANUFACTURER to provide terminals with designation shown on drawings for external connections provided in the field. MANUFACTURER shall wire out to such terminals as shown.
   5. Wiring diagrams shall indicate the component terminations.
   6. Indicate the terminal identification (terminal block and terminal number) for all connections to equipment provided under this section.
   7. Indicate the wiring/cable tags for all factory wiring.
   8. Indicate the device equipment tag number to which the wiring is connected.
   9. Provide cross reference information to drawings where wiring extends across multiple drawings.

10. Document and provide revised wiring diagrams for all field wiring changes made after equipment is delivered to the project site through commissioning.

E. Operation and Maintenance Manuals:
   1. Submit for OWNER review no later than 60 days after shop drawing approval.
   2. Record issue of all drawings reflecting as-constructed status.
   3. Specifications for all components and accessories.
   4. Manufacturer's instructions for all components and accessories.
   5. Complete spare parts lists.

F. Spare Parts List:
   1. Provide spare parts list including all renewal parts and MANUFACTURER's recommended spares.
   2. Provide list in paper format and electronic format in either MS Word or MS Excel.

G. Provide electronic files in AutoCAD compatible format of record version of elevations, control panel layouts, schedules, one-line, three-line, schematic and wiring diagrams.
   1. Electronic files shall include field changes.

1.5 PROJECT CONDITIONS

A. Equipment will be installed indoors within the substation operating and maintenance electrical room.

B. Equipment shall fit within the space identified on the drawings without reducing clearances below those required by NEC and OSHA. Over-sized equipment will be rejected.

C. Provide shipping splits such that field disassembly is not required for move-in. Each split shall have provisions and instructions for rigging and lifting.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Switchgear Assembly:
   1. Cutler Hammer
   2. Square D
   3. Siemens
   4. Powell Industries
   5. S&C
   6. Areva
   7. Approved equal

B. Circuit Breakers:
   1. General Electric
   2. Square D
   3. Powell Industries
   4. Approved equal

C. Instrument Transformers:
   1. General Electric
   2. Approved equal

D. Protective Relays:
   1. GE Multilin
   2. Schweitzer Engineering Laboratories
   3. Basler Electric
   4. ABB
   5. Areva
   6. Approved equal.

E. Control Switches:
1. Electroswitch Series 24
2. General Electric
3. Approved equal.

F. Test Switches:
1. ABB
2. GE Multilin
3. Approved equal

2.2 SWITCHGEAR

A. General Requirements:
1. 35kV class medium voltage metalclad switchgear complying with all applicable ANSI standards.
2. Ratings as specified herein.
3. Arrange circuit breaker units and auxiliary compartments as specified herein.
4. Provide fully equipped spaces for future circuit breakers shown on the drawings, complete with current transformers, control devices and all internal wiring connected to field wiring terminal boards to permit future installation of circuit breakers with a minimum of work required in the switchgear cubicles.
5. Conduit Entry Provisions:
   a. Termination Cubicles: Three (3) bottom, provide NEMA 4 hole compression lugs for terminating six 1000 kCM, Copper, 35kV, Shielded, EPR cable per phase, with a 500 kCM, bare copper ground conductor.
   b. Tie Cubicle: One (1) bottom, provide NEMA 4 hole compression lugs for terminating six 1000 kCM, Copper, 35kV, Shielded, EPR cable per phase, with a 500 kCM, bare copper ground conductor.
   c. Feeder Circuit Breakers: Bottom fed, provide NEMA 4 hole compression lugs for terminating two 250 kCM, Copper, 35kV, Shielded, EPR cable per phase, with a 1/0 AWG, bare copper ground conductor.
6. The switchgear shall be constructed with provisions for protection against moisture contamination due to operation in ambient relative humidity in excess of 90 percent.
7. Calculations and ratings involving temperature rises (e.g., wire sized, types of insulation, etc.) shall be based on a 40°C ambient temperature.
8. Equipment specified for operation in 125 VDC circuits shall have a normal operating voltage range of 105 VDC to 135 VDC and shall be operable, without loss of life, at voltages up to 150 VDC for a 24-hour duration during battery equalization charging.
9. Insulated for a temperature controlled environment.

B. Switchgear Units:
1. The switchgear shall be designed, constructed and tested to be arc-resistant in accordance with Accessibility Type 1 of IEEE C37.20.7.
2. The front panel of the unit shall be hinged, and it shall be equipped with a latching handle (screw knobs not acceptable) for opening, closing and latching the panel. Panel shall be hinged and open in such a manner as to not interfere with maintenance of the breaker.
3. The rear panel of the unit shall be hinged on the power transformer side of the panel and shall be secured with a minimum of three and a maximum of six bolts. If the hinge is not adequately shielded from direct rain contamination, the hinge shall have a stainless steel pin. The panel shall be equipped with a doorstop and a wind latch.

C. Ratings:
1. Operating Voltage: 34.5kV RMS.
2. Rated Maximum Voltage: 36.2kV RMS.
3. Amperage: 2500 amp.
4. Number of phases: 3.
5. Frequency: 60 Hz.
6. Short Circuit Current: 40 kA RMS SYM at maximum voltage.

7. Basic Impulse Level (BIL): 200kV.
8. Comply with ANSI C37.06 for ratings not specified.

D. Construction:
1. Indoor switchgear.
2. Individual, freestanding, vertical sections housing circuit breakers and auxiliaries and bolted together to form a rigid metal-clad switchgear assembly. Single high units only. Double high units not acceptable.
3. Vertical sections isolated from adjoining sections by grounded metal barriers.
4. Circuit breakers, buses, instrument transformers, control power transformers, and cable terminations isolated from each other by grounded metal barriers.
5. Provide shutters that close automatically when the circuit breaker is in the test position, disconnected position or withdrawn.
6. Provide rails to allow withdrawal of the circuit breakers to the test, disconnected and withdrawn positions from the operating position.
7. Hinged, gasketed and removable front doors over each circuit breaker or auxiliary equipment compartment.
8. Hinged rear cover(s) for each vertical section.
   a. Full-height.
9. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and MANUFACTURERs' standard paint.

E. View Ports:
1. All cubes with a breaker require view ports to check switch positions.

F. Identification:
1. Label all compartments to correspond to circuit breaker identification on the drawings, or auxiliary.
   a. Engraved phenolic white on black with ½" minimum text height.

G. Metal-Enclosed Bus:
1. The bus enclosure shall be fabricated from steel and/or aluminum sheet metal.
2. The MANUFACTURER shall supply all required supports for the bus enclosure.
3. Heating Provisions:
   a. Metal-enclosed bus shall be equipped with 208-volt heaters that will provide a minimum of 200 watts heating capacity for every four feet of bus length.
   b. Heaters shall be spaced at intervals not to exceed four feet, and heaters and barriers within the bus enclosure shall be situated such that there is uniform heating throughout the bus.
   c. Heaters shall be mounted in a manner that will minimize heat loss through the bus enclosure but shall not be located near meltable materials such as splice joint covers. Heaters shall be accessible without requiring a bus clearance.
   d. Each heater shall be wired to a terminal block not less than six inches from the heater.

H. Buses:
1. Material: Insulated silver-plated copper rectangular bars and shall be completely insulated with 35kV non-tracking, flame-retardant insulation.
2. Bus supports, stand-off insulators and sleeves: Porcelain or cyco-aliphatic epoxy.
3. Main bus: 2500 amps.
4. Ground bus: 1/4 x 2 IN copper, minimum, continuous over length of the switchboard.
5. Provisions for future extension.
6. Neutral/Ground Bus Connection Terminals:
   a. Each feeder breaker unit shall have one (1) terminal for connection of the exit circuit neutral cable.
   b. Switchgear shall have two (2) external terminals, one at each end of the switchgear, for connection to station ground, and the neutral/ground bus shall be continuous to these terminals.
7. A copper bar shall be provided for grounding each circuit breaker chassis.

8. The switchgear enclosure shall be connected to the neutral/ground bus in each and every unit.
9. Bus joints fully insulated with removable boots and connected using through bolts and conical spring-type washers for maximum conductivity.
10. Arrange bus work so that Phase A, B and C are arranged from left to right (viewed from the front of the switchgear), front to back or top to bottom.

I. Control Power:
1. 125 VDC supplied from external sources.
2. Provide a single external connection point for each cubicle.
3. Separate internal circuits with individual overcurrent devices required for:
   a. Trip circuit – each circuit breaker.
   b. Close circuit – each circuit breaker.
4. Provide a power supervision relay on the load side of each overcurrent device.
   a. Contacts wired in series or parallel to provide a common DC Power Failure alarm for each cubicle.

J. Structure Requirements:
1. Switchgear shall be designed using the following minimum loads:
   a. Dead Load (weight of structure and all equipment)
   b. Floor Live Load = 100 psf
   c. Roof Live Load = 20 psf
2. Switchgear Base Structure:
   a. Switchgear shall have a base structure consisting of structural steel beams mounted to the switchgear and running parallel with the length of the switchgear assembly.
   b. Base framework shall include lateral bracing between the longitudinal beams to provide rigidity for the base structure.
3. Maximum Number and Minimum Spacing:
   a. A maximum of three (3) longitudinal support beams may be used in the base structural framework.
   b. The minimum allowable center-to-center distance between parallel beams shall be 5 feet.

2.3 COMPONENTS

A. Circuit breakers.
1. Standards: ANSI C37.04, C37.06, C37.11.
2. Ratings:
   a. Rated maximum voltage: 36.2kV RMS.
   b. Continuous current: As indicated on the Drawings.
   c. Basic Insulation Level: 200kV.
   d. Frequency: 60 Hz.
   e. Short Circuit Current: 40 kA RMS SYM at 35kV.
   f. Duty cycle: Two unit operations with 15 second interval between operations (CO - 15s - CO)
   g. Rated interrupting time: 5 cycles maximum.
3. Vacuum type interrupter.
4. Silver-plated copper primary disconnecting contacts.
5. Horizontal drawout type.
6. Operated by a motor-charged stored energy spring mechanism.
   a. Charged by an electric motor with an emergency manual handle.
7. Silver-plated copper secondary contacts automatically engage in the connected position and are manually engaged in the test position.
8. Interlocks:
   a. Prevent closing of a breaker between connected and test positions.
   b. Trip breaker upon insertion or removal from enclosure.
   c. Discharge stored energy mechanisms upon insertion or removal from enclosure.

9. Control voltages:
    a. 125 VDC closing power, closing control and tripping.
    b. From external source.
10. Auxiliary and control devices:
    a. One trip coil.
    b. Extra auxiliary switches for OWNER's use: Six "a" and six "b" switches, wired to terminal strip.
    c. Contact wear indicators.
    d. Manual trip button.
    e. Manual close button.
    f. Open-Close indicator.
    g. Manual spring charging capability.
    h. Spring charge-discharge indicator.
    i. Event counter.
    j. Nameplate.

B. Auxiliary devices:
1. Circuit Breaker control switch.
2. Differential lockout relay (86T).
3. Amber indicating light indicating lockout relay picked up.
4. Red and green indicator lights indicating circuit breaker contact position.
5. Overcurrent relay and associated test switches.
6. Bus differential relay and associated test switches.
7. Terminal block

C. Current Transformers:
1. Standards: ANSI C57.13.
2. Ratio: Main Breaker: 2000:5 single-ratio, connected as indicated on drawings.
Feeder Breaker: 1200:5 single-ratio, connected as indicated on drawings.
Tie Breaker: 2000:5 single-ratio, connected as indicated on drawings.
3. Accuracy:
    a. General: C400, standard relay accuracy as listed in ANSI C37.20.2, minimum, at all taps.
    b. Metering: Metering Class accuracy 0.3B1.8.
4. Mechanical and thermal ratings coordinated with breaker ratings.
5. Connections:
    a. All taps wired out to shorting terminal block.
    b. Connections between CTs made at shorting terminal block, not behind shutters.
    c. Ground connections made at shorting terminal block.

D. Current Transformer Shorting Terminal Blocks:
1. Ratings: 600 V, 30 amps.
2. Molded one piece thermoplastic body.
3. Washer head terminal screws to accommodate up to a #10 AWG wire.
4. Short circuiting strip for shorting screws and screw "parking stations".

E. Voltage Transformers:
1. Three voltage transformers with 70:1 ratios will be provided and connected wye-wye on the switchgear bus of the two main termination cubicles.

2.4 CONTROL AND PROTECTION

A. General Requirements:
1. Solid state devices:
    a. Meet or exceed transient over-voltage withstand test per NEMA ICSI-109 and surge withstand capability tests (SWC) per IEEE Standard 472 (ANSI C37.90A).
2. Where UL standards exist for components, devices and/or assemblies, such standards apply.
3. Provide control relays suitable and adequately rated for intended service in control system.

a. Provide relays used in low-voltage, low-current DC control circuits with gold flashed contacts to ensure positive contact make.
b. Relays used for other than logic and dry contact switching to have contact ratings suitable for make and carry of their duty current at voltage of operation.
c. Provide plug-in type relays for control circuit duty with retaining clips and transparent plastic or glass covers.
d. Clearly mark relays for control voltage.

4. Pilot Lights and indicator lamps:
   a. Press-to-test type with LED-type lamps.
   b. Incandescent lamps not acceptable.
5. Use control switches for the following functions applications:
   a. Circuit breaker control circuits.
6. Wire spare and unused inputs, outputs, and contacts for all circuit breaker auxiliary devices, protective relays and other devices out to terminal boards to permit future use without disturbing wiring harnesses.
7. Arrange operator controls and indicators in an intuitive manner.
8. Label all devices to correspond to schematic and wiring diagrams.
   a. Engraved phenolic white on black with ¼" minimum text height.
   b. Door-mounted devices labeled on front and rear of door.

B. Control Wiring:
1. Conductors:
   a. 600 Volt copper type SIS or MTW.
   b. Minimum wire gauge:
      1) DC and AC potential circuits: #12 AWG
      2) AC current circuits: # 10 AWG
      3) Control and protection circuits: #14 AWG
   c. Ring terminal connectors for current, potential and 125 VDC conductors.
   d. Labeled at both ends to correspond to the schematic and wiring diagrams.
   e. Provide segregation of wiring between voltage levels and signal types:
      1) 125 VDC and AC potential and current circuits.
      2) Digital signals
      3) Analog signals
2. Terminal blocks:
   a. 600 V, 30 A, screw-clamp type with center marker strip for all current, potential and 125 VDC wiring,
      1) GE Type EB-25 or equal.
   b. Provide for all field wiring and inter-unit connections.
   c. Provide for internal wiring of switchgear as required.
   d. Segregate field wiring terminal boards from internal and inter-unit wiring terminal boards.

C. Protective Relays:
1. All relays shall be utility-grade, solid state or microprocessor based, 125 volts DC, semi-flush draw-out mounted.
2. Comply with ANSI C37.90 requirements.
3. Provide protective relays and tripping schemes as specified and as indicated on the drawings.
4. Microprocessor-based relays:
   a. Continuous self-diagnostic routine.
   b. Power supply failure alarm.
   c. Front panel operator interface.
   d. Provide RS232 or 485 serial communications port using DNP 3.0.
   e. Event log.
   f. Program-assignable input and output contacts.
   g. Programmable logic.
   h. Independent setting groups.

5. Install relays associated with a particular circuit breaker in the door of circuit breaker compartment. Install bus relays in doors of auxiliary compartments.
    a. Crossing-over of relay locations requires OWNER approval.

D. Relay Schedule:
    1. Microprocessor-based multi-function relays:
        a. Feeder Protection Relay: Equal to SEL-351.
        b. Bus Differential Relay: Equal to SEL-387.
    2. Lockout Relay (Device 86): Equal to Electroswitch Series 24 LOR.

E. Tripping Schemes:
    1. General:
        a. All overcurrent and fault protection relay functions directly trip the circuit breakers through trip contacts or lockout relay contacts in the breaker control circuit.
        b. Feeder relays shall direct trip feeder circuit breaker.
    2. Feeder protection relay (FPR):
        a. Provides overcurrent protection for the circuit breaker it is connected to.
        b. Provide the following additional inputs and outputs:
            1) Breaker status 52a contact output to terminal strip.
            2) Relay failure output to terminal strip.
    3. Bus differential relay:
        a. Provides differential protection for the bus.
        b. Provide the following additional inputs and outputs:
            1) Relay failure output to terminal strip.
            2) Lockout relay output to terminal strip.

2.5 CUBICLE DESCRIPTION

A. Switchgear Cubicles:
    1. Termination Cubicles.
    2. Main (Switchgear) Breaker Cubicles.
    3. Feeder/Auxiliary Cubicles.
    4. Spare Cubicles.
    5. Tie Breaker Cubicle.

B. Termination Cubicles:
    1. Bus bar:
        a. Silver flashed copper.
        b. 2.5kA rms continuous current.
    2. Insulators:
        a. Epoxy material.
    3. Voltage Transformers:
        a. Shall be directly used as the source potential for the SEL-351relays.

C. Main Breaker Cubicle:
    1. Circuit Breaker:
        a. 2.5 kA rms continuous current
        b. 40kA rms short-circuit current at maximum rated voltage.
        c. Six (6) "a" auxiliary switches for relay and control.
        d. Six (6) "b" auxiliary switches for relay and control.
    2. Current Transformers:
        a. Six (6) wye-connected 2000:5 single-ratio, current transformers on the line side of the main breaker.
        b. Three (3) are for overcurrent relaying and three (3) are for switchgear bus differential relaying.
        c. Six (6) Wye-connected 2000:5 single-ratio, current transformers on the load side of the main breaker.
        d. Three (3) are for transformer differential and three (3) are spares.

3. Loss of DC-Alarm (Device 27DC):
    a. One loss-of-DC alarm relay shall be provided and connected to alarm for either loss-of-DC or trip coil failure (open circuit) at the secondary breaker.
4. Digital Relay (SEL-351):
    a. One digital, directional overcurrent, reclosing, fault locating relay shall be provided for phase protection of the secondary breaker.
5. Test Switch (Device TSX):
    a. Based on electrical schematics provide and wire as required semi-flush mounted, back connected, 10-pole test switches with four (4) potential and six (6) current shorting (make before break) contacts arranged P P P C-C C-C C-C P for potential and current inputs of the SEL-351.
6. Digital Bus Differential Relay for Switchgear Bus (SEL-387)
7. Test Switch (Device TSX):
    a. Based on electrical schematics provide and wire as required semi-flush mounted, back connected, 10-pole test switches with four (4) potential and six (6) current shorting (make before break) contacts arranged P P P C-C C-C C-C P for potential and current inputs of the SEL-387.
8. Auxiliary Lockout Relay (Device 86B):
    a. One manual reset, lockout relay shall be provided to trip and lockout all power circuit breakers surrounding the switchgear bus differential zone.
9. Test Switch (Device TS86B):
    a. One flush-mounted, back connected, 10-pole test switch shall be provided and wired such that each trip circuit from Device 86B may be opened for testing Device 86B.
10. Loss of DC Alarm (Device 27DC):
    a. One loss-of-DC alarm relay shall be provided and connected to alarm for either loss of DC or Device 86B trip coil failure (open circuit).
11. Control Switch 52-MB#:
    a. Control switch shall operate main cubicle circuit breaker.
12. Indicating lights:
    a. Indicating red and green lights for breaker status.
13. Loss of Switchgear Heaters-Alarm (Device 27H):
    a. One loss-of-AC alarm relay shall be provided and connected to the load side of the heater circuit breaker.

D. Feeder/Auxiliary Breaker Cubicles:
1. Circuit Breakers:
    a. 1.2 kA rms continuous current
    b. 40 kA rms short-circuit current at maximum rated voltage
2. Six (6)"a" auxiliary switches to provide for relay and control.
3. Six (6)"b" auxiliary switches to provide for relay and control.
4. Current Transformers
    a. Six (6) 1200:5 single-ratio, wye-connected current transformers on the load side of the breaker.
    b. Three (3) are for switchgear bus differential relaying and three (3) are for overcurrent relaying.
5. Loss of DC Alarm (Device 27DC):
    a. One loss-of-DC alarm relay shall be provided and connected to alarm for either loss of DC or trip coil failure (open circuit) at the feeder breaker.
6. Digital Relay (SEL-351):
    a. One digital, directional overcurrent, reclosing, fault locating relay shall be provided for phase and ground protection of the feeder breaker.
7. Test Switch (Device TSX):
    a. Based on electrical schematics provide and wire as required semi-flush mounted, back connected, 10-pole test switches with four (4) potential and six (6) current shorting (make before break) contacts arranged P P P C-C C-C C-C P for potential and current inputs of the SEL-351.
8. Auxiliary Lockout Relay (Device 86B):

a. One manual reset, lockout relay shall be provided to trip and lockout all power circuit breakers surrounding the switchgear bus differential zone.

9. Test Switch (Device TS86B):
   a. One flush-mounted, back connected, 10-pole test switch shall be provided and wired such that each trip circuit from Device 86B may be opened for testing Device 86B.
10. Loss of DC Alarm (Device 27DC):
   a. One loss-of-DC alarm relay shall be provided and connected to alarm for either loss of DC or Device 86B trip coil failure (open circuit).
11. Control Switches 52-FD1, FD2, FD3, FD4, FD5, FD6, FD7, FD8, AUX1 and AUX2:
   a. Control switches shall operate feeder and auxiliary cubicle circuit breakers.
12. Indicating lights:
   a. Indicating red and green lights for breaker status.
13. Surge Arresters:
   a. Three (3) 22 MCOV station class, polymer, metal-oxide surge arresters, one per phase, shall be connected to the load side of the breaker.
14. Feeder Cable Connection Provision:
   a. Each feeder breaker unit shall have a cable terminator compartment.
15. A terminator mounting board shall be provided with adequate space for mounting three standard, single-conductor, 15kV porcelain cable terminators.

E. Spare Cubicles:
   1. Spare cubicles must be bussed and have provisions for future breakers and equipment.

F. Tie Breaker Cubicle:
   1. Circuit Breaker:
      a. Normally Opened.
      b. 2.5 kA rms continuous current
      c. 40kA rms short-circuit current at maximum rated voltage
      d. Six (6) "a" auxiliary switches for relay and control.
      e. Six (6) "b" auxiliary switches for relay and control.
   2. Current Transformers:
      a. Six (6) wye-connected 1200:5 single-ratio, current transformers on the switchgear T1 side of the main breaker.
      b. Three (3) are for bus differential and three (3) are spares.
      c. Six (6) Wye-connected 1200:5 single-ratio, current transformers on the load side of the main breaker.
      d. Three (3) are for bus differential and three (3) are spares.
   3. Control Switch 52-TB:
      a. Control switch shall operate main cubicle circuit breaker.
   4. Indicating lights:
      a. Indicating red and green lights for breaker status.

2.6 ACCESSORIES

A. Circuit breakers accessories for testing, inspection, maintenance and operation:
   1. Tool to charge closing springs manually.
   2. Portable lift crane for removing breakers.
   3. Lifting yoke.
   4. Test jumper for electrically operating the breaker while out of its compartment.
   5. Test jumper for operating the breaker remotely while in its compartment.
   6. Levering crank to crank breakers between Test and Connected positions.
   7. Rail extensions.
   8. Other maintenance tools or equipment recommended by breaker manufacturer.

2.7 SOURCE QUALITY CONTROL

A. Switchgear shall be completely assembled and wired at factory, with functional checks of all wiring and controls, and then disassembled as required for shipment.

B. Factory Tests:
   1. Make design tests specified in ANSI C37.20.2.
   2. Make production tests specified in ANSI C37.20.2, including:
      a. Low frequency withstand, 1 minute.
      b. Mechanical operations.
      c. Grounding of instrument transformer cases.
      d. Control wiring continuity.
      e. Control wiring insulation.
      f. Polarity verification.
      g. Sequence tests.

2.8 MAINTENANCE MATERIALS

A. Provide spare parts and maintenance materials adequate for MANUFACTURER's recommended service and one cycle of renewal parts replacement to include, but not limited to:
   1. One quart of touch-up paint.
   2. Spare fuses, one carton of each type and rating used.
      a. For potential transformer banks: 3 spares for each fuse type and size.
   3. Spare indicator lamp (LED) assemblies, minimum three of each color.
   4. Connectors for use with test blocks and test switches, minimum two of each type used.

B. Submit recommended spare parts list with shop drawings. Include Manufacturer, part number and current price.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Provide the services of a qualified field service and testing agency to perform field tests and supervision of installation to maintain MANUFACTURER's warranty of equipment. Work includes but is not limited to:
   1. Visual inspection and operational tests for physical damage, alignment and proper fit of assembly parts.
   2. Performance test of devices and removal of supports, blocks, and restraints placed for shipping, as MANUFACTURER recommends. Inspect devices and verify lubricants are in good condition and properly applied.
   3. Test all protective relays fully per MANUFACTURER's instructions and at final settings to be provided by the OWNER. Tests shall utilize three phase adjustable current, voltage and frequency test sources and shall be performed by injection of current and potential at CT and PT secondary terminals to verify all switchgear wiring.
   4. Perform a comprehensive step-by-step verification test of all control system functions including automatic sequences, manual control functions, response to all specified contingencies, and all maintenance modes. Demonstrate satisfactory performance of test procedure to OWNER once-through start to finish without failure following completion of startup. Any failure during demonstration requires complete re-test.
   5. Field testing personnel shall have a minimum of five years of experience in acceptance testing electrical apparatus of the type and ratings furnished.
      a. Submit testing personnel qualifications for OWNER review.
   6. Record tests performed, results of test, date of test, and name and signature of test technician. Submit for review and for final records of project.

3.2 ACCEPTANCE TESTING

A. General:
   1. Complete visual inspection, mechanical and electrical operational tests and electrical acceptance tests shall be performed in accordance with NETA ATS.
   2. The following paragraphs identify items to be tested and scope of testing.
      a. All required tests per NETA shall be performed.
      b. Tests identified by NETA ATS as optional shall be performed when listed below.
      c. Additional tests not required by NETA ATS are also listed when required.
   3. Perform and report all tests recommended or required by the equipment MANUFACTURER's installation, operation and maintenance instructions, even if not included in NETA ATS or listed below.
   4. Repairs shall be made when test values do not meet known acceptable values. Test report shall clearly indicate "as found" and "as left" values, the cause of the unacceptable values, and the details of the corrective action taken to obtain acceptable results.
   5. Provide field setting and programming of all adjustable protective devices to settings provided by the OWNER.

B. Switchgear:
   1. Perform inspections and tests per NETA ATS 7.1.
   2. Components: Test all components per applicable paragraphs of this specification and NETA ATS.

C. Medium Voltage Circuit Breakers:
   1. Perform inspections and tests per NETA ATS 7.6.2.
   2. Components: Test all components per applicable paragraphs of this specification and NETA ATS.
   3. Perform the following optional tests per NETA ATS:
      a. Control wiring insulation resistance.
      b. Minimum trip and close voltage.
      c. Overpotential.
   4. Perform the following additional tests:
      a. High-potential vacuum integrity test per MANUFACTURER's recommendations.

D. Protective Relays
   1. Perform inspections and tests per NETA ATS 7.9.
      a. Tests to be performed using secondary injection of three-phase current and potential at final settings.
      b. Test at MANUFACTURER's recommended test points and critical timing points identified on relay setting sheet.
   2. Perform all tests identified as optional per NETA ATS:
   3. Perform the following additional tests:
      a. Verification of direct trip of associated lockout relay or circuit breaker(s) by using relay test function or shorting trip contact at relay case.
      b. Microprocessor-based relays:
         1) Complete commissioning procedure per MANUFACTURER's instructions, followed by tests of each relay element at final settings.
         2) Verification of all internally-programmed logic.
      c. Verification of all auxiliary input and output signals.
      d. Verification of power supply/ self-diagnostic alarm contact and remote annunciation.
   4. Relay settings will be provided by OWNER.

E. Instrument Transformers
   1. Perform inspections and tests per NETA ATS 7.10.
   2. Components: Test all components per applicable paragraphs of this specification and NETA ATS.
   3. Perform the following optional tests per NETA ATS:
      a. Dielectric withstand test on potential transformers

F. Grounding
   1. Perform inspections and tests per NETA ATS 7.13.
   2. Components: Test all components per applicable paragraphs of this specification and NETA ATS.

G. Control System Functional Test:
   1. Perform test upon completion of equipment acceptance tests.
   2. The test is to prove the correct interaction of all sensing, processing and action devices.
   3. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
   4. Perform the following tests:
      a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
      b. Verify the correct operation of all sensing devices, alarms and indicating devices.
   5. Systems to be tested:
      a. Protective Relaying Systems.

3.3 DEMONSTRATION AND TRAINING

A. Provide the services of the MANUFACTURER's field service Engineer to demonstrate the equipment and provide training to OWNER's personnel. Includes but is not limited to:
   1. Safety precautions to be followed in operation and maintenance of the equipment.
   2. Theory of operation, operating modes, use and interpretation of operator controls and indicators.
   3. Procedures for preventive maintenance and adjustment of equipment.
   4. Troubleshooting and root cause failure analysis.
   5. Procedures for replacement and repair of equipment and renewable components.

B. Training shall be based on the Operations and Maintenance manuals provided under this contract and shall include both classroom and field components. Training may be videotaped and reproduced by OWNER for their future internal use.

C. Allow a minimum of 4 hours on site for training on equipment furnished under this specification section.

END OF SECTION

SECTION 16350
POWER CIRCUIT BREAKER(S)

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Two (2) 230 kV SF_6 outdoor power circuit breaker.
   2. Deliver circuit breaker F.O.B. at OWNER's jobsite located in McPherson County, South Dakota near the North Dakota border.
   3. Furnish all labor, equipment and material for the following:
      a. Filling with insulating medium.
      b. Making all necessary adjustments.
      c. Checkout and field testing.
   4. Provide factory trained service representative for technical direction, inspections and testing.

B. Work by others:
   1. CONTRACTOR will provide the following:
      a. Unloading at job site and assembly of all components removed for shipment.
      b. Breaker foundation.
      c. Connection to OWNER's bus.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Perform work in accordance with best present-day installation and manufacturing practices.
   2. Unless specifically noted to contrary, conform with and test in accordance with applicable sections of latest revisions of following codes and standards:
      a. American National Standards Institute (ANSI):
         1) C2, National Electrical Safety Code (NESC).
         2) C37.04, IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
         3) C37.06, American National Standard Preferred Ratings and Related Required Capabilities for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
         4) C37.09, Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
         5) C37.11, Requirements for Electrical Control for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis or a Total Current Basis.
         6) C57.13, IEEE Standard Requirements for Instrument Transformers.
         7) C76.1, Standard General Requirements and Test Procedures for Outdoor Apparatus Bushings.
         8) C76.2, Electrical, Dimensional, and Related Requirements for Outdoor Apparatus Bushings.
      b. American Society for Testing and Materials (ASTM):
         1) ASTM D2472, Specification for Sulfur Hexafluoride.
         2) D3487, Specifications for Mineral Insulating Oil Used in Electrical Apparatus.
      c. National Fire Protection Association (NFPA):
         1) NEC, National Electrical Code.
   3. Conflicts between referenced codes and standards: Code or standard establishing more stringent requirements shall be followed. Engineer shall be the final judge as to which requirement is more stringent.

B. Qualifications:
1. Circuit breakers furnished shall be identical to existing designs having acceptable history of service in similar applications for not less than three years.

1.3 DEFINITIONS

A. Dead Tank Design: Interrupters contained within a grounded metal tank.

B. Vendor or Seller: Manufacturer of power circuit breaker.

C. Contractor: Person responsible for erecting substation equipment.

1.4 SYSTEM DESCRIPTION

A. Application:
1. Breaker will be used for line switching and protection including load splitting (parallel or loop switching), load dropping, line dropping, and fault interrupting.
2. To be installed on an electric system having nominal voltage of 230 kV line-to-line, 3 PH, effectively grounded as shown on drawings.

1.5 SUBMITTALS

A. DRAWINGS AND INSTRUCTION MATERIAL

1. Shop Drawings for Approval:
   a. "Shop Drawings" refers to all the detailed installation drawings prepared by the Seller and/or his suppliers required to construct the material as defined in the specifications, and shall include all fabrication drawings, working drawings, design calculations, foundation loadings, material schedules, detailed layouts, and assembly information.
   b. The Seller agrees that submittals and shop drawings processed by the Engineer are not change orders; that the purpose of submittals and shop drawings by the Seller is to demonstrate to the Engineer that the Seller understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use. The Seller alone accepts all responsibility for assuring that all materials furnished under these specifications meet in full all requirements of the contract documents. The Engineer's review is for general conformance with the design concept and contract documents. Markings or comments shall not be construed as relieving the Seller from compliance with the project plans and specifications, nor departures there from. The Seller remains responsible for details and accuracy for confirming and correlating all quantities and dimensions, for selecting fabrication processes, and for techniques of assembly.
   c. Submit the following shop drawings to the Engineer in the manner specified hereinafter. Make initial submittal of information requested on or before the date specified in the Summary of Proposal:
      1) Certified outline assembly and installation drawings as appropriate for each item.
      2) Complete nameplate data for each item.
      3) Schematic diagrams of all control and alarm circuits.
      4) Bushing current transformer data, including excitation and ratio correction factor curves.
      5) Certified arrangement for anchor bolts.
      6) Factory test reports (at least two weeks prior to shipment). See Section 1-11.
      7) Such other similar information as the Engineer may request.

B. Engineer's Action
1. Engineer will review shop drawings and indicate action taken according to the following classifications:
   a. No Exceptions Taken: Indicates that the shop drawing has been reviewed and appears to be in general agreement with the requirements. Seller may make further distribution of shop drawings and proceed with fabrication and/or installation of the work detailed on the drawing.

b. Furnish As Corrected: Design revisions, deletions, additions, and comments shown on these drawings shall be incorporated into the design before proceeding with fabrication or drawing distribution.

c. Revise and Resubmit: Indicates that the shop drawing, or part thereof, does not appear to be in general agreement with the requirements. Engineer's comments are noted on the shop drawing and/or separate letter. Seller shall recheck and make any necessary revisions and resubmit for Engineer's review.

d. Rejected: Indicates that the shop drawings do not conform to requirements. Reasons for rejection are noted on the shop drawing and/or separate letter.

2. Shop Drawing Submittal and Distribution

a. Initial Submittal (REVIEW): Submit three (3) copies of each shop drawing to the Engineer; direct mailing to the Engineer's address given in Division O. One copy of the shop drawings indicating the Engineer's action will be returned to Seller within three (3) weeks from the date of receipt.

b. Resubmittal: If drawing is returned to the Seller with Engineer's comments and action noted "RESUBMIT", the drawing should be rechecked and revised as necessary with two copies resubmitted in manner described in "Initial Submittal".

c. Final Distribution (CERTIFIED): Within the time schedule listed in the Summary of Proposal, Seller shall submit to the Engineer, final drawings covered in Section B above utilizing AutoCAD software. All drawing information shall be stored and submitted on a compact disk. Direct mailing to the Engineer's address given in Division O.

C. Instruction Manuals, Test Reports, and Parts Lists

1. Seller shall furnish complete instruction manuals covering installation, operation and maintenance for all equipment. Manuals, bound in vinyl and properly labeled to indicate the facilities covered, shall include:
   a. All shop drawings listed in Section 1.5-A.1c. (Reduce as required to fit in manuals).
   b. Specific equipment instruction books.
   c. Renewable parts lists for all replaceable parts and assemblies.
   d. Test report for all shop tests required under Section 3.3.
2. Submit five (5) copies to Engineer for distribution. Engineer's address is given in Division O.

D. Shop Drawing and Instructional Material Transmittal Form

1. Seller may use his own form of transmittal letter for distribution of shop drawings, clearly marked "For Approval" or "Certified" as applicable.
2. Submit one (1) copy of transmittal form with each set of drawings or instructional materials.

E. Seller's Responsibility

1. Prior to submittal, check shop drawings for errors, correctness of details, and conformance with the specifications.
2. Notify Engineer of any inconsistencies or questions regarding approval revisions or comments on the drawings.
3. Review of shop drawings by Engineer does not relieve the Seller of responsibility for errors, correctness of details, or conformance with the specifications.
4. Fabrication and shipment of materials or equipment prior to Owner's release of drawings, data, and information mentioned hereinbefore, shall be at Seller's risk.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Bid shall include delivery F.O.B. jobsite, freight prepaid, with final destination delivery date as specified by the Seller in the Summary of Proposal. Jobsite is located in McPherson County, South Dakota near North Dakota border.

B. The Seller shall notify the Engineer when equipment is ready for shipment. Such notice shall include projected routing and estimated time in shipment.

1. All equipment in this contract with a common delivery destination shall be made in a common shipment. The Seller shall be responsible for all incidental costs incurred by the Owner due to separate shipments of such equipment.
2. Immediately after shipment, Seller shall notify the Engineer of transportation carrier and all transfers and references to permit follow-up on status of shipment and delivery.

C. The Seller shall investigate all limitations in regard to shipping the equipment F.O.B. jobsite. Circuit breakers shall be shipped as completely assembled and as transportation limits and manufacturer warranty allow.

D. In case of rail use for any part of delivery:
1. Equipment shall be shipped on cushioned underframe or end-of-car cushioned railcars on which the cushioning devices have been recently inspected and determined to be 100 percent operable, or other means agreed to by the Engineer.
2. Impact recorders furnished by the Seller shall be properly packaged, oriented and attached to the rail cars as near the equipment bases as possible. The recorders shall indicate impacts separately, on two axes, and the charts shall be stamped adequately to determine the date, time and place of severe impacts. Impact recorders shall be placed in operation before the equipment begins shipment and shall remain attached and in operation until the equipment has been sited at the proper rail siding. Equipment will not be accepted by the Owner until after the Engineer has examined the recorders for impacts and any visible damage to equipment.
3. Final portion of delivery from rail siding to job site shall be by truck.

E. Prior to shipment, all gauge and indicator glass shall be thoroughly cleaned and covered with non-adhesive shipping protectors.

F. Circuit breakers shall be shipped as complete as practical. Gas interrupters shall be pre-charged prior to shipment, with any supplemental gas furnished as part of one single shipment.

G. Delivery shall not be made prior to earliest acceptable delivery specified in Summary of Proposal. Should delivery be made prior to earliest acceptable delivery date, the Owner reserves the right to withhold initial payment without any additional cost until 30 days after the earliest acceptable delivery date. In addition, the supplier shall be responsible for all incidental costs incurred by the Owner due to early delivery.

1.7 EQUIPMENT GUARANTEE

A. Without limiting any other provision of this specification regarding guarantees, guarantee the equipment as follows:
1. Seller shall guarantee to the Owner the complete power circuit breaker, together with all parts included in the original purchase, is free of defect in workmanship and materials and is capable of continuous and satisfactory performance when operated in accordance with the instructions provided by the Seller at the specified rating and capacity.
2. Guarantee shall extend for a minimum of one year from the date of commercial operation. It shall cover all defects and malfunctions of the breaker and accessories. Guarantee shall cover all out-in freight by common carrier in full and the costs of removal from the site and reinstallation after repair. Seller shall not be liable for special, indirect or consequential damages, nor costs of moving structures or associated equipment.

1.8 DEFECTIVE EQUIPMENT

A. Should equipment fail to conform to specifications or to operate satisfactorily, Owner will have right to operate equipment until defects are corrected and guarantees met.

B. Owner will have right to operate rejected equipment until it is replaced, without cost for depreciation, use or wear.

C. Equipment may be removed from operation for examination, adjustment, alteration, or change only at time approved by Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. HVB
   2. ABB
   3. Mitsubishi
   4. Siemens

B. Submit requests for substitution.

2.2 MATERIALS

A. Sulfur Hexafluoride (SF_6) Gas: Meet requirements of ASTM D2472.

B. All exposed unpainted parts shall be fabricated of corrosion resisting metal.

2.3 POWER CIRCUIT BREAKER

A. Service Conditions:
   1. Outdoor, continuous duty.
   2. Altitude: Circuit breaker shall be suitable for operating at an altitude of 1,900 feet above sea level. For altitudes above 3,300 feet, apply Altitude Correction Factors to the voltage and continuous current ratings in accordance with ANSI/IEEE C37.04, Table 1.
   3. Ambient Conditions: Circuit breakers shall be suitable for operating at standard ratings for ambient temperatures between -30°C and 40°C as well as for special low temperating rating specified in Section 2-2.A.21. Severe wind with blowing dust and snow is common at this location.
   4. Auxiliary A.C. power available: 120/208 volt, single-phase.
   5. Auxiliary D.C. power available: 125 volt DC
   6. PCB terminal connections shall be constructed to withstand the following mechanical loading: 100 lb applied in any direction.

B. The frame shall be such that the lowest live part on the breaker or lowest point for connection to the breaker shall be at an elevation in accordance with the National Electric Safety Code.

C. The circuit breaker shall not be limited to a specified number of operations within a time period as long as critical gas pressure and critical stored operating energy is maintained within normal ranges. The circuit breaker operating mechanism shall not be thermally limited within the ambient operating temperature range of the breaker.

D. Ratings:
   1. Quantity to be furnished ..... Two
   2. Construction ..... Dead Tank Only
   3. Insulating medium ..... SF_6 Gas
   4. Number of phases ..... Three
   5. Maximum voltage ..... 242 kV
   6. Rated voltage range factor (k) 1.0
   7. BIL ..... 900 kV
      a. Note: Bushings shall meet the BIL after applying any altitude correction factors per Section 2.3-A.2.
   8. Continuous current ..... 1200 A (min.)
      a. Note: All circuit breakers shall meet the continuous current rating after applying any altitude correction factors per Section 2.3-A.2.
   9. Maximum symmetrical interrupting rating ..... 40 KA (min.)
   10. Three second short time current-carrying capability ..... 40 KA (min.)
   11. Rated short circuit current (at rated maximum KV) ..... 40 KA (min.)

12. Closing and latching capability (rms) ..... 108 KA (min.)
13. Interrupting time (cycles) ..... Three (max.)
14. Frequency ..... 60 Hertz
15. Closing control voltage ..... 125 VDC
16. Tripping control voltage ..... 125 VDC
17. Control and auxiliary power protection .....
    a. Separate knife switches with separate fuses for DC trip, DC close and AC.
18. Number of Trip Coils ..... Two
19. Motor voltage ..... 120 VAC 1ϕ
20. Auxiliary heater voltage ..... 120 VAC

E. Switching Performance
1. Circuit breaker shall be suitable for reclosing duty cycle, as specified by ANSI/IEEE C37.04.
2. Circuit breaker line charging switching rating shall be in accordance with Tables 1A, 2A and 3A of ANSI/IEEE C37.06.
3. The recovery voltage during interruption of line charging current shall be a minimum of 2.4 times maximum phase-to-ground voltage at 0.5 cycle and thereafter per ANSI/IEEE C37.09-1979.
4. The circuit breaker shall be capable of out-of-step interruption in accordance with ANSI/IEEE C37.09.
5. The circuit breaker shall be capable of capacitive switching of parallel shunt capacitor banks in accordance with ANSI/IEEE C37.06 Tables 1A, 2A, and 3A as defined in ANSI/IEEE C37.12.

F. Standard Features
1. All porcelain sleeves and bushings shall be wet glazed, ANSI No. 70 light grey. Porcelain condenser bushings shall be in accordance with ANSI/IEEE C76.1, as applicable. Dead and live tank SF_6 circuit breakers shall have SF_6 gas insulated bushings.
2. One mechanical tripped-closed position indicator for mechanically interlocked mechanisms. Non-mechanically interlocked circuit breakers shall be provided with one indicator for each pole or operating mechanism.
3. External emergency manual trip device which shall electrically operate the breaker. Trip device shall be interlocked with SF_6 gas pressure contacts to prevent opening the breaker without sufficient gas interrupting medium. Trip device shall also block against electrical closure of the breaker.
4. Gas circuit breaker standard equipment:
    a. Provide three (3) gas pressure gauges for circuit breakers with individually pressurized poles. Only one (1) pressure gauge is required for single-tank circuit breakers or individually pressurized pole breakers with common piping.
    b. The SF_6 system shall be supplied with separate shut off valves to each interrupter. All SF_6 devices shall be piped to a common manifold to allow for filling or testing from a single connection point without affecting the SF_6 pressure in all of the interrupters. There shall also be a main shut off valve for the SF_6 system.
    c. Provide temperature compensated low pressure alarm and cutout switches for each separately pressurized interrupter module. For single-tank and three-tank systems with common piping, only one (1) alarm and one (1) cutout switch will be required. Low pressure alarm should be set to operate, due to either leakage or "critically low" gas pressure, at a higher pressure than cutout switch, actual pressure settings to be per manufacturer's recommendations. Cutout switches shall be provided with a sufficient number of contacts to block tripping of all three phases of the circuit breaker plus two additional contacts for customers use as cutout alarm.
    d. Complete mounting stand for circuit breaker and any required oil filled current transformers.
    e. Breakers shall be shipped with partial internal SF_6 gas pressure to eliminate the need for evacuation of the pole unit for installation.

f. An operating mechanism mounted and enclosed in a weatherproof enclosure for opening and closing the contacts. Operating mechanism shall be trip free with latch check switch and anti-pumping device. Features and performance shall be in conformance with NEMA Standard SG-4, Part 3, where applicable. Other features shall include the following for specific mechanism, types or combinations thereof.
   1) For spring-drive operated mechanisms:
      a) Closing spring shall both close the breaker and tension the opening spring.
      b) With the tensioning motor inoperative, the number of available close operations shall not be less than one with the breaker closed and closing spring tensioned upon last close operation, i.e., breaker shall be capable of an open-close-open cycle.
      c) Tensioning motor shall be rated for operation at specified A.C. motor voltage and D.C. control voltage. Control shall include a throw-over circuit that will automatically switch to the DC source if the AC motor voltage is lost. Include 3 minute delayed alarm upon loss of VAC.
      d) The time required to tension the springs to operating level shall not exceed 15 seconds.
      e) Closing mechanism shall be manually operable from outside of the tank.
      f) Alarm contact indicating that the spring is not fully charged. Alarm shall include a 3 minute delay.

g. Standard (NEMA) two bolt ground terminal pads on opposite corners of frame(s).

h. Operations counter visible from outside the mechanism enclosure.

i. Manufacturer's standard screened strip heater(s) mounted in mechanism and control enclosures for anti-condensation purposes. Heaters shall be rated for operation at voltage listed in Section 2.3-A.4 above.

j. Special tools and devices required to install or to dismantle and reassemble breaker, including maintenance closing device for manual operation.

k. Terminal boards for control wiring shall be rated 600 V, 30 A, molded block type with insulating barriers between terminals. Terminals shall be strap screw type connections for ring lugs. Blocks shall have a removable marking strip and cover. Approximately 10 percent spare terminals shall be provided on each block for terminating spare conductor and control cables. The arrangement and location shall be such that incoming and outgoing cables can be supported. Adjacent rows of terminal blocks shall be separated at least six (6) inches edge-to-edge, and at least six (6) inches from sides, top, or bottom of cabinet, for all wiring which will be made in the field. Wiring which will be done at the factory may be made in a space which is not less than three (3) inches. Blocks used for interpanel wiring shall be readily accessible. Heavy-duty terminal blocks with barriers shall be furnished and installed for external power supply cables if required.

2.4 ACCESSORIES

A. Control Panel:
   1. Provide hinged panel in mechanism enclosure.
   2. Furnish equipment and devices, factory mounted on panel and interconnected, as follows:
      a. One each - Control switch with lights.
      b. One each - "Remote/Local" switch.
   3. Control features:
      a. Local control switch to have lockout position (pull out).
      b. Lights to be as follows:
         1) Green: Circuit breaker open.
         2) Red: Circuit breaker closed.
      c. Furnish a "closed in released position only" contact for use with alarm circuit.
      d. For "Remote/Local" switch, breaker cannot be operated from a remote location if the switch is set for "Local" operation.
   4. Furnish nameplates (black with white cut letters) with lettering approved by ENGINEER for all devices and relays mounted on panel.

2.5 REQUIRED ACCESSORIES

A. Two NEMA standard grounding lugs per stand for use with 4/0 to 350 MCM copper conductor. Grounding lugs shall be Royal Type DT or approved equal.

B. Manufacturer sized standard control cabinet strip heater for anti-condensation which shall be on continuously. Additional strip heaters rated 1-1000 watt and 1-500 watt strip, each to have a control thermostat with an adjustable control range which includes 0°F to 45°F for operation during severe weather conditions shall be furnished. Heater(s) shall be rated for operation at the voltage listed in Section 2.3-A.4 and screened to protect maintenance personnel from physical contact. Accessory heaters shall have overcurrent protection devices separate from those for standard heaters. AC heater circuits must be supplied with alarm circuits with a 3 minute time delay on loss of AC. Provide heaters in mechanism and control compartments as required.

C. Motor start counter for spring operated mechanisms.

D. Minimum of 14 "a" and 14 "b" spare auxiliary switch contacts available for customer's use. In addition, Breaker shall be supplied with two (2) adjustable delayed "b" contacts. These contacts shall be adjustable from 3 to 120 cycles and shall be for customer use only. Manufacturer shall provide additional contacts, as required, for standard breaker control and alarm functions. Auxiliary switches shall be mounted in a dust tight enclosure to prevent contact exposure to foreign particles. Enclosure shall be removable for access to each switch contact. Auxiliary contacts shall be field convertible to either normally open or normally closed.

E. Mechanism cabinet illuminating light with clear safety globe. Light shall be push button controlled, activated by opening cabinet door.

F. 120 VAC, NEMA 5-20R convenience receptacle, ground fault interrupter type.

G. Control switch (52CS) for electrically operating circuit breaker. Switch shall be Electroswitch series 24 or equal, with pistol handle and spring return.

H. Local-Remote Selector switch (43LR) for selecting between the local test control switch (52CS) and remote operation of the breaker. Switch shall be Electroswitch Series 24 or equal, with oval handle and maintained contacts. The Local-Remote selector switch shall be furnished with the following minimum numbers of electrically separate contacts wired in the breaker control circuits or to outgoing terminal blocks as required:
   1. Contacts as indicated below that close in the "Remote" and open in the "Local" position to disconnect the following circuit:
      a. Remote closing
      b. Remote reclosing
      c. Remote tripping (including red lamp). One contact for each trip coil.
      d. Remote green lamp
      e. One breaker "a" contact for supervisory indication.
      f. Two breaker "a" contacts used in the auxiliary tripping relay circuits.
      g. Two contacts for future use.
   2. Contacts that close in the "Local" and open in the "Remote" position:
      a. Local control switch close circuit.
      b. Local control switch trip circuit. One contact for each trip coil.
      c. Two contacts for future use.

I. A copper bar, twelve (12) inches in length, one (1) inch in width, and 1/4 inch thick, shall be mounted near the bottom of the control cabinet. Where the control cabinet is not mounted directly on the frame of the circuit breaker, the ground bar shall be mounted on insulated supports. Where the control cabinet is mounted directly on the frame of the circuit breaker, the ground bar shall be grounded on the cabinet. The ground bar shall be drilled and tapped for #10/32 screws to ground control cable shields and spare conductors.

J. Provide all necessary hoses, regulators, or other devices normally required to perform gas filling operations for SF_6 breakers.

K. Provide thermostatically controlled tank heaters as required to maintain adequate gas temperature and pressure for operation at minimum operating temperature specified in Section 2-2. Heaters shall be rated to operate at voltage listed in Section 2.3-A.4, wattage, as required. Thermostat shall be variable over a minimum range of 0°F to 45°F. Provide low voltage circuit breaker for heater circuit overcurrent protection.

L. Provide one current monitor relay which will supply a 3 minute time delayed alarm to indicate the failure of any of the tank heaters or loss of AC to tank heaters.

M. Provide phase discordance protection for all circuit breakers with non-mechanically interlocked poles. Protection shall utilize auxiliary switch contacts from circuit breaker poles to detect failure to close any circuit breaker. Provide an auxiliary tripping relay to initiate re-trip upon detection of phase discordance conditions. Relay shall be rated to operate at DC control voltage listed in Section 2.3-A.5. Provide a minimum of two spare contacts from auxiliary relay for customer's use.

N. Current Transformers

1) Two relaying accuracy multi-ratio bushing current transformer s on bushings 1, 3 and 5 (total of nine current transformers with short-circuiting terminal boards in mechanism cabinet. Bushing current transformers shall be rated 1200:5 multi-ratio, C800 accuracy class.

2) Two relaying accuracy multi-ratio bushing current transformer on bushings 2, 4 and 6 (total of nine current transformers), with short-circuiting terminal boards in mechanism cabinet. Bushing current transformers shall be rated 1200:5 multi-ratio C800 accuracy class.

O. Provide one bolted, bronze tin plated, stud to NEMA 4 hole pad connector on each bushing.

2.6 REQUIRED SPARE PARTS

A. One complete set of gaskets.

B. One trip coil and one close coil.

C. All spare parts shall be shipped with the power circuit breaker to the destination as quoted in the Summary of Proposal, Section A. Provide engineer with a signed receipt acknowledging delivery of all spare parts to owner.

2.7 OPTIONAL ACCESSORIES/SPARE PARTS

A. Provide a manufacturer's list of recommended spare parts and costs for these parts. This section will not be used in the bid evaluation.

2.8 FABRICATION

A. Fabrication:

1. All connecting parts to fit together accurately and permit erection without cutting or mutilation of members.
2. Bent, warped or otherwise improperly fabricated members will be rejected.

B. Paint and Finish

1. Preparation for and application of paint to exterior of tank frame and accessories shall meet or exceed requirements of RUS specification S-4. Color shall be ANSI 70, light grey. Provide two quarts of touch-up paint for each circuit breaker.
2. All masking materials shall be removed from the equipment prior to shipment. Protective shipping covers for gauges, etc., shall be provided in accordance with Section 1.6.

2.9 SOURCE QUALITY CONTROL

A. Breaker furnished to be identical to existing designs having acceptable history of service in similar applications for not less than 3 years.

B. Perform design tests per ANSI C37.09 (required for general design of breaker furnished).

C. Perform all applicable production tests included in ANSI C37.09.

D. Other Factory Tests:
   1. Measure actual contact opening time from energization of trip coil to contact parting.
   2. Provide travel record curve from a time travel device. (Provide equivalent timing information for breakers not adaptable to time travel devices.)
   3. Measure maximum DC resistance of the power carrying circuit from terminal to terminal of circuit breaker when new.

2.10 MAINTENANCE MATERIALS

A. Spare Parts and Tools:
   1. All special tools required for installation of breaker.
   2. Complete set of special tools or other devices required to dismantle and reassemble the circuit breaker.
   3. One quart of touch-up paint for each breaker.
   4. For SF_6 puffer circuit breakers, furnish filling hose with regulator and gauge.

B. Time Travel Device:
   1. When time travel device is adaptable to breaker, include provisions for mounting.
   2. If time travel device is not adaptable to breaker, provide instructions and any required devices for such timing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receiving:
   1. CONTRACTOR shall furnish all labor, material and equipment required for receiving and inspection.
   2. If any damage is observed or suspected, provide written report to OWNER describing damage and proposed remedy (include pictures of any visible damage)
   3. Repair damage to OWNER's satisfaction..
   4. Verify that all parts have been received in accordance with the shipping list.
   5. Advise OWNER of inspection results.

3.2 INSTALLATION

A. Assembly and Installation:
   1. Equipment will be received, unloaded, assembled and connected by CONTRACTOR.
   2. Assemble exactly to Vendor's recommendations.
   3. Short all current transformer secondaries at terminal blocks in mechanism enclosure (unless directed otherwise by relay test technician).
   4. Make connections to external wiring in accordance with the Drawings, these Specifications, and Vendor's instructions and drawings (as required to permit checkout and testing of breaker).
   5. Make adjustments recommended by Vendor.
   6. Paint any scratched surfaces with touch-up paint.

B. Fill with Insulating SF_6 Gas:
   1. Follow Vendor's recommendations.
   2. Schedule shipments of SF_6 gas.
   3. Use procedures and equipment which insure integrity of the insulating SF_6 gas.

3.3 FIELD QUALITY CONTROL

A. Coordinate with factory service representative so that he may be present during assembly and installation, filling with insulating SF_6 gas checkout and field testing, and placing in service.

B. Inspect Installed Breaker and Components (Checkout):
   1. Satisfactory workmanship.
   2. Conformance with Specifications and Drawings.
   3. Correct nameplate information and ratings.
   4. Proper alignment and fit.
   5. Required grounding connections including frame, mechanism and current transformers.
   6. Tightness of bolting hardware.
   7. Tightness of wiring terminals.
   8. Tap setting and shorting of current transformers.
   9. SF_6 gas pressure, where applicable.
   10. Make functional check of all controls.
   11. All inspections recommended by Vendor.
   12. Make field tests (see below).

C. CONTRACTOR shall furnish all labor, material, and equipment required for field tests.

D. Perform the following field tests:
   1. Timing tests (ANSI C37.09-1979, Article 5.12).
   2. Measure DC resistance of the power carrying circuit from terminal to terminal (use 100 ADC minimum).
   3. Current transformers:
      a. Ratio test (use primary current injection).
      b. Polarity test.
      c. Megger between secondary leads (all phases tied together) and ground. Use 1000 V test voltage for 1 minute, or until reading remains constant for 15 seconds.
      d. Acceptable megger reading: 5 megohms, minimum.
   4. Single-phase motors:
      a. Visual inspection.
      b. Megger motors with supply cables connected (but disconnected at source).
      c. Motor to be at ambient temperature.
      d. Use 500 V test voltage for 1 minute, or until reading remains constant for 15 seconds.
      e. Megger between phase and neutral conductor, tied together, and ground.
      f. Acceptable reading: 5 megohms, minimum.
      g. Verify satisfactory performance and rotation by running motor.
      h. Check lubrication.
   5. Sensors and alarm/control contacts:
      a. Megger between leads and case (see manufacturer's instructions for test voltage).
   6. Energize cabinet heaters and thermostat and verify operation.
   7. Verify proper operation of manual trip.

E. For Acceptance: Pass all inspections and tests.

F. Records:
   1. Statement that equipment has passed all inspections.
   2. Megger readings versus time data, including converted values and ambient temperature at time of test.
   3. Contact resistance values.
   4. Results of timing tests.
   5. Results of CT tests.
   6. Results of all tests recommended by Vendor.

3.4 DUTIES OF SERVICE REPRESENTATIVE

A. Vendor's factory trained service representative shall perform services described within the following constraints of this Contract:
   1. Service representative's time at site shall be as needed to complete the job.
   2. One trip to site shall be furnished.
   3. Provide service representative's transportation and living expense.
   4. Inspect the mechanical and electrical installation and certify the equipment has been installed in accordance with manufacturer's instructions and is ready for startup and initial operation.
   5. Instruct personnel designated by OWNER in operation and maintenance of equipment.

B. Service representative shall supervise the following:
   1. Assembly and installation.
   2. All inspections, adjustments and tests required by the Vendor.
   3. Field tests and checkout described herein.
   4. Placing equipment in operation.

C. Testing equipment and procedures subject to approval and direction of factory service representative.

D. A written report shall be completed by the service representative following all successful testing before leaving the jobsite. Formal documentation six (6) certified copies must be received within ten (10) working days.

END OF SECTION

SECTION 16411
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 GENERAL

A. Section Includes:
   1. Two (2) automatic transfer switches.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Standard for Safety Enclosed and Dead-Front Switches.
      b. 1008, Standard for Safety Switch Equipment.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:

B. Operation and Maintenance Manuals:
   1. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the listed manufacturers are acceptable:
   1. Automatic transfer switches:
      a. Automatic Switch Company.
      b. Kohler.
      c. Onan.
      d. Russelectric.
      e. Zenith Products.

2.2 AUTOMATIC TRANSFER SWITCH

A. Construction:
   1. Electrically operated mechanically held, double throw, air-break type.
   2. Silver-surface main contacts and protect by arcing contacts.
   3. Switch shall have provisions for visual inspection of switch blades and contacts.
   4. Mechanical design will positively open all ungrounded conductors from normal source before connection is made to alternate source and will positively open alternate source before connection is made to normal source.
   5. Mechanical interlock to ensure the switch cannot be readily disabled, disconnected, improperly adjusted, removed or otherwise made inoperative.

6. Make all contacts and coils readily accessible for replacement from front of panel without major disassembly.
7. Ratings:
   a. Continuous duty in both normal and emergency.
   b. Three phase, three pole, four wire.
   c. Voltage rating to be 480V.
   d. Current rating to be 800A.
   e. Short circuit withstand rating equal to or greater than the normal source electrical gear.
8. Standards: UL 1008.

B. Operation:
1. Microprocessor based control module.
2. Open transition.
3. Red and green indicating lights with fuses, identification nameplates, and test switch on front to simulate normal power failure at switch.
4. Engine starting contacts and all other auxiliary contacts and accessory devices for functions to be performed.
5. Supervisory voltage relays on each phase of normal source and single phase supervisory voltage and frequency relay for emergency source.
   a. Normal source voltage sensing.
      1) Adjustable pickup from 85-100 percent of rated voltage, factory set 90 percent.
      2) Adjustable dropout from 75-98 percent of pickup setting, factory set 85 percent.
   b. Emergency source voltage and frequency sensing:
      1) Adjustable pickup from 85-100 percent of rated voltage, factory set 90 percent.
      2) Fixed voltage dropout at 85 percent of pickup setting.
      3) Adjustable pickup from 90-100 percent of rated frequency, factory set 95 percent.
      4) Fixed frequency dropout at 88 percent of pickup setting.
6. Time delays:
   a. Engine start, adjustable from 0 to 10 seconds, factory set at 4 seconds, to avoid unnecessary starting caused by short time outages.
   b. Transfer to generator, adjustable from 0 to 120 seconds, factory set at 10 seconds.
   c. Retransfer to normal, adjustable from 2 to 30 minutes, factory set at 15 minutes to avoid erratic operation caused by short time reestablishment of normal source.
      1) Automatically bypassed when emergency source fails and normal source is available.
   d. Generator cool down, adjustable from 0 to 60 minutes, factory set at 10 minutes.
7. Exerciser timer:
   a. Enable and disable function.
   b. Selectable to exercise with or without transferring load.
   c. Adjustable exercise duration from 1 minute to 24 HRS, factory set at 15 minutes.
   d. Adjustable day of the week exercise setting, factory set for Monday.
8. Inphase monitor:
   a. Compare the phase relationship and frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency differences.
   b. Inphase transfer accomplished if both sources are within 2 Hz of rated frequency and 70 percent or more of rated voltage.

C. Enclosure:
1. NEMA 1 rated.
2. Body and cover: Sheet steel finished with a rust inhibiting primer and manufacturers standard paint inside and out.
3. No knockouts, hinged and lockable door.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Connect as indicated in AC one-line diagram.

C. Mounting of automatic transfer switches:
   1. Wall-mounted.

3.2 FIELD QUALITY CONTROL

A. Automatic Transfer Switch Testing:
   1. Simulate power outage by opening normal source overcurrent device.
      a. Verify engine generator starts and switch transfers in the specified time.
   2. Close normal source overcurrent device to simulate the return of normal power.
      a. Verify the switch retransfers and engine generator shuts down in the specified time.
   3. Perform a manual transfer and retransfer.
   4. Verify the indicator lights function properly.

END OF SECTION

SECTION 16412
HIGH VOLTAGE GROUP-OPERATED DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 GENERAL

A. Section Includes:
1. 230 kV Vertical Break Group-Operated Disconnect Switch shall be three-pole, single-throw outdoor, group-operated disconnect switches for use on three-phase 60 hertz ungrounded, effectively grounded and solidly ground systems. The switches shall include insulators, operating mechanisms and other accessories, as specified.

B. Work By Others:
1. CONTRACTOR will provide the following:
   a. Switch Foundation and Structural Steel.
   b. Connection to OWNER's Bus.
   c. Receiving and Unloading.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. Work shall be performed in accordance with best present-day installation and manufacturing practices.
2. Unless specifically noted to the contrary, equipment shall conform to and be tested in accordance with applicable sections of the latest revisions of the following codes and standards:
   a. American National Standards Institute (ANSI).
   b. National Electrical Manufacturer's Association (NEMA).
3. Conflicts between referenced codes and standards:
   a. Code or standard establishing more stringent requirements shall be followed. Engineer shall be the final judge as to which requirement is more stringent.

1.3 SUBMITTALS

A. Manufacturing Progress Reports
1. Within 30 days of order, the MANUFACTURER shall furnish to the Engineer a manufacturing schedule for switches to be furnished under this specification. MANUFACTURER's schedule shall include projected time allotment for engineering, major materials delivery, all major divisions of fabrication and assembly, testing, and shipment. This schedule shall allow for work completed on each item to be shown in conjunction with projected schedule in a manner which allows updating for furnishing progress reports.

B. Shop Drawings For Approval
1. "Shop Drawings" refers to all detailed installation drawings prepared by the MANUFACTURER and/or his suppliers required to construct the equipment as defined by the specifications, and shall include all fabrication drawings, working drawings, catalog data, manufacturer's specifications, equipment and material scheduled, detailed layouts, and assembly information.

2. The MANUFACTURER agrees that submittals and shop drawings processed by the Engineer are not change orders; that the purpose of submittals and shop drawings by the MANUFACTURER is to demonstrate to the Engineer that the MANUFACTURER understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use. The MANUFACTURER alone accepts all responsibility for assuring that all materials furnished under these specifications meet in full all requirements of the contract documents. The Engineer's review is for general conformance with the design concept and contract documents. Markings or comments shall not be construed as relieving the MANUFACTURER from compliance with the project plans and specifications, nor departures there from. The MANUFACTURER remains responsible for details and accuracy for confirming and correlating all quantities and dimensions, for selecting fabrication processes techniques of assembly.
3. Submit the following shop drawings to the Engineer in the manner specified hereinafter. The following drawings shall be submitted not later than 30 days after receipt of order and steel structure drawings showing switch mounting details.
   a. Switch pole outline with dimensions.
   b. Mounting base detail.
   c. Location and size of mounting holes for all steel support brackets.
   d. Control arrangement for group operated switches.

C. Engineer's Action
1. Engineer will review shop drawings and indicate action taken according to the following classifications:
   a. No Exceptions Taken: Indicates that the shop drawing has been reviewed and appears to be in general agreement with the requirements. MANUFACTURER may make further distribution of shop drawings and proceed with fabrication and/or installation of the work detailed on the drawing.
   b. Furnish As Corrected: Design revisions, deletions, additions and comments shown on these drawings shall be incorporated into the design before proceeding with fabrication or drawing distribution.
   c. Revise and Resubmit: Indicates that the shop drawing, or part thereof, does not appear to be in general agreement with the requirements. Engineer's comments are noted on the shop drawing and/or separate letter. MANUFACTURER shall recheck and make any necessary revisions and resubmit for Engineer's review.
   d. Rejected: Indicates that the shop drawings do not conform to requirements. Reasons for rejection are noted on the shop drawing and/or separate letter.
2. Shop Drawing Submittal and Distribution
   a. Initial Submittal (Review): Submit three (3) copies of each shop drawing to the Engineer; direct mailing to the Engineer's address given in Division O. One copy of the shop drawings indicating the Engineer's action will be returned to MANUFACTURER within three (3) weeks from date of receipt.
   b. Resubmittal: If drawing is returned to the MANUFACTURER with Engineer's comments and action noted "RESUBMIT", the drawing should be rechecked and revised as necessary and two copies resubmitted in manner described in "Initial Submittal".
   c. Final Distribution (Certified): Within the time schedule listed in the Summary of Proposal, MANUFACTURER shall submit to the Engineer, final drawings covered in Section B above utilizing AutoCAD software. All drawing information shall be stored on a compact disk. Direct mailing to the Engineer's address is given in Division O.

D. Instruction Manuals, Test Reports, and Parts Lists
1. MANUFACTURER shall furnish complete instruction manuals covering installation, operation, and maintenance for all equipment. Manuals, bound in vinyl and properly labeled to indicate the facility covered, shall include:
   a. All shop drawings listed in 1.3-B.3 (Reduce as required to fit in manuals).

b. Specific equipment instruction books.
c. Renewal parts lists for all replaceable parts and assemblies.
Furnish five (5) copies at least two weeks prior to shipment. Manuals shall be submitted to the Engineer, Division O for distribution.

E. Shop Drawing and Instructional Material Transmittal Form
1. MANUFACTURER may use his own form of transmittal letter for distribution of shop drawings, clearly marked "For Approval" or "Certified" as applicable.
2. Submit one (1) copy of transmittal form with each set of drawings or instructional materials.

F. MANUFACTURER's Responsibility
1. Check shop drawings prior to submittal for errors, correctness of details and conformance with the specifications.
2. Notify Engineer of any inconsistencies or questions regarding approval revisions or comments shown on the drawings.
3. Review of shop drawings by Engineer does not relieve the MANUFACTURER of responsibility for errors, correctness of details, or conformance with the specifications.
4. Fabrication and shipment of materials or equipment prior to OWNER's release of drawings, data, and information mentioned hereinbefore, shall be at MANUFACTURER's risk.
a. Fabrication and/or layout drawings.
b. Certifications:
c. Test reports:

1.4 DELIVERY, STORAGE, AND HANDLING

A. All bids shall include F.O.B. destination jobsite, located in McPherson County, South Dakota near the North Dakota border..

B. The MANUFACTURER shall notify the Engineer when equipment is ready for shipment. In addition, MANUFACTURER shall advise Engineer of method of shipment, projected routing and estimated time in shipment.
1. Provide shipping papers on all materials and equipment.
2. Immediately after shipment, MANUFACTURER shall notify Engineer of transportation carrier and all transfers and references to permit follow-up on status of shipment and delivery.

C. The MANUFACTURER shall investigate all limitations in regard to shipping the equipment F.O.B. jobsite.

D. Vertical opening switches rated 115kv and above shall be shipped with the live parts and bearing assembled and bolted into position on the bases with blades securely secured closed into the contacts. Insulators shall be separately packaged. Switches rated below 115kv and all "V" type switches shall be shipped with each pole fully assembled. The operating mechanism and interphase linkages shall be packaged separately. All accessories or parts shall be crated or boxed and shipped with the switches. Switches shall be shipped with all components secured to prevent damage. The blade contact surfaces, hinge, contact fingers, and contact subassemblies shall be protected to prevent abrasion of the contact surfaces due to movement between the blade and contact fingers during handling and shipment. Nuts and heads of all bolts used only for shipping purposes shall be painted a bright identifying color.

1.5 EQUIPMENT GUARANTEE

A. Without limiting any other provision of this specification, guarantee of the equipment shall be as follows:
1. MANUFACTURER shall guarantee to the OWNER that the equipment, together with all parts included in the original purchase, is free of defect in workmanship and materials, and is capable of continuous and satisfactory performance when operated in accordance with the instructions provided by the MANUFACTURER at the specified rating and capacity.

2. Guarantee shall extend for a minimum of one year from the date of commercial operation. It shall cover all defects and malfunctions of the switch and accessories. Guarantee shall cover all out-in freight by common carrier in full and the costs of removal from the site and reinstallation after repair. MANUFACTURER shall not be liable for special, indirect, or consequential damages, nor costs of moving structures or associated equipment.

1.6 DEFECTIVE EQUIPMENT

A. Should equipment fail to conform to specifications or to operate satisfactorily, OWNER will have right to operate equipment until defects are corrected and guarantees met.

B. OWNER will have right to operate rejected equipment until it is replaced, without cost for depreciation, use or wear.

C. Equipment may be removed from operation for examination, adjustment, alteration, or change only at time approved by Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the listed manufacturers are acceptable:
1. Pacific Air Switch Corp (PASCOR)
2. Southern States
3. USCO Power Equipment

B. Submit request for substitution.

2.2 CONSTRUCTION AND PERFORMANCE

A. The electrical characteristics and mechanical features of the disconnect switches supplied under these specifications shall be capable of meeting all the requirements specified herein and shall conform to the latest revisions of all applicable NEMA and ANSI Standards.

B. Switches and operators shall be designed to be located where extremes of temperature and severe icing conditions exist. Satisfactory operation will be required over a temperature range of -50°F to +110°F and icing conditions up to 3/4 inch of ice.

2.3 CONTACTS

A. Switch contact surfaces shall be finished with high pressure silver to silver contacts which meet all applicable ANSI, IEEE and manufacturer's practices and recommendations.

B. All contacts shall be self-cleaning.

C. Temperature rise testing shall be in accordance with IEEE C37.34. Temperature rise limitations shall be in accordance with IEEE C37.30.

2.4 LINE TERMINALS

A. Terminal drilling shall be 6-hole for use with either 4-hole or 2-hole NEMA terminals.

B. For copper or copper alloy switches the terminal pads shall be tinned. For aluminum switches, the terminals may be of high-conductivity aluminum.

2.5 INSULATORS

A. NEMA standard strength porcelain station-post insulators with ANSI #70 gray glaze shall be provided by the switch manufacturer.

2.6 OPERATING MECHANISM

A. Group operated disconnect switches shall be furnished with an operating mechanism as specified in Section 2.7, complete with inter-phase pipes, fittings, levers, clevises, operating pipe and grounding strap.

B. Operators shall be furnished with position indicators and provisions for padlocking in "open" or "closed" position, fully adjustable for operator rotation from fully closed to fully open. Operator shall be left-handed or right-handed as required for operator location. Operators shall be located as required to provide proper rotation of operator pipe. Provide proper grounding straps to bond operating pipe immediately above operator to steel structure.

C. Manufacturer shall provide any mounting hardware and steel supports required for attaching the operating mechanism to steel structures. Manual swing operating handles should be mounted approximately 3 feet above the base of the switch-stand and manual crank and motor operators should be mounted approximately 2 feet 6 inches above the base of the switch-stand.

D. Mounting bolts for complete switch, including pole units and all additional steel shall be furnished by the Bidder. All mounting hardware and steel shall be hot-dip galvanized.

E. The operating mechanism shall travel over center beyond the open position to prevent possible accidental closing of an open switch.

F. All inter-phase and control pipes shall be continuous with fittings located only at extremities. All pipe connections on the vertical control pipe shall be secured with positive locks. (Puncture bolts or piercing screws.)

G. If motor operator is specified in Section 2.7, ratings and accessories shall be as follows:
   1. Motor and control rated for DC operation as specified in Section 2.7.
   2. Local electrical control and provision for remote operation.
   3. Provisions for manual operation with the motor engaged and disengaged.
   4. Mechanical position indicator for "open" and "closed" position.
   5. Weatherproof, dustproof control cabinet with provisions padlocking.
   6. Thermostatically controlled 150 watt control cabinet strip heater 120/240 volt AC operation.
   7. Operations counter.
   8. Laminated safety plate window for inspection of position indicator and operations counter.
   9. Control cabinet light with switch.
   10. DC protection provided by fused knife switches.
   11. Minimum of four 'a' and four 'b' contacts which correspond to motor operator position plus a minimum of three 'a' and three 'b' contacts in a separate assembly which correspond directly to the switch/operator pipe position for customer use.

2.7 GROUP OPERATED DISCONNECT SWITCHES

A. Ratings
   1. Quantity ..... Four
   2. Type ..... 3-pole Group Operated, Vertical Break
   3. Maximum Operating Voltage ..... 242 kV
   4. BIL ..... 900 kV
   5. Nominal Cont. Current Rating ..... 1200 A
   6. Momentary Current Rating ..... 61 KA
   7. Mounting Orientation ..... Horizontal
   8. Phase Spacing ..... 16' -0"
   9. Height to Switch Terminal ..... 15'-0"

10. Switch Live-Parts Material ..... Aluminum
11. Insulators TR-304
12. Operating Mechanism ..... Swing Handle

PART 3 - EXECUTION

3.1 INSTALLATION

A. The OWNER anticipates that equipment will be received, unloaded at jobsite, assembled and connected by CONTRACTOR.

3.2 TESTING

A. Shop Tests
   1. Perform tests on switches in accordance with ANSI C37.34.
      The switches shall be completely assembled, adjusted and tested at the factory.
   2. Provide Engineer with five (5) certified copies of all test data. Copies shall be in the form that they can be bound into instruction books by others.

B. Field Tests
   1. Field Service Engineer will conduct tests and inspection as he deems necessary to determine that equipment functions properly after installation. Any special test equipment will be furnished by Field Service Engineer.
   2. If equipment fails to function properly because of defects, MANUFACTURER will make necessary corrections, and upon completion thereof, demonstrate to Engineer that these defects have been corrected.

END OF SECTION

SECTION 16441
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Power distribution panelboards
      a. One (1) - 120/208V, 3PH, 150A with 30 Branch Pole Positions.
      b. One (1) - 277/480V, 3PH, 800A with 30 Branch Pole Positions.
   2. DC distribution panelboards
      a. One (1) - 125VDC, 225A with 40 Branch Pole Positions.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 1, Panelboards.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
      a. 50, Cabinets and Boxes.
      b. 67, Panelboards.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Fabrication and/or layout drawings:
      a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Cutler-Hammer.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.

2.2 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. Ratings as follows unless indicated otherwise on Drawings:
   1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
   2. Panelboards rated 208 Vac or less: 10,000 amp minimum short circuit rating.
   3. Panelboards rated 480 Vac: 14,000 amp minimum short circuit rating.

C. Construction:
1. Service entrance rated as indicated on Drawings.
2. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
3. Multi-section panelboards: Feed-through or sub-feed lugs.
4. Main lugs: Solderless type approved for copper and aluminum wire.

D. Bus Bars:
1. Main bus bars: Plated aluminum or copper sized to limit temperature rise to a maximum of 65 DegC above an ambient of 40 DegC. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
2. Ground bus and isolated ground bus, when indicated on Drawings: Solderless mechanical type connectors.
3. Neutral bus bars: Insulated 100 percent rated or 200 percent rated, when indicated on the Drawings and with solderless mechanical type connectors.

E. Enclosure:
1. Boxes: Code gage galvanized steel, furnish without knockouts.
2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
3. Power distribution panelboard:
a. Trims cover all live parts with switching device handles accessible.
b. Less than or equal to 12 IN deep with gutter space in accordance with NEC.
c. Clear plastic cover for directory card mounted front of enclosure.
d. NEMA 1 rated.

F. Overcurrent and Short Circuit Protective Devices:
1. Main overcurrent protective device:
a. Molded case circuit breaker.
2. Branch overcurrent protective devices:
a. Mounted molded case circuit breaker.
3. Factory installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on Drawings, in accordance with the NEC, and in accordance with manufacturer's instructions.

B. Provide NEMA 1 or rated enclosure as indicated on the Drawings.

C. Provide each panelboard with a typed directory:
1. Identify all circuit locations in each panelboard with the load type and location served.
2. Mechanical equipment shall be identified by Owner-furnished designation if different than designation indicated on Drawings.
3. Room names and numbers shall be final building room names and numbers as identified by the Owner if different than designation indicated on Drawings.

END OF SECTION

SECTION 16460
DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. One (1), 75kVA dry-type transformer.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. C57.96, Loading Dry-Type Distribution and Power Transformers.
      b. C89.2, Dry-Type Transformers for General Applications.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ST 20, Dry Type Transformers for General Applications.
      c. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.
   3. Underwriters Laboratories, Inc. (UL):
      a. 506, Standard for Safety Specialty Transformers.
      b. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. UL nameplate data.
   2. Certifications:
      a. Sound level certifications.

B. Operation and Maintenance Manuals:
   1. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Cutler-Hammer.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.
   5. Sola/Hevi-Duty.

2.2 GENERAL PURPOSE DRY-TYPE TRANSFORMERS

A. Ventilated or non-ventilated, air cooled, two winding type.

B. Cores: High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point.

C. Coils: Continuous wound with electrical grade aluminum.

D. Ventilated Units:
   1. Core and coils assembly impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture and completely isolated from the enclosure by means of vibration dampening pads.
   2. Dripproof, NEMA 1, steel enclosure finished with a weather-resistant enamel and ventilation openings protected from falling dirt.

E. Furnish Taps for Transformers as Follows:
   1. 3 PH, 15 kVA and above: Two 2.5 percent FCAN and four 2.5 percent FCBN.

F. Sound Levels: Manufacturer shall guarantee not to exceed the following:
   1. 51 to 150 kVA: 50 dB.

G. Efficiency:
   1. Ventilated, 15 kVA and larger: Energy efficient meeting NEMA TP 1 requirements.

H. Insulating Material (600 V and below):
   1. 15 kVA and above units: 220 DegC insulation system with a 150 DegC rise.

I. Ratings: 60 Hz, 480-120/208V, 100KVA and three phase, as indicated on the Drawings.

J. Finish: Rust inhibited primer and manufacturers standard paint inside and out.

K. Standards: ANSI C57.96, ANSI C89.2, NEMA ST 20, NEMA TP 1, UL 506, UL 1561.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Indoor Locations:
   1. Provide ventilated type for 15 kVA units and above.
   2. Mount 15 kVA units and above on chamfered 4 IN high concrete housekeeping pad.
   3. Provide rubber vibrations isolation pads.

C. Enclosures: Painted steel in all areas except stainless steel in highly corrosive areas.

END OF SECTION

SECTION 16461

CAPACITIVE COUPLING VOLTAGE TRANSFORMER(S)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Three (3) outdoor Capacitive Coupling Voltage Transformers (CCVT).

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. National Electrical Manufacturer's Association (NEMA).

1.3 DEFINITIONS

A. CCVT: Is a transformer used in power systems to step-down extra high voltage signals and provide low voltage signals either for measurement or to operate a protective relay.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Capacitive Coupling Voltage Transformer:
      a. Ritz.
      b. ABB.
      c. Or Approved Equal.

2.2 MANUFACTURED UNITS

A. Capacitive Coupling Voltage Transformer:
   1. Quantity: Three (3).
   2. Voltage Class: 230kV.
   3. Basic Insulation Level (BIL): 900kV.
   4. Nominal Capacitance: 0.003uf, High C.
   5. Frequency: 60Hz.
   6. Primary Terminals: Top Cover Adapter Plate with 5 inch bolt circle drilling for pedestal mounted line trap.
   7. Type Mounting: Vertical Base.
   8. Color of Porcelain and Tank: ANSI #70 Light Grey.
   9. Accessories:
      a. Carrier Accessories.
      b. Carrier lead in bushing.
      c. Anti-condensation heater.
      d. Ground terminal connector for #2-250 KCM copper cables.

PART 3 - EXECUTION

3.1 CONSTRUCTION AND PERFORMANCE

A. Instrument transformers shall be suitable for continuous operation for altitudes up to 1000 meters and ambient temperatures between -30°C and 40°C.

3.2 INSTALLATION

A. Install per MANUFACTURER'S recommendations.

B. Capacitive Coupling Voltage Transformer shall be located as shown on Plan and Elevation Drawings.

END OF SECTION

SECTION 16471
BATTERY AND BATTERY CHARGER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Battery and Charger.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronic Engineers/American National Standards Institute (IEEE/ANSI) 1106 and 1115:
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 70B, National Electrical Code (NEC).

1.3 SUBMITTALS

A. Proposal Data:
   1. Battery Bank and Charger:
      a. General Information:
         1) Manufacturer.
         2) Model.
         3) Catalog Number.
         4) Weight of entire bank with stand.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Battery Bank and Charger:
      a. ALCAD.
      b. EXIDE.
      c. C&D.
      d. Or Approved Equal.

2.2 MANUFACTURED UNITS

A. Battery and Charger:
   1. Nickel Cadmium Battery:
      a. One hundred fifty (150) amp-hr. with a capacity at eight (8) hour discharge rate to 1.75 volts per cell final at 77°F. The float charge shall have a range of 2.15 to 2.25 volts per cell. Plate composition shall be lead calcium.
      b. Inter-cell and inter-step connections (plus two spares with bolts and nuts).

c. Terminal connectors with plated copper lugs for connection of the battery's main positive and negative terminals to 4/0 A.W.G copper power cable.

2. Battery Accessories:
   a. Protective cover to prevent accidental contact with the terminals.
   b. Lifting straps and lifting hardware.
   c. Cell numerals with polarity indicators for all cells furnished.
   d. Battery nameplates and warning labels.
   e. One half-pin of No-Oxide grease.
   f. Installation and maintenance instructions.
   g. Any other accessories required by OSHA, including Material Safety Data Sheets.
3. Battery Rack:
   a. Provide back-to-back two step battery rack.
   b. Rack shall be designed to fit in area given.
   c. Rack shall allow individual cell replacement.
   d. Rack shall be constructed of steel with acid-resistant insulation between the cells and the steel of the rack as per IEEE Std. 484.
4. Battery Charger:
   a. Furnish one (1) floor mounted complete automatic battery charger with as a minimum, the following ratings and accessories.
   b. Rated input: Single-phase, 208 volts AC, 60 Hz.
   c. Output: 125 VDC, 25 amps.
   d. Filtered battery eliminator option.
   e. DC ammeter rated 2% accuracy, scale per MANUFACTURER's recommendation, based on charger output.
   f. DC output voltmeter, 2% accuracy, expanded scale.
   g. AC input and DC output circuit breakers.
   h. Dual-rate capability with float/high-rate switch and float/high-rate voltage adjustment potentiometer.
   i. High DC voltage shut-down.
   j. Automatic charging control with timer and high-rate charge indicator light.
   k. Alarm relays for AC power loss, DC failure, high and low VDC and ground fault.
   l. Terminal block for termination of all relay alarm contacts, factory wired.
   m. Installation, operation, and maintenance instructions and parts lists.
   n. 120V, 20 amp auxiliary output contact to close during equalize charge.
   o. Ground connector.
5. Enclosure:
   a. One (1) enclosure with hinged doors, ANSI-61 grey finish for location within inside of building. Enclosure shall be sized to include supporting the batteries and battery charger.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install per MANUFACTURER'S recommendations.

B. Battery and Charger shall be located as shown on Plan and Elevation Drawings.

END OF SECTION

SECTION 16494
ELECTRICAL INSULATORS AND LIGHTNING ARRESTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Station Post Insulators.
      b. Suspension Insulators.
      c. Lightning Arresters.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronic Engineers/American National Standards Institute (IEEE/ANSI):
      a. ANSI Class 52-6.
      b. C62.11, Metal-Oxide Surge Arresters for Alternating Current Power Circuits.
      c. C62.22, Guide for Application of Metal-Oxide Surge Arresters for Alternating Current Systems.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 70B, National Electrical Code (NEC).

1.3 DEFINITIONS

A. Insulator: Insulating material, often glass or porcelain, in a unit form designed so as to support a charged conductor and electrically isolate it.

B. Arrester: Protective devices for limiting surge voltage due to lightning strikes or equipment faults.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Insulators (Station and Post):
      a. LAPP.
      b. NGK Locke.
      c. Sediver.
      d. Or Approved Equal.
   2. Arresters:
      a. Ohio Brass.
      b. General Electric Company.
      c. Or Approved Equal.

2.2 MANUFACTURED UNITS

A. Insulators:

1. 230kV Station Post Insulator:
    a. 900kV BIL, TR-304.
    b. Gray.
    c. Standard Strength.
    d. 5 inch Bolt Circle.
2. 230kV Suspension Insulator:
    a. 30,000lbs Minimum Ultimate Tensile Strength.
    b. Gray.
    c. 10 inch diameter.
    d. Ball to Socket.

B. Lightning Arresters:
1. 230kV Arrester:
    a. 140kV MCOV.
    b. Polymer housed station class Type PVN.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Clamp supports and associated hardware shall have a strength exceeding that of the insulator.

B. Insulators shall be located as shown on Plan and Elevation Drawings.

END OF SECTION

SECTION 16600
SUBSTATION FENCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Substation chain link fence.

1.2 DEFINITIONS

A. Chain Link Fence: Is a type of woven fence usually made from galvanized or LLDPE coated steel wire.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. General:
   1. Fence is to be non-climable type equivalent to Real Lock Type 423.
   2. Fence should be 7' high unless otherwise specified with a bracket of 3 strands of barbed wire extended above the 7' height; and cantilevered to the outside.
   3. Fence is to be constructed in a workmanlike manner with material as listed in 2.1.B.
   4. Posts and top railings are to be aligned as straight as possible and must have a pleasing appearance.
   5. Gates and removable sections, if required, to be installed where shown on drawings.
   6. All materials except aluminum to be heavily galvanized by the hot-dip process.
   7. All end, corner and gate posts to be furnished with diagonal braces where required.

B. Fence Characteristics:
   1. Type 423 (Heavy Construction):
      a. 2-1/2" O.D. pipeline posts, 3.65 lb/ft.
      b. 1- 5/3" Top rail, 2.27 lb/ft.
      c. End, corner and gate posts: 3" O.D. pipe, 5.79 lb/ft or approved equal, H-Section Posts and Rails.
   2. Gates:
      a. 2" O.D. pipe frame, 2.72 lb/ft.
      b. All joints welded and braced wherever necessary; covered with fabric to metal fence.
      c. Furnished with suitable hinges and locking devices.
   3. Fabric:
      a. 2" O.D. pipe frame, 2.72 lb/ft.
      b. 2" mesh, No. 11 gauge basic open hearth steel, hot-dip galvanized after fabrication.
      c. 1.2 oz. of zinc per ft. squared of wire surface.
      d. Standard finish, twisted and barbed salvage top and bottom.
   4. Post Settings:
      a. Posts to be set in concrete to a depth of 36".
   5. Fittings:
      a. Malleable iron, pressed steel, and/or aluminum.
   6. Ties:
      a. Aluminum and/or galvanized steel wire.

b. For line posts, furnish one tie to every foot of fabric height.

C. Barbed Wire:
   a. Three strands of galvanized steel running entire length of fence above fabric and gates.
   b. Composed of two strands of 12-1/2 gauge wire, 4 point, spaced approximately 3" apart, supported on the line posts by means of heavy galvanized mallcable iron tops with pressed steel extension arms at an angle of 45°.
   c. Where H-Sections are used, arms maybe fabricated as an integral part of the posts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All post holes shall be clean and loose material removed before placing concrete.

B. Concrete shall be formed up to finish grade around each post, a minimum of 6" above grade, and sloped to provide drainage way from the post.

C. Fence fabric and barbed wire shall be stretched according to manufacturer's instructions, leaving no slack and forming a neat appearance.

END OF SECTION

SECTION
SINGLE-MODE FIBER OPTIC CABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Single-Mode Fiber Optic Cable.
      b. Fiber termination cabinet.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Telcordia:
      a. GR-20-CORE, Optical Fiber and Optical Fiber Cable.
   2. Insulated Cable Engineers Association (ICEA):
      a. S-87-640-1999, Optical Fiber Communication Cables Intended For Outdoor Use.
   3. International Organization for Standards (ISO):
      b. ISO 9001-14001-TL 9000
   4. ASTM:
      a. D4565-90a, Standard Test Methods for Physical and Environmental Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).

   Underwriters Laboratories, Inc. (UL):

B. Qualifications:
   1. Cable technician:
      a. Three years experience in handling, terminating and splicing single-mode fiber optic cable.
      b. Specifically trained by a factory representative on the terminations and splices to be used on the project. If not trained on the products to be used, on-site training by the factory representative shall be preformed before any terminations or splices are made.

1.3 SUBMITTALS

A. Miscellaneous:
   1. Cable Technician qualifications.
   2. Independent testing organization qualifications.
   3. Engineering Technician qualifications.
   4. Cable test reports signed by the engineering technician including the following information:
      a. Summary of Project.
      b. Description of equipment/components tested.
      c. Visual inspection report.
      d. Description of tests.
      e. Test results including appropriate test forms.
      f. Conclusions and recommendations.
      g. Identification of test equipment used.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Ship cable with removable watertight end seals, and store in dry place.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Single-Mode Fiber Optic Cable:
      a. Superior Essex, Inc.
      b. Alcoa Fujikura.
      c. Or approved equal.
   2. Fiber termination cabinet:
      a. ADC Telecommunications.
      b. Or approved equal.

2.2 SINGLE-MODE FIBER OPTIC CABLE

A. Cable Construction:

1. Double Jacket: Double Jacket cable offers additional mechanical protection except in heavily infested rodent areas. The design shall provide reliable transmission performance over a broad temperature range.

2. Physical Description: Optical fibers shall be placed inside gel filled buffer tubes in loose tube cable or bundles in solid designed cable. Core construction shall be by stranding the buffer tubes or fiber groups around a central member using a reverse oscillated lay. Central strength member shall be dielectric.

3. Fiber Protection: The Core shall be wrapped with flexible strength members covered with a water blocking tape and encased with a black polyethylene inner jacket. A second jacket shall have water-blocking yarns and a block polyethylene outer jacket. Rip cords shall be located under each jacket.

B. Standards:
   1. GR-20-CORE, Optical Fiber and Optical Fiber Cable.
   2. S-87-640-1999, Optical Fiber Communication Cables Intended For Outdoor Use.
   3. ISO 9001-14001-TL 9000.
   4. D 4565-90a.

C. Physical Characteristics:
   1. Fiber cables shall be within the range listed below.

Fiber Content	Nominal Diameter In. (mm)	Nominal Weight Lbs.kft (ka/km)	Max. Tensile Loading Lbs (N)	Min. Bend Radius In. (mm)
12	0.56 (14.3)	95 (147)	200 (890)	11.3 (286)

D. Environmental:
   1. Operating Range: The fiber shall be capable of withstanding operation and storage temperatures of -50°C/-122°F to +70°C/+158°F and installation temperatures of -30°C/--86°F to +75°C/+167°F.
   2. Stress: Fiber cable shall meet the requirements of ASTM D 4565-90a.

E. Optical Specifications:
   1. Outside Plant: Fiber optic cable shall meet the following requirements:

Fiber Type:	Single-Mode	Attenuation
	8.3/125μm	62.5/125μm
Wavelength	1310-1550nm	850μm/1300nm
Max. Attenuation	0.40/0.30dB	3.50μm/0.00dB/km
Typical Attenuation	0.35/0.20dB	3.00-0.80dB/km

Min. Band Width	-----	220-600(MHz-km)

F. Light:
1. The single-mode fiber shall be lit by a laser-based light transmitted down the core of the fiber for communications applications.

G. Splicing:
1. The single-mode fiber shall be spliced with mechanical splices.

H. Identification:
1. Each cable reel shall be either stenciled or tagged firmly with the following information.

OPTICAL FIBER

Number of Fibers
Armored or Non-Armored
Year of Manufacture
Name of Cable Manufacturer
Length of Cable
Continuous – Sequential Numbering in One-Foot Increments
Reel Number
Fiber Attenuation dB/km @ 1350/1550 Single-Mode
Dry or Flooded Cable
Size of Buffer Tubes in nm
Results of Factory Tests on 20% of Fibers in Cable

I. Fiber and Buffer Tube Identification:
1. The buffer tubes and individual fibers shall be color-coded to meet the ANSI/TIA/EIA-568A Standards.

2.3 FIBER TERMINATION CABINET

A. Provides termination and splicing for up to 144 fibers within 8.75 inch height (5 RU).

B. Rear flip-down splicing area uses standard splice trays and provides slack storage OSP/IFC buffer tubes.

C. Angled bulkhead ensures ease of access to individual connectors.

D. Panel is equipped with six dual height splice trays.

E. Optional lock for front door.

F. Removable front polycarbonate door.

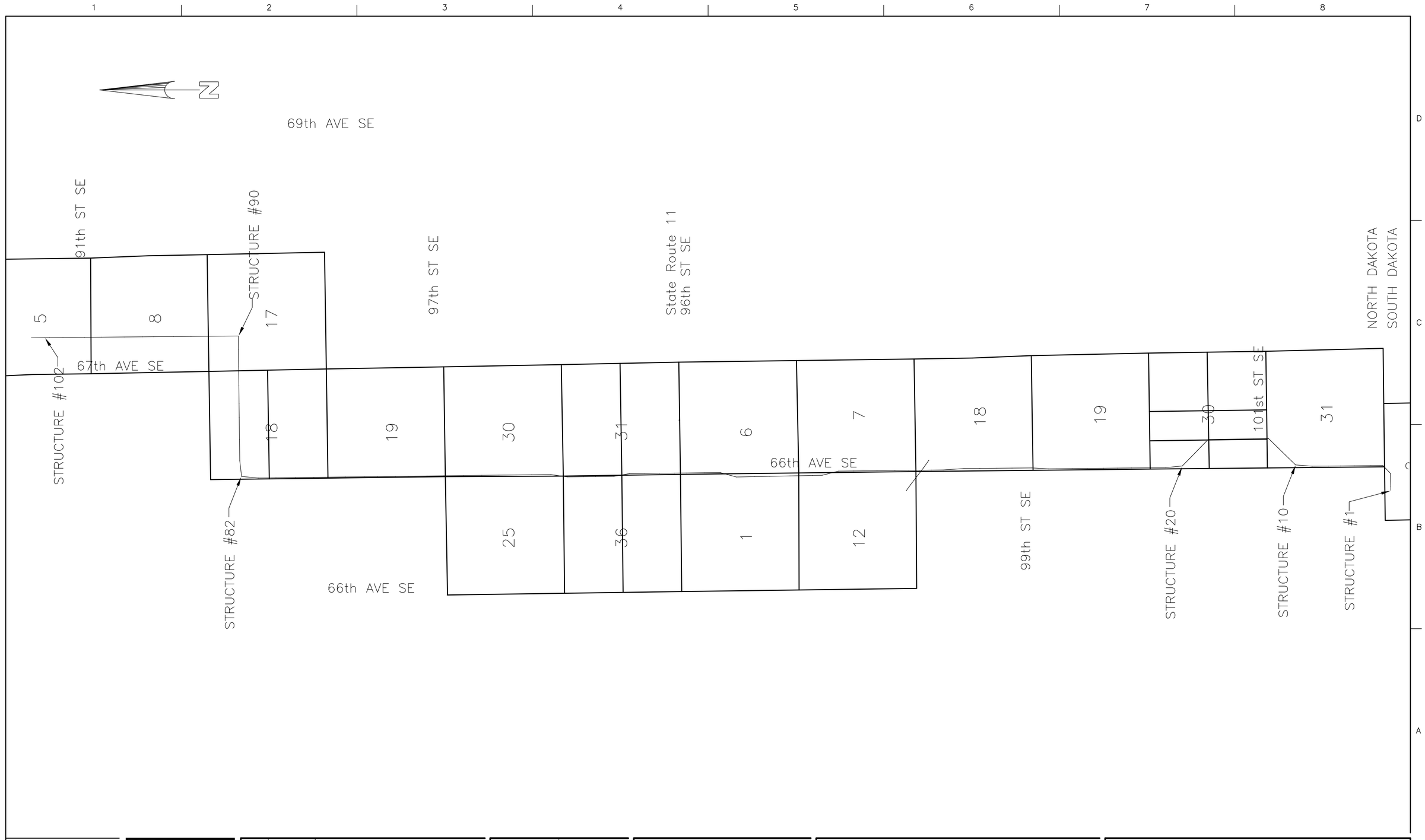
G. Designation labels included with each panel.

H. Mounting brackets included with panel may be flipped t accommodate 19-ince or 23-inch mounting and 4-inch or 5-inch recess.

I. Panel available with pigtails only.

J. Maximum of three panels to be used within one rack for a total of 432 terminations.

END OF SECTION



HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
2	4–17–08	AS–BUILT
1	4–30–07	RE–ISSUED FOR CONSTRUCTION
0	4–20–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

MORTENSON

acciona

TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
ROUTE MAP

0 1" 2"

FILENAME	RM–01.dwg
SCALE	NONE

SHEET
RM-01

Inspection Report

Date 1/-13-07 Time 9:23 am

Level or inclined span Level

Method of sagging; Return waves, Target, or Angle of sight Return Wave

Ruling Span 200'

Location of Puller #17

Location of Tensioner #4

Conductor size, type and stranding: 397 T-2 26-7

O.H.G.W. size, type and stranding: 3/8" EHS

' numbers used: Conductor Up #5

;O.H.G.W.

Location of sleeves 5-6 16-17

Guys properly adjusted yes

Structures clipped in within time frame

Comments

(Contractor's stringing foreman)

(Owner's inspector)

Sag Report

PRIMARY SAG LOCATION: (2/3 sag section length away from puller)

Sag between structures 8 and 9

Wind speed and direction 9 mph N.W. temperature 36° f

Length of span between conductor supports: 727'

Slope distance Vertical spacing Vertical span

Span measurements by:

	CONDUCTOR	O.H.G.W
Sag in inches	126"	155"
Time for return waves	9.7	10.8

Temperature at end of sagging 49° Number of return waves 3

SECONDARY SAG LOCATION: (1/3 of sag section length away from puller)

Sag between structures 14 and 15

Wind speed and direction 9 mph N.W. temperature 49° f

Length of span between conductor supports: 742'

Slope distance Vertical spacing Vertical span

Span measurements by:

	CONDUCTOR	O.H.G.W
Sag in inches	117"	140"
Time for return waves	9.3	10.2

Temperature at end of sagging 49° Number of return waves 3

HDR	Engr:	Scale: None	INSPECTION REPORT SAG REPORT
	Dwn:	Date:	File: IR-SR
	Chkd:	Plot:	Sheet 1 of 1
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Rev. 0

Inspection Report

Date 11-7-02 Time 10:42am

Level or inclined span Level

Method of sagging; Return waves, Target, or Angle of sight Return Wave

Ruling Span 700'

Location of Puller #32

Location of Tensioner #17

Conductor size, type and stranding:
397. T-2 26-7

O.H.G.W. size, type and stranding:
3/8" EHS

numbers used: Conductor: BC 168211 BC 201812 BC 167944

;O.H.G.W.

Location of sleeves

Guys properly adjusted yes

Structures clipped in within time frame

Comments

(Contractor's stringing foreman)

(Owner's inspector)

Sag Report

PRIMARY SAG LOCATION: (2/3 sag section length away from puller)

Sag between structures 32 and 33

Wind speed and direction 5mph S.W. temperature 33° F

Length of span between conductor supports: 765'

Slope distance Vertical spacing Vertical span

Span measurements by:

	CONDUCTOR	O.H.G.W
Sag in inches	136"	169"
Time for return waves	10.14	11.2

Temperature at end of sagging 33° Number of return waves 3

SECONDARY SAG LOCATION: (1/3 of sag section length away from puller)

Sag between structures 21 and 22

Wind speed and direction 5mph SW temperature 33°

Length of span between conductor supports: 666'

Slope distance Vertical spacing Vertical span

Span measurements by:

	CONDUCTOR	O.H.G.W
Sag in inches	99"	123"
Time for return waves	8.7	9.63

Temperature at end of sagging 33° Number of return waves 3

Engr:	Scale: None	**INSPECTION REPORT** SAG REPORT	File: IR-SR Rev. 0
Dwn:	Date:		Sheet 1 of 1
Chkd:	Plot:		IR-SR
App:	Proj. No:		

Inspection Report

Date 10-29-07 Time 1:51 pm

Level or inclined span _____

Method of sagging; Return waves, Target, or Angle of sight Return Wave

Ruling Span 800'

Location of Puller Str # 38

Location of Tensioner Str # 56

Conductor size, type and stranding: 397 T2 26/7

O.H.G.W. size, type and stranding: 3/8 EHS

' numbers used: Conductor BC 201754 BC 101327

_____ ;O.H.G.W. BC 101259

Location of sleeves 52-56

Guys properly adjusted Yes

Structures clipped in within time frame ____

Comments _____

_____
(Contractor's stringing foreman)

_____
(Owner's inspector)

Sag Report

PRIMARY SAG LOCATION: (2/3 sag section length away from puller) * Brian Abeld present

Sag between structures 50 and 51

Wind speed and direction Calm temperature 66°F

Length of span between conductor supports: 675'

Slope distance _____ Vertical spacing _____ Vertical span _____

Span measurements by: _____

	CONDUCTOR	O.H.G.W
Sag in inches	131	134
Time for return waves	9.9	10.0

Temperature at end of sagging 66°F Number of return waves 3

SECONDARY SAG LOCATION: (1/3 of sag section length away from puller)

Sag between structures 46 and 47

Wind speed and direction Calm temperature 66°

Length of span between conductor supports: 750'

Slope distance _____ Vertical spacing _____ Vertical span _____

Span measurements by: _____

	CONDUCTOR	O.H.G.W
Sag in inches	158"	155"
Time for return waves	10.9	10.7

Temperature at end of sagging 66°F Number of return waves 3

HDR	Engr:	Scale: None	**INSPECTION REPORT** SAG REPORT	File: IR-SR	Rev. 0
	Dwn:	Date:		Sheet 1 of 1	
	Chkd:	Plot:		IR-SR	
	App:	Proj. No:			

Inspection Report

Date _____ Time 3:26 pm

Level or inclined span Level

Method of sagging; Return waves, Target, or Angle of sight Return Wave

Ruling Span 800'

Location of Puller str# 82

Location of Tensioner str# 57

Conductor size, type and stranding: 397.5 T2 26/7

O.H.G.W. size, type and stranding: 3/8 EHS

' numbers used: Conductor: BC101327 BC126113

_____ ;O.H.G.W. BC 29733

Location of sleeves 75-76

Guys properly adjusted yes

Structures clipped in within time frame ____

Comments _____

_____
(Contractor's stringing foreman)

_____
(Owner's inspector)

Sag Report

PRIMARY SAG LOCATION: (2/3 sag section length away from puller)

* Brian Abold present

Sag between structures ~~82~~ 69 and ~~83~~ 70

Wind speed and direction Calm temperature 58°

Length of span between conductor supports: 853'

Slope distance _____ Vertical spacing _____ Vertical span 853'

Span measurements by: _____

	CONDUCTOR	O.H.G.W
Sag in inches	203"	210"
Time for return waves	12.28	12.41

Temperature at end of sagging 58° Number of return waves 3

SECONDARY SAG LOCATION: (1/3 of sag section length away from puller)

Sag between structures 76 and 77

Wind speed and direction Calm temperature 58°f

Length of span between conductor supports: 776'

Slope distance _____ Vertical spacing _____ Vertical span _____

Span measurements by: _____

	CONDUCTOR	O.H.G.W
Sag in inches	169"	187"
Time for return waves	11.28	11.78

Temperature at end of sagging 58° Number of return waves 3

HDR	Engr:	Scale: None	INSPECTION REPORT SAG REPORT
	Dwn:	Date:	
	Chkd:	Plot:	
	App:	Proj. No:	

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Inspection Report

Date 10-20-07 Time 12:21

Level or inclined span _____

Method of sagging; Return waves, Target, or Angle of sight Return Waves

Ruling Span 800

Location of Puller Str # 82

Location of Tensioner Str #90

Conductor size, type and stranding: 397.5 T2 26/7

O.H.G.W. size, type and stranding: 3/8" EHS

numbers used: Conductor: BC 168211 BC 201812 ; O.H.G.W. BC 167949

Location of sleeves NA

Guys properly adjusted Yes

Structures clipped in within time frame ____

Comments _____

_____
(Contractor's stringing foreman)

_____
(Owner's inspector)

Sag Report

PRIMARY SAG LOCATION: (2/3 sag section length away from puller)

Sag between structures 86 and 87

Wind speed and direction Calm temperature 51° F

Length of span between conductor supports: 792'

Slope distance _____ Vertical spacing _____ Vertical span _____

Span measurements by: _____

	CONDUCTOR	O.H.G.W
Sag in inches	173"	182
Time for return waves	11.4	11.61

Temperature at end of sagging 51° F Number of return waves 3

SECONDARY SAG LOCATION: (1/3 of sag section length away from puller)

Sag between structures _____ and _____

Wind speed and direction _____ temperature _____

Length of span between conductor supports:

Slope distance _____ Vertical spacing _____ Vertical span _____

Span measurements by: _____

	CONDUCTOR	O.H.G.W
Sag in inches		
Time for return waves		

Temperature at end of sagging _____ Number of return waves _____

HDR	Engr:	Scale: None	**INSPECTION REPORT** SAG REPORT	File: IR-SR	Rev. 0
	Dwn:	Date:		Sheet 1 of 1	
	Chkd:	Plot:		IR-SR	
	App:	Proj. No:			

Inspection Report

Date 10-12-07 Time 9:30 am

Level or inclined span Level

Method of sagging; Return waves, Target, or Angle of sight Return Wave

Ruling Span 800'

Location of Puller Str # 101

Location of Tensioner Str # 90

Conductor size, type and stranding: 397.5 T2 26/7

O.H.G.W. size, type and stranding: 7/8 x 7 steel EHS

numbers used: Conductor: BC 125831 ;O.H.G.W. BC 154719

Location of sleeves None

Guys properly adjusted Yes

Structures clipped in within time frame

Comments

(Contractor's stringing foreman)

(Owner's inspector)

Sag Report

*Brian Abeld present

PRIMARY SAG LOCATION: (2/3 sag section length away from puller)

Sag between structures 99 and 98

Wind speed and direction Calm temperature 51° F

Length of span between conductor supports: 943'

Slope distance ____ Vertical spacing ____ Vertical span 772'

Span measurements by: ____

	CONDUCTOR	O.H.G.W
Sag in inches	163	171
Time for return waves	11.2	11.29

Temperature at end of sagging ____ Number of return waves ____

SECONDARY SAG LOCATION: (1/3 of sag section length away from puller)

Sag between structures 94 and 93

Wind speed and direction Calm temperature 60° F

Length of span between conductor supports: 885'

Slope distance ____ Vertical spacing ____ Vertical span 799'

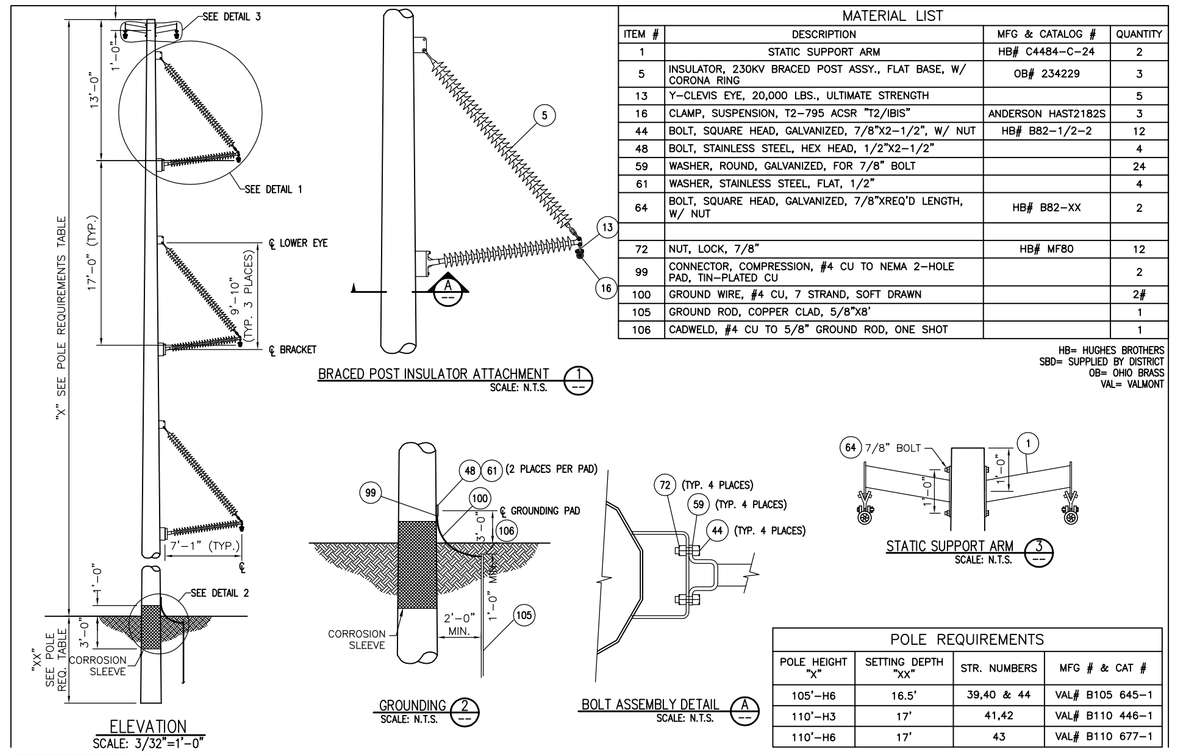
Span measurements by: ____

	CONDUCTOR	O.H.G.W
Sag in inches	180"	187"
Time for return waves	11.61	11.7

Temperature at end of sagging 62° F Number of return waves 3

HDR	Engr:	Scale: None	INSPECTION REPORT SAG REPORT
	Dwn:	Date:	
	Chkd:	Plot:	
	App:	Proj. No:	

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IR-SR



MATERIAL LIST			
ITEM #	DESCRIPTION	MFG & CATALOG #	QUANTITY
1	STATIC SUPPORT ARM	HB# C4484-C-24	2
5	INSULATOR, 230KV BRACED POST ASSY., FLAT BASE, W/ CORONA RING	OB# 234229	3
13	Y-CLEVIS EYE, 20,000 LBS., ULTIMATE STRENGTH		5
16	CLAMP, SUSPENSION, T2-795 ACSR "T2/IBIS"	ANDERSON HAST2182S	3
44	BOLT, SQUARE HEAD, GALVANIZED, 7/8"X2-1/2", W/ NUT	HB# B82-1/2-2	12
48	BOLT, STAINLESS STEEL, HEX HEAD, 1/2"X2-1/2"		4
59	WASHER, ROUND, GALVANIZED, FOR 7/8" BOLT		24
61	WASHER, STAINLESS STEEL, FLAT, 1/2"		4
64	BOLT, SQUARE HEAD, GALVANIZED, 7/8"XREQ'D LENGTH, W/ NUT	HB# B82-XX	2
72	NUT, LOCK, 7/8"	HB# MFBO	12
99	CONNECTOR, COMPRESSION, #4 CU TO NEMA 2-HOLE PAD, TIN-PLATED CU		2
100	GROUND WIRE, #4 CU, 7 STRAND, SOFT DRAWN		2#
105	GROUND ROD, COPPER CLAD, 5/8"X8'		1
106	CADWELD, #4 CU TO 5/8" GROUND ROD, ONE SHOT		1

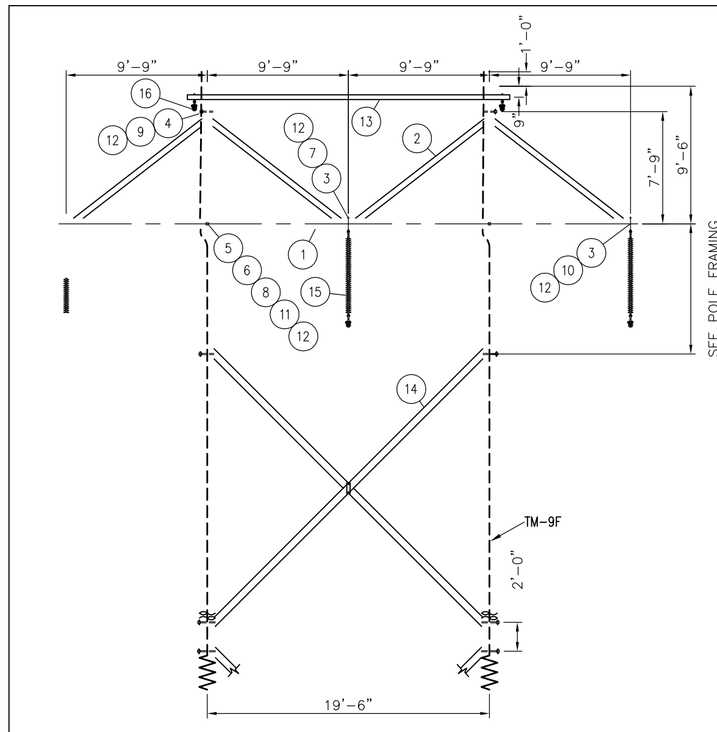
HB= HUGHES BROTHERS
SBD= SUPPLIED BY DISTRICT
OB= OHIO BRASS
VAL= VALMONT

POLE REQUIREMENTS			
POLE HEIGHT "X"	SETTING DEPTH "XX"	STR. NUMBERS	MFG # & CAT #
105'-H6	16.5'	39,40 & 44	VAL# B105 645-1
110'-H3	17'	41,42	VAL# B110 446-1
110'-H6	17'	43	VAL# B110 677-1

TATANKA WIND FARM
230KV TRANSMISSION LINE

STRUCTURE DRAWING
STEEL TANGENT BRACE POST
-

48049 | 1 OF 1 | SBP.dwg | 4-11-2007 | SBP

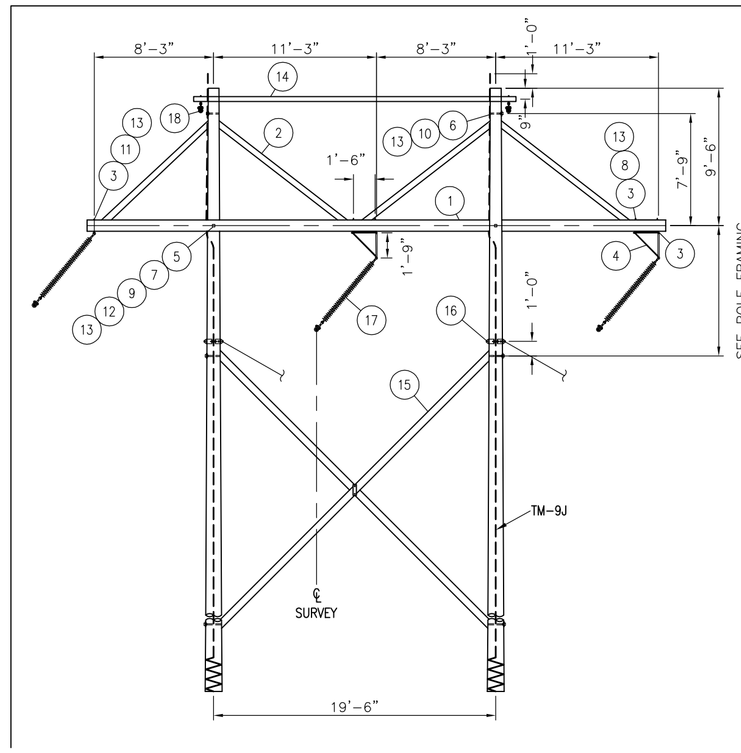


LIST OF MATERIALS		
ITEM	REQ.	DESCRIPTION
1	2	X-ARM, 40'-0" #81
2	4	BRACE, X-ARM, 3-3/8" X 5-3/8" X REQ'D.
3	3	SPACER ASSEMBLY, SEE CONST. SPEC.
4	2	GRID GAIN, 4" X 4", 15/16" HOLE
5	4	PLATE, GAIN
6	4	PLATE, RIBBED TIE
7	1	D.E. BOLT, 7/8" BENT W/ 2 RESCUE NUTS
8	2	ROD, THREADED, 7/8" W/ 2 NUTS
9	2	BOLT, MACHINE 7/8" X REQ'D LENGTH
10	2	BOLT, 7/8" BENT
11	2	WASHER, SPRING, 15/16" HOLE
12	10	LOCKNUT, 7/8" MF TYPE
13	1	OHGW SUPPORT ASSEMBLY, TM-7D
14	1	X-BRACE ASSEMBLY, TM-110C
15	3	INSULATOR ASSEMBLY, TANGENT, TM-1B
16	2	OHGW ASSEMBLY, TANGENT, TM-4A, 4B (NOTE 1)

MISC. ASSEMBLIES:
TD-15F, TD-17F, TD-20, TCD-40, TPF-50, TM-121

NOTE 1:
USE TM-4A ON 3/8" EHS,
USE TM-4B ON OPGW

PROJECT TITLE	PROJECT NUMBER	REFERENCE SHEET
TATANKA WIND FARM 230KV TRANSMISSION LINE	48049	1 OF 1
SHEET TITLE	**PROJECT MANAGER**	**REFERENCE DOCUMENT**
TANGENT H-FRAME - -		TH-230
	DATE 4/20/07	**EXHIBIT NUMBER** TH-230

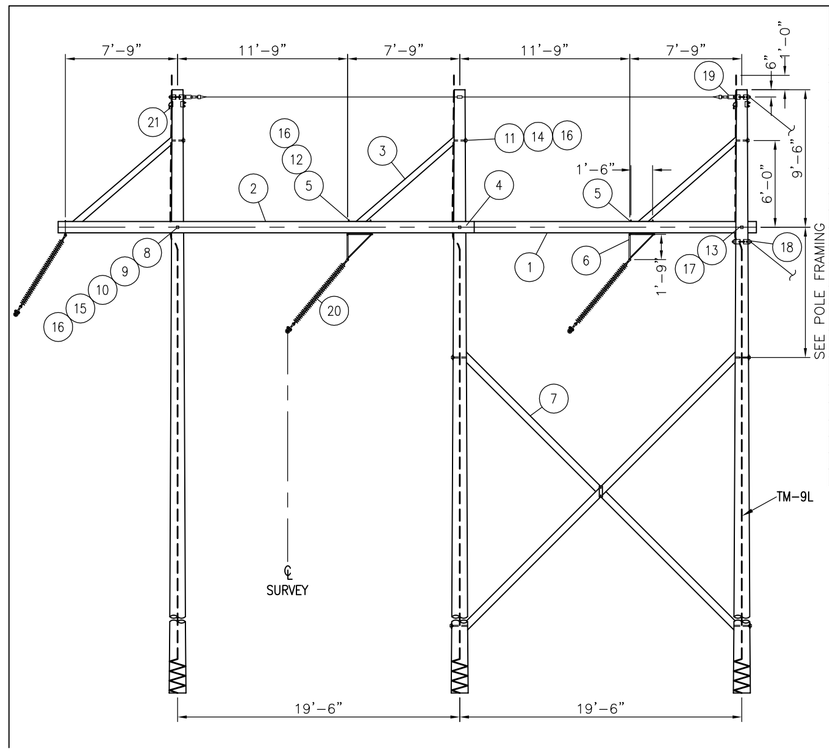


LIST OF MATERIALS		
ITEM	REQ.	DESCRIPTION
1	2	X-ARM, 40'-0" #82
2	4	BRACE, X-ARM, 3-3/8" X 5-3/8" X REQ'D.
3	5	SPACER ASSEMBLY, SEE CONST. SPEC.
4	2	BRACKET, SWINGING ANGLE, ASSEMBLY, TM-112C
5	4	GRID GAIN, 4-1/2" X 9", 15/16" HOLE
6	2	GRID GAIN, 4" X 4", 15/16" HOLE
7	4	PLATE, RIBBED TIE
8	1	BOLT, D.E., 7/8" BENT W/ 2 RESCUE NUTS
9	2	ROD, THREADED, 7/8" W/ 2 NUTS
10	2	BOLT, MACHINE, 7/8" BY REQ'D LENGTH
11	2	BOLT, 7/8" BENT
12	2	WASHER, SPRING, 15/16" HOLE
13	10	LOCKNUT, 7/8" MF TYPE
14	1	OHGW SUPPORT ASSEMBLY, TM-7D
15	1	X-BRACE ASSEMBLY, TM-110C
16	2	GUY ATTACHMENT, MEDIUM DUTY, TG-26C
17	3	INSULATOR ASSEMBLY, TANGENT, TM-1B
18	2	OHGW ASSEMBLY, TANGENT, TM-4A, 4B (NOTE 1)

MISC. ASSEMBLIES:
TG-21C, TM-111, TD-15F, TD-17F, TD-20, TCD-40, TPF-50, TM-121

NOTE 1:
USE TM-4A ON 3/8" EHS,
USE TM-4B ON OPGW

PROJECT TITLE	PROJECT NUMBER	REFERENCE SHEET
TATANKA WIND FARM 230KV TRANSMISSION LINE	48049	1 OF 1
SHEET TITLE	**PROJECT MANAGER**	**REFERENCE DOCUMENT**
SMALL ANGLE H-FRAME - -		TH-231
	DATE 4/20/07	**EXHIBIT NUMBER** TH-231



LIST OF MATERIALS		
ITEM	REQ.	DESCRIPTION
1	2	X-ARM, 3-5/8"X9-3/8"X20'-0", #37
2	2	X-ARM, 3-5/8"X9-3/8"X28'-0", #62
3	3	BRACE, X-ARM, 3-3/8"X5-3/8"X REQ'D LENGTH
4	1	CHANNEL SPLICE ASSEMBLY, TM-114B
5	5	SPACER ASSEMBLY, SEE CONSTRUCTION SPEC.
6	2	BRACKET, SWING ANGLE, ASSEMBLY, TM-112C
7	1	X-BRACE ASSEMBLY, TM-110C
8	6	GRID GAIN, 4-1/2"X9", 15/16" HOLE
9	4	PLATE, RIBBED TIE, 3"X9-1/2"X1/4"
10	3	ROD, THREADED, 7/8" BY REQ'D LENGTH
11	3	BOLT, MACHINE, 7/8" X REQ'D LENGTH
12	3	BOLT, BENT, 7/8"
13	2	BOLT, WASHER HEAD, 1/2" W/ WASHER NUT
14	3	WASHER, CUVED, 4" SQX1/4", 15/16" HOLE
15	3	WASHER, SPRING, 15/16" HOLE
16	12	LOCKNUT, 7/8" MF TYPE
17	2	LOCKNUT, 1/2" MF TYPE
18	1	GUY ATTACHMENT, MEDIUM DUTY, TG-26C
19	1	POLE TIE, LARGE ANGLE, MED. DUTY, TG-56A
20	3	INSULATOR ASSEMBLY, TANGENT, TM-1B
21	2	OHGW ASSEMBLY, TANGENT, TM-4A, 4B (NOTE 1)

MISC. ASSEMBLIES:
TM-111, TG-21A, TD-15F, TD-17F, TD-20, TCD-20, TPF-50, TM-121, TCD-26, TG-92, TMG-12

NOTE 1:
USE TM-4A ON 3/8" EHS,
USE TM-4B ON OPGW

PROJECT TITLE	PROJECT NUMBER	REFERENCE SHEET
TATANKA WIND FARM 230KV TRANSMISSION LINE	48049	1 OF 1
SHEET TITLE	**PROJECT MANAGER**	**REFERENCE DOCUMENT**
INTERMEDIATE ANGLE H-FRAME - -		TH-232
	DATE 4/20/07	**EXHIBIT NUMBER** TH-232

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
3	4-17-08	AS-BUILT
2	8-17-07	RE-ISSUED FOR CONSTRUCTION
1	4-30-07	RE-ISSUED FOR CONSTRUCTION
0	4-20-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

MORTENSON

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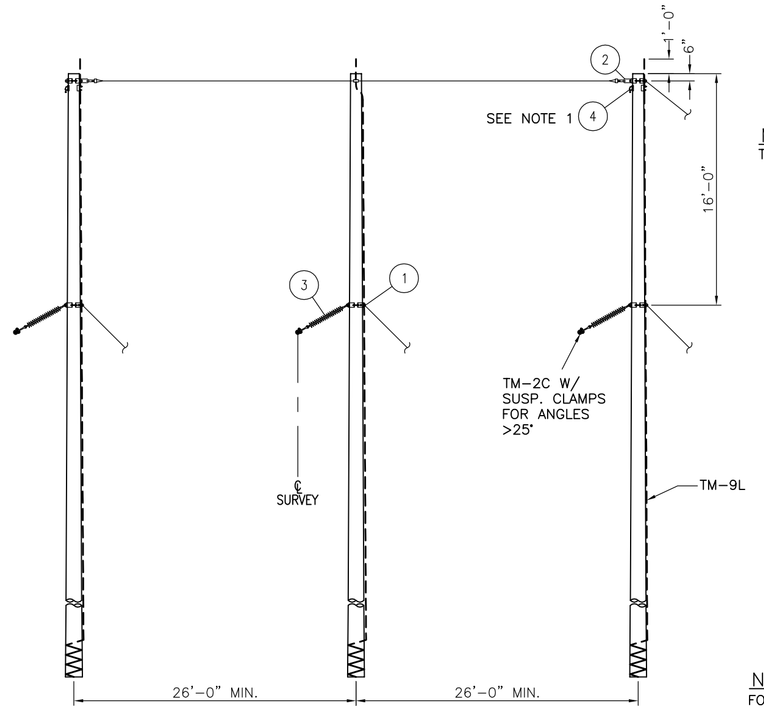
TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE DRAWINGS

0 1" 2"

FILENAME	SD-01.dwg
SCALE	NONE

SHEET **SD-01**



LIST OF MATERIALS		
ITEM	REQ.	DESCRIPTION
1	3	GUY ATTACHMENT, MEDIUM DUTY, TG-26D
2	1	POLE TIE, LARGE ANGLE, MEDIUM DUTY, TG-56A
3	3	INSULATOR ASSEMBLY, ANGLE, TM-1C
4	2	OHGW ASSEMBLY, ANGLE, TM-4A, 4B, 4C

MISC. ASSEMBLIES:
TG-21A, TG-92, TD-9F, TM-121, TPF-50

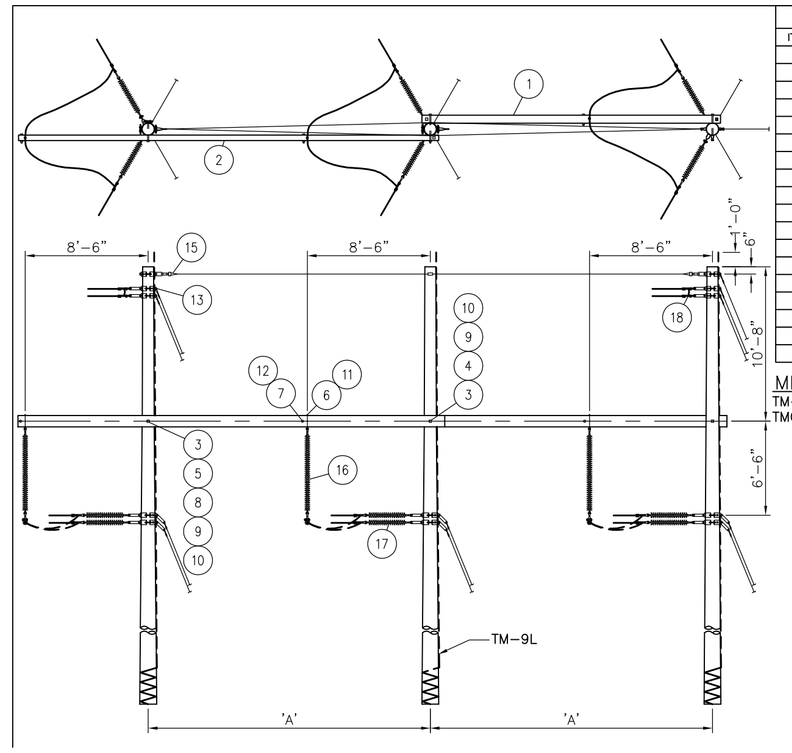
NOTE 1:
FOR ANGLES >25°: USE TM-4C W/AGS CLAMPS ON OPGW. USE TM-4C W/SUSP. CLAMPS ON ⅜" EHS.

HDR

PROJECT TITLE: TATANKA WIND FARM
230KV TRANSMISSION LINE

SHEET TITLE: **LARGE ANGLE**
-
-

PROJECT NUMBER	REFERENCE SHEET
48049	1 OF 1
PROJECT MANAGER	REFERENCE DOCUMENT
	TH-234
DATE	EXHIBIT NUMBER
4/20/07	TH-234



LIST OF MATERIALS		
ITEM	REQ.	DESCRIPTION
1	1	X-ARM, 3-5/8" X 9-3/8" #92
2	1	X-ARM, 3-5/8" X 9-3/8" #94
3	4	PLATE, RIBBED TIE, 3" X 9-1/2" X 1/4"
4	1	ROD, THREADED 7/8" W/ 2 NUTS
5	2	BOLT, MACHINE 7/8" X REQ'D LENGTH
6	3	BOLT, SHOULDER EYE, 3/4" W/ WASHER NUT
7	3	BOLT, WASHER HEAD, 1/2" W/ WASHER NUT
8	2	WASHER, CURVED, 4" SQ. X 1/4", 15/16" HOLE
9	3	WASHER, SPRING, 15/16" HOLE
10	4	LOCKNUT, 7/8" MF TYPE
11	3	LOCKNUT, 3/4" MF TYPE
12	3	LOCKNUT, 1/2" MF TYPE
13	4	GUY ATTACHMENT, MEDIUM DUTY, TG-21A
14	6	GUY ATTACHMENT, _____ DUTY, TG-36E
15	1	POLE TIE, GUYING, MEDIUM DUTY, TG-56F
16	3	INSULATOR ASSEMBLY, TANGENT, TM-1B
17	6	INSULATOR ASSEMBLY, DEADEND, TM-1E
18	4	OHGW ASSEMBLY, DEADEND, TM-4E

MISC. ASSEMBLIES:
TM-121, TG-92, TD-9F, TD-15F, TCD-92, TPF-50, TMG-15

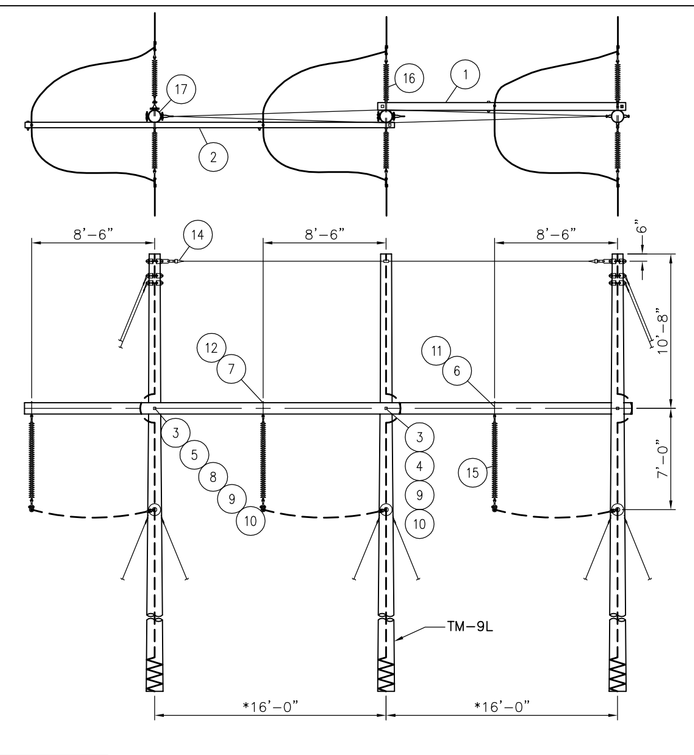
LINE ANGLE	DIM 'A'
< 50°	21'-6"
50° TO 60°	22'-6"
60° TO 70°	24'-6"
70° TO 80°	27'-0"
80° TO 90°	30'-0"

HDR

PROJECT TITLE: TATANKA WIND FARM
230KV TRANSMISSION LINE

SHEET TITLE: **LARGE ANGLE DOUBLE DEADEND**
-
-

PROJECT NUMBER	REFERENCE SHEET
48049	1 OF 1
PROJECT MANAGER	REFERENCE DOCUMENT
	TH-235
DATE	EXHIBIT NUMBER
4/20/07	TH-235



LIST OF MATERIALS		
ITEM	REQ.	DESCRIPTION
1	1	X-ARM, 3-5/8" X 9-3/8" #92
2	1	X-ARM, 3-5/8" X 9-3/8" #94
3	4	PLATE, RIBBED TIE, 3" X 9-1/2" X 1/4"
4	1	ROD, THREADED 7/8" W/ 2 NUTS
5	2	BOLT, MACHINE 7/8" X REQ'D LENGTH
6	3	BOLT, SHOULDER EYE, 3/4" W/ WASHER NUT
7	6	BOLT, WASHER HEAD, 1/2" W/ WASHER NUT
8	2	WASHER, CURVED, 4" SQ. X 1/4", 15/16" HOLE
9	3	WASHER, SPRING, 15/16" HOLE
10	4	LOCKNUT, 7/8" MF TYPE
11	3	LOCKNUT, 3/4" MF TYPE
12	6	LOCKNUT, 1/2" MF TYPE
13	5	GUY ATTACHMENT, TG-36E
14	1	POLE TIE, DEADEND, TG-56C
15	3	INSULATOR ASSEMBLY, TANGENT, TM-1B
16	6	INSULATOR ASSEMBLY, DEADEND, TM-1E
17	4	OHGW ASSEMBLY, DEADEND, TM-4E

MISC. ASSEMBLIES:
TM-121, TG-92, TD-9F, TD-15F, TCD-92, TPF-50, TMG-15D

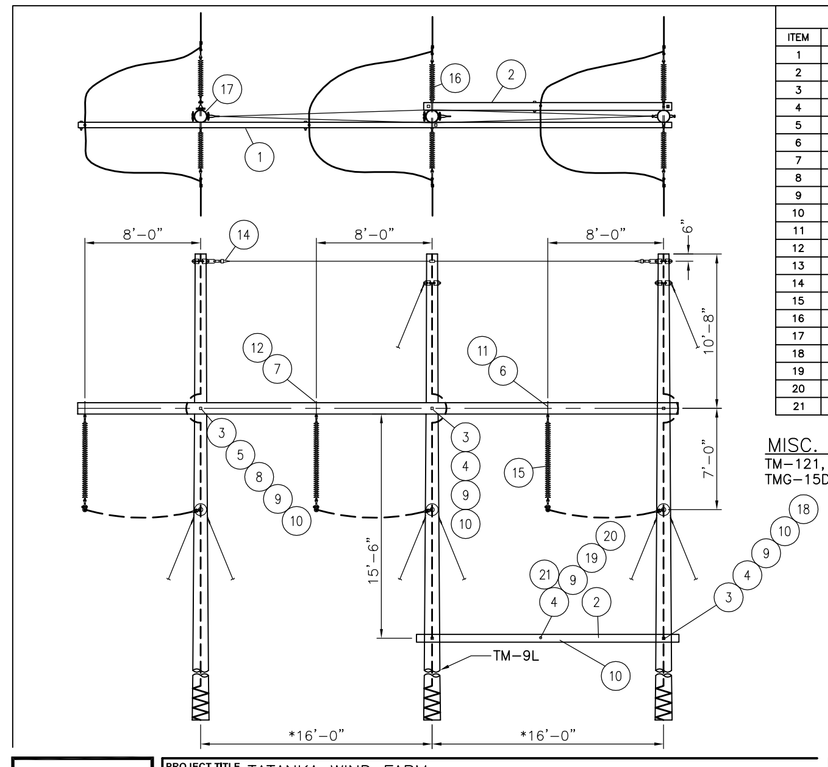
HDR

PROJECT TITLE: TATANKA WIND FARM
230KV TRANSMISSION LINE

SHEET TITLE: **TANGENT DOUBLE DEADEND**

***SPECIAL FRAMING**

PROJECT NUMBER	REFERENCE SHEET
48049	1 OF 1
PROJECT MANAGER	REFERENCE DOCUMENT
	TH-235D
DATE	EXHIBIT NUMBER
4/20/07	TH-235D



LIST OF MATERIALS		
ITEM	REQ.	DESCRIPTION
1	1	X-ARM, 3-5/8" X 9-3/8" X 41'-0"
2	2	X-ARM, 3-5/8" X 9-3/8" X 17'-0"
3	8	PLATE, RIBBED TIE, 3" X 9-1/2" X 1/4"
4	3	ROD, THREADED 7/8" W/ 2 NUTS
5	3	BOLT, MACHINE 7/8" X REQ'D LENGTH
6	3	BOLT, SHOULDER EYE, 3/4" W/ WASHER NUT
7	6	BOLT, WASHER HEAD, 1/2" W/ WASHER NUT
8	3	WASHER, CURVED, 4" SQ. X 1/4", 15/16" HOLE
9	7	WASHER, SPRING, 15/16" HOLE
10	10	LOCKNUT, 7/8" MF TYPE
11	3	LOCKNUT, 3/4" MF TYPE
12	6	LOCKNUT, 1/2" MF TYPE
13	5	GUY ATTACHMENT, TG-36E
14	1	POLE TIE, DEADEND, TG-56C
15	3	INSULATOR ASSEMBLY, TANGENT, TM-1B
16	6	INSULATOR ASSEMBLY, DEADEND, TM-1E
17	4	OHGW ASSEMBLY, DEADEND, TM-4E
18	4	PLATE, GAIN
19	2	7/8" WASHER, HEAD NUT
20	1	7/8" OVAL EYE NUT
21	2	WASHER, 4" SQ X 3/16", 15/16" HOLE

MISC. ASSEMBLIES:
TM-121, TG-92, TD-9F, TD-15F, TCD-92, TPF-50, TMG-15D

HDR

PROJECT TITLE: TATANKA WIND FARM
230KV TRANSMISSION LINE

SHEET TITLE: **TANGENT DOUBLE DEADEND**

***SPECIAL FRAMING**

PROJECT NUMBER	REFERENCE SHEET
48049	1 OF 1
PROJECT MANAGER	REFERENCE DOCUMENT
	TH-235D SPEC
DATE	EXHIBIT NUMBER
4/20/07	TH-235D SPEC

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
3	4-17-08	AS-BUILT
2	8-17-07	RE-ISSUED FOR CONSTRUCTION
1	4-30-07	RE-ISSUED FOR CONSTRUCTION
0	4-20-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

MORTENSON

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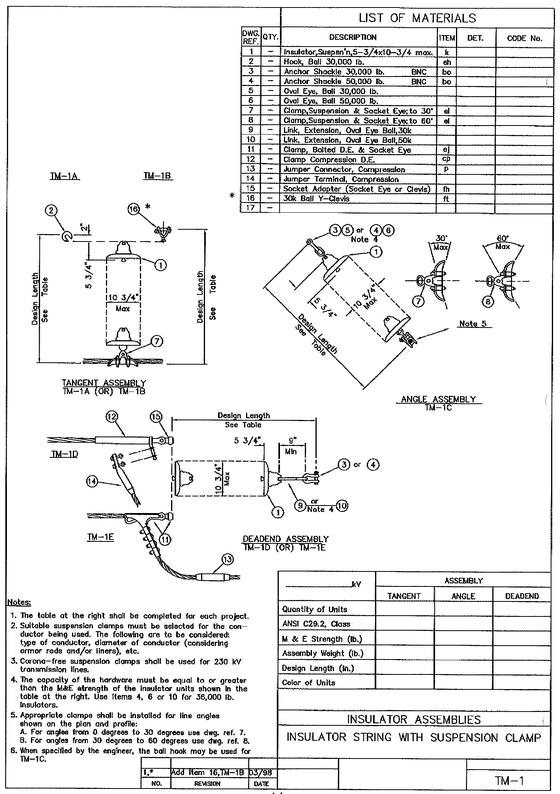
TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE DRAWINGS

0 1" 2"

FILENAME	SD-02.dwg
SCALE	NONE

SHEET: **SD-02**



DWG. REF.	QTY.	DESCRIPTION	ITEM	DET.	CODE No.
1	–	Insulator,Suspsn'n,5-3/4x10-3/4 max.	k		
2	–	Hook, Ball 30,000 lb.	eh		
3	–	Anchor Shackle 30,000 lb. BNC	bo		
4	–	Anchor Shackle 50,000 lb. BNC	bo		
5	–	Oval Eye, Ball 30,000 lb.			
6	–	Oval Eye, Ball 50,000 lb.			
7	–	Clamp,Suspension & Socket Eye;to 30°	el		
8	–	Clamp,Suspension & Socket Eye;to 60°	el		
9	–	Link, Extension, Oval Eye Ball,30k			
10	–	Link, Extension, Oval Eye Ball,50k			
11	–	Clamp, Bolted D.E. & Socket Eye	ej		
12	–	Clamp Compression D.E.	cp		
13	–	Jumper Connector, Compression	p		
14	–	Jumper Terminal, Compression			
15	–	Socket Adapter (Socket Eye or Clevis)	fh		
16	–	30k Ball Y-Clevis	ft		
17	–				

Notes:
1. The table at the right shall be completed for each project.
2. Suitable suspension clamps must be selected for the conductor being used. The following are to be considered: type of conductor, diameter of conductor (considering armor rods and/or liners), etc.
3. Corona-free suspension clamps shall be used for 230 kV transmission lines.
4. The capacity of the hardware must be equal to or greater than the M&E strength of the insulator units shown in the table at the right. Use items 4, 6 or 10 for 36,000 lb. insulators.
5. Appropriate clamps shall be installed for line angles shown on the plan and profile:
   A. For angles from 0 degrees to 30 degrees use dwg. ref. 7.
   B. For angles from 30 degrees to 60 degrees use dwg. ref. 8.
6. When specified by the engineer, the ball hook may be used for TM-1C.

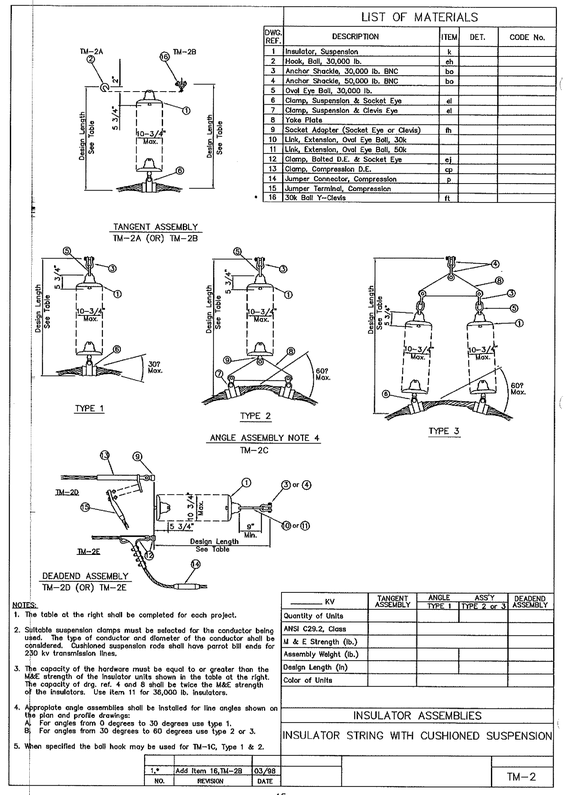
kV	ASSEMBLY TANGENT	ANGLE	DEADEND
Quantity of Units			
ANSI C29.2, Class			
M & E Strength (lb.)			
Assembly Weight (lb.)			
Design Length (in.)			
Color of Units			

INSULATOR ASSEMBLIES
INSULATOR STRING WITH SUSPENSION CLAMP

1,*	Add Item 16,TM-1B	03/98
NO.	REVISION	DATE

TM-1

44



DWG. REF.	DESCRIPTION	ITEM	DET.	CODE No.
1	Insulator, Suspension	k		
2	Hook, Ball, 30,000 lb.	eh		
3	Anchor Shackle, 30,000 lb. BNC	bo		
4	Anchor Shackle, 50,000 lb. BNC	bo		
5	Oval Eye Ball, 30,000 lb.			
6	Clamp, Suspension & Socket Eye	el		
7	Clamp, Suspension & Clevis Eye	el		
8	Yoke Plate			
9	Socket Adapter (Socket Eye or Clevis)	fh		
10	Link, Extension, Oval Eye Ball, 30k			
11	Link, Extension, Oval Eye Ball, 50k			
12	Clamp, Bolted D.E. & Socket Eye	ej		
13	Clamp, Compression D.E.	cp		
14	Jumper Connector, Compression	p		
15	Jumper Terminal, Compression			
16	30k Ball Y-Clevis	ft		

NOTES:
1. The table at the right shall be completed for each project.
2. Suitable suspension clamps must be selected for the conductor being used. The type of conductor and diameter of the conductor shall be considered. Cushioned suspension rods shall have parrot bill ends for 230 kv transmission lines.
3. The capacity of the hardware must be equal to or greater than the M&E strength of the insulator units shown in the table at the right. The capacity of drg. ref. 4 and 8 shall be twice the M&E strength of the insulators. Use item 11 for 36,000 lb. insulators.
4. Appropiate angle assemblies shall be installed for line angles shown on the plan and profile drawings:
   A. For angles from 0 degrees to 30 degrees use type 1.
   B. For angles from 30 degrees to 60 degrees use type 2 or 3.
5. When specified the ball hook may be used for TM-1C, Type 1 & 2.

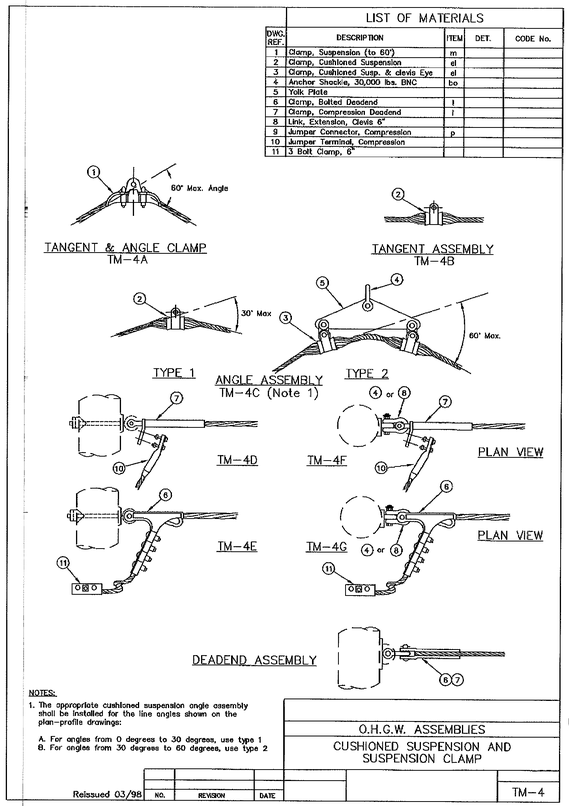
kV	TANGENT ASSEMBLY	ANGLE ASSY TYPE 1	ANGLE ASSY TYPE 2 or 3	DEADEND ASSEMBLY
Quantity of Units				
ANSI C29.2, Class				
M & E Strength (lb.)				
Assembly Weight (lb.)				
Design Length (in)				
Color of Units				

INSULATOR ASSEMBLIES
INSULATOR STRING WITH CUSHIONED SUSPENSION

1,*	Add Item 16,TM-2B	03/98
NO.	REVISION	DATE

TM-2

45



DWG. REF.	DESCRIPTION	ITEM	DET.	CODE No.
1	Clamp, Suspension (to 60°)	m		
2	Clamp, Cushioned Suspension	el		
3	Clamp, Cushioned Susp. & clevis Eye	el		
4	Anchor Shackle, 30,000 lbs. BNC	bo		
5	Yolk Plate			
6	Clamp, Bolted Deadend	t		
7	Clamp, Compression Deadend	t		
8	Link, Extension, Clevis 6"			
9	Jumper Connector, Compression	p		
10	Jumper Terminal, Compression			
11	3 Bolt Clamp, 6"			

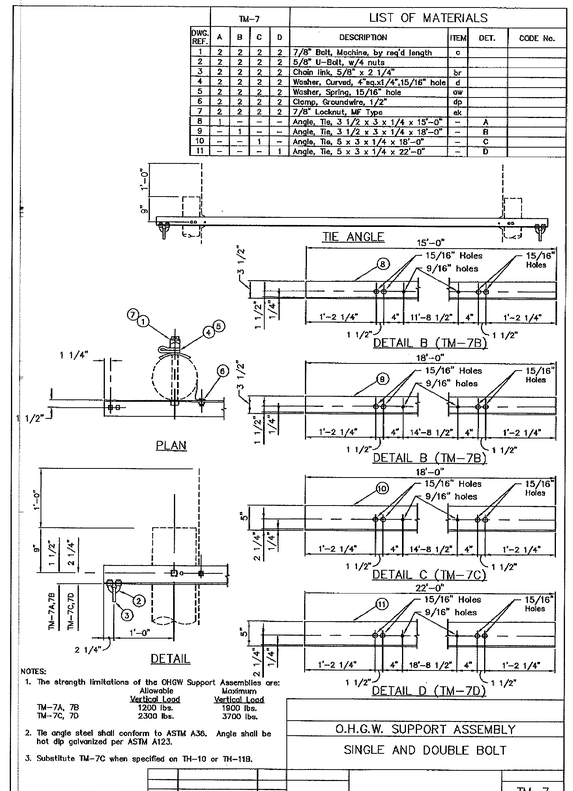
NOTES:
1. The appropriate cushioned suspension angle assembly shall be installed for the line angles shown on the plan-profile drawings:
   A. For angles from 0 degrees to 30 degrees, use type 1
   B. For angles from 30 degrees to 60 degrees, use type 2

O.H.G.W. ASSEMBLIES
CUSHIONED SUSPENSION AND SUSPENSION CLAMP

Reissued 03/98

NO.	REVISION	DATE

TM-4



DWG. REF.	TM-7 A	B	C	D	DESCRIPTION	ITEM	DET.	CODE No.
1	2	2	2	2	7/8" Bolt, Machine, by req'd length	c		
2	2	2	2	2	5/8" U-Bolt, w/4 nuts			
3	2	2	2	2	Chain link, 5/8" x 2 1/4"	br		
4	2	2	2	2	Washer, Curved, 4"sq.x1/4",15/16" hole	d		
5	2	2	2	2	Washer, Spring, 15/16" hole	sw		
6	2	2	2	2	Clamp, Groundwire, 1/2"	dp		
7	2	2	2	2	7/8" Locknut, MF Type	ek		
8	1	–	–	–	Angle, Tie, 3 1/2 x 3 x 1/4 x 15'-0"	–	A	
9	–	1	–	–	Angle, Tie, 3 1/2 x 3 x 1/4 x 18'-0"	–	B	
10	–	–	1	–	Angle, Tie, 5 x 3 x 1/4 x 18'-0"	–	C	
11	–	–	–	1	Angle, Tie, 5 x 3 x 1/4 x 22'-0"	–	D	

NOTES:
1. The strength limitations of the OHGW Support Assemblies are:

	Allowable Vertical Load	Minimum Vertical Load
TM-7A, 7B	1200 lbs.	1900 lbs.
TM-7C, 7D	2300 lbs.	3700 lbs.

2. The angle steel shall conform to ASTM A36. Angle shall be hot dip galvanized per ASTM A123.
3. Substitute TM-7C when specified on TM-10 or TM-11B.

O.H.G.W. SUPPORT ASSEMBLY
SINGLE AND DOUBLE BOLT

Reissued 03/98

NO.	REVISION	DATE

TM-7

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
2	4-17-08	AS-BUILT
1	4-30-07	RE-ISSUED FOR CONSTRUCTION
0	4-20-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

MORTENSON

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TATANKA WIND ENERGY
NORTH DAKOTA

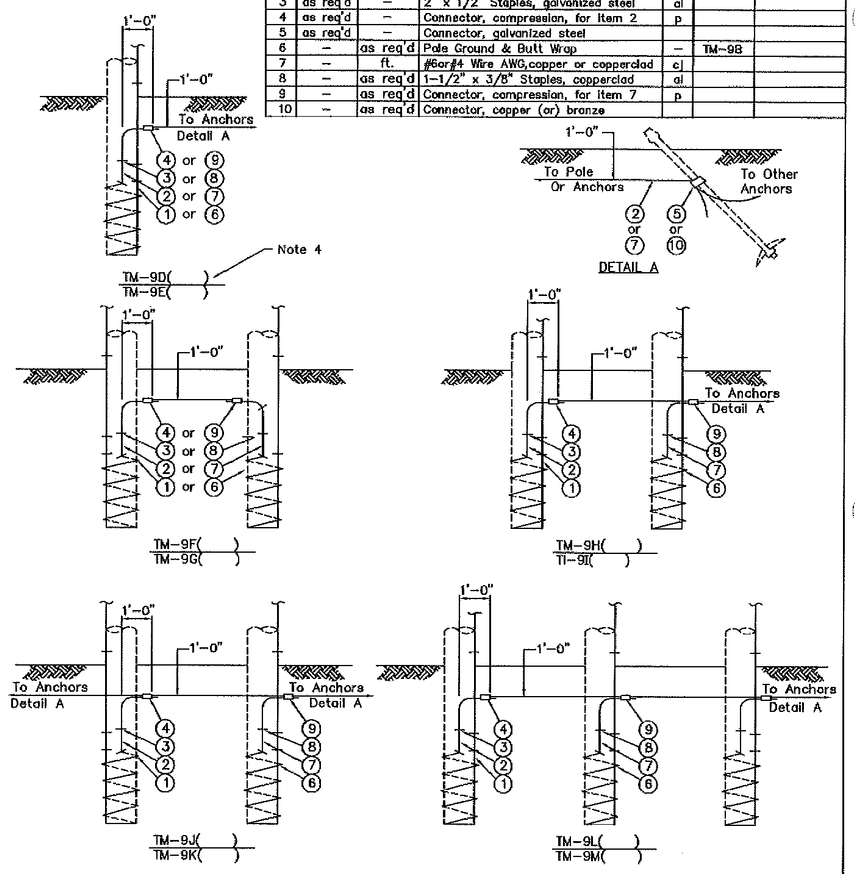
TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE ASSEMBLY DETAILS

0 1" 2"

FILENAME	SD-03.dwg
SCALE	NONE

SHEET
SD-03

DWG. REF.	DWG D, F, H, J, L,	E, G, I, K, M,	LIST OF MATERIALS DESCRIPTION	ITEM	DET.	CODE No.
1	as req'd	—	Pole Ground & Butt Wrap	—	TM–9A	
2	ft.	—	5/16" Wire, soft annealed iron	cj		
3	as req'd	—	2" x 1/2" Staples, galvanized steel	ai		
4	as req'd	—	Connector, compression, for Item 2	p		
5	as req'd	—	Connector, galvanized steel			
6	—	as req'd	Pole Ground & Butt Wrap	—	TM–9B	
7	—	ft.	#6or#4 Wire AWG,copper or copperclad	cj		
8	—	as req'd	1–1/2" x 3/8" Staples, copperclad	ai		
9	—	as req'd	Connector, compression, for Item 7	p		
10	—	as req'd	Connector, copper (or) bronze			

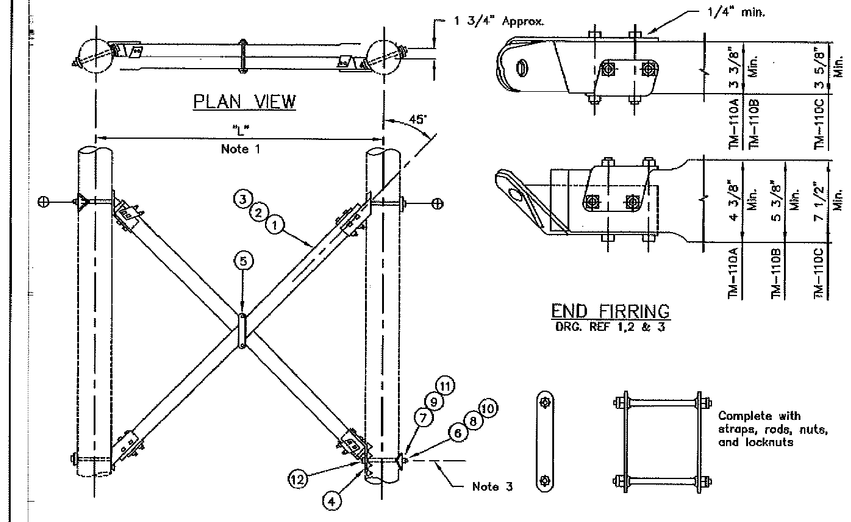


Notes:
1. For other installation details, refer to sheet 1 of 2, TM–9.
2. Grounding materials must be consistent with good corrosion prevention practices. When galvanized hardware and 5/16" iron wire are used, anchor rods shall be galvanized steel. When copper, copperclad or bronze hardware are used, anchor rods shall be copperclad.
3. Bid items on this drawing include material to top of pole in accordance with sheet 1 of 2, TM–9.
4. ( ) indicates number of anchors.

GROUNDING ASSEMBLIES
MULTIPLE POLE AND ANCHOR GROUNDING

Reissued 03/98 | NO. | REVISION | DATE | Aug., 1986 | 2 OF 2 | TM–9

DWG. REF.	TM–110 A	B	C	LIST OF MATERIALS DESCRIPTION	ITEM	DET.	CODE No.
1	1	—	—	Set, X–Brace, 3–3/8 x 4–3/8min.			
2	—	1	—	Set, X–Brace, 3–3/8 x 5–3/8min.			
3	—	—	1	Set, X–Brace, 3–3/8 x 7–1/2min.			
4	—	—	4	Grid Gain, 4" x 6", 1–1/16" hole			
5	1	1	1	Clamp, Center, Assembly			
6	—	—	4	1" Bolt, Machine, by req'd length	vk		
7	4	4	—	7/8" Bolt, Machine , by req'd length			
8	—	—	4	Washer, Curved,4"sq. x 3/8", 1–1/16h.			
9	4	4	—	Washer, Curved,4"sq. x 1/4", 15/16h.			
10	—	—	4	1" Locknut, MF Type			
11	4	4	—	7/8" Locknut, MF Type			
12	—	—	4	Washer, Flat 3–1/2"sq.x3/8"x1–1/16"h.		note 5	



NOTES:
1. X–Brace length shall be suitable to accommodate the pole spacing shown on the respective transmission line structure. drawings.
2. Machine bolts must pass through center of pole and fit tightly in the holes.
3. Lower holes shall be field drilled and be thoroughly treated.
4. Use of X–Brace should be economically justified by the engineer.
5. End fittings for TM–110C may be channel type. Item 12, reinforcing washer, shall be supplied when channel type end fittings are used. The washer shall be placed between the head of the bolt and the end fitting.
6. Bolts with rolled threads or cut threads and full size shanks shall be used for Item 6 and 7.
7. Minimum number of bolts for end fittings are shown.
8. Supplier shall test the X–Brace assembly and obtain REA standard approval.
9. Maximum tensile–compressive capacity of X–Brace assembly is 20,000 lbs. for the following:

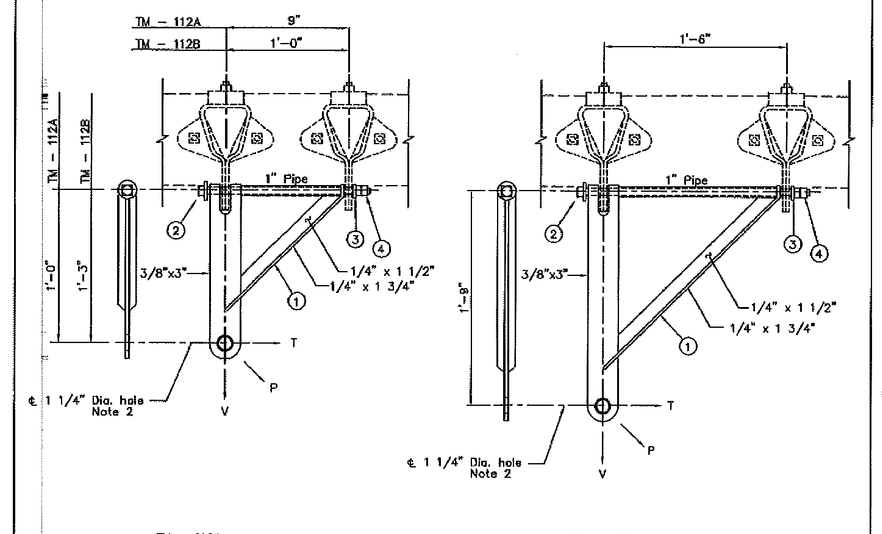
X–Brace	Max. Pole Spacing
TM–110A	14'–0"
TM–110B	15'–6"
TM–110C	19'–6"

10. For other assembly requirements, see REA Specifications T–7 and T–8.

MISCELLANEOUS ASSEMBLIES
X–BRACE
(20,000 lb. MAXIMUM)

Reissued 03/98 | NO. | REVISION | DATE | Aug., 1986 | TM–110A,B,C

DWG. REF.	QTY.	LIST OF MATERIALS DESCRIPTION	ITEM	DET.	CODE No.
1	—	Bracket, Welded Assembly			
2	—	3/4" Bolt, Washer Head			
3	—	Washer Nut, or std. nut			
4	—	3/4" Locknut			
5	—				



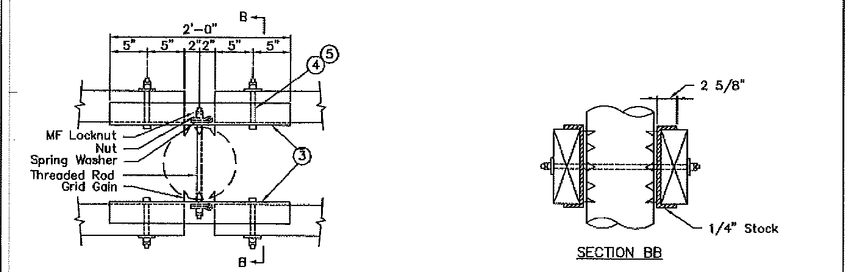
Notes:
1. The above brackets are used with spacer assemblies TM–111.
2. The 1–1/4" diameter hole shall be reamed on both sides suitable for self–locking ball hook.
3. Loads "P" and "T" also act to the left.
4. Strength limitation of swinging angle bracket assembly:
   A. Maximum vertical load – – – – – – V=10,000 lbs.
   B. Maximum transverse load – – – – – – T= 5,000 lbs.
   C. Maximum oblique load – – – – – – – P=12,000 lbs.

MISCELLANEOUS ASSEMBLIES
X–ARM ANGLE BRACKET

Reissued 03/98 | NO. | REVISION | DATE | TM–112

DWG. REF.	TM–114 A	B	LIST OF MATERIALS DESCRIPTION	ITEM	DET.	CODE No.
1	—	—	Angles, Formed, from 3/8" steel plate			
2	—	—	5/8" Bolt, Machine, by req'd length	c		
3	—	2	Channel, Formed, from 1/4" steel plate	c		
4	—	4	7/8" Bolt, Machine, w/Washer Nut	ek		
5	—	4	7/8" Locknut, MF Type			

(For future use)
TM–114A



CHANNEL SPLICE ASSEMBLY
TM–114B

MISCELLANEOUS ASSEMBLIES
X–ARM SPLICE

1 | Remove TM–114A | 03/98 | TM–114
NO. | REVISION | DATE

62

ISSUE	DATE	DESCRIPTION
2	4–17–08	AS–BUILT
1	4–30–07	RE–ISSUED FOR CONSTRUCTION
0	4–20–07	ISSUED FOR CONSTRUCTION

HDR Engineering, Inc.

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

MORTENSON®

acciona

TATANKA WIND ENERGY
NORTH DAKOTA

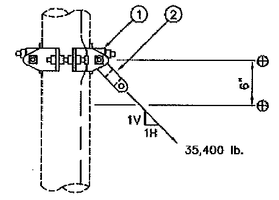
TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE ASSEMBLY DETAILS

0 1" 2"

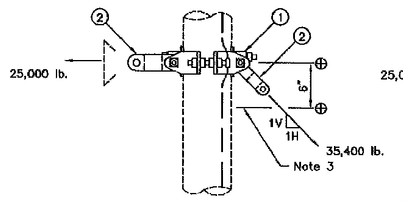
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SHEET
SD–04

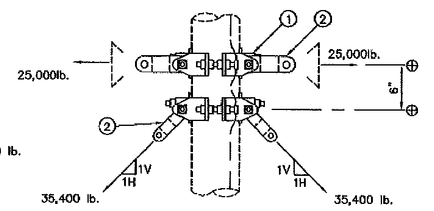
DWG. REF.	TG-25 A	B	C	D	E	DESCRIPTION	ITEM	DET.	CODE No.
1			1	1	2	Band, 4Way Pole, ass'y w/7/8 thru rod	fv		
* 2			1	2	2	Links, Connecting	du		
* 3				1	2	Links, Connecting	du		



TG-26C



TG-26D



TG-26E

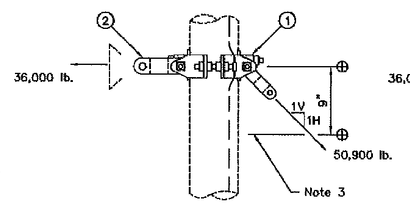
Notes:
1. The indicated loads are design maximum.
2. For guy slopes more than 1V to 1H the maximum vertical capacity should not exceed 25,000 lbs.
3. The lower work points (@) are for locations where two guy attachments are required.
4. A groundwire clamp is included with item 1, pole band assembly.

GUY ATTACHMENTS
MEDIUM DUTY POLE BANDS

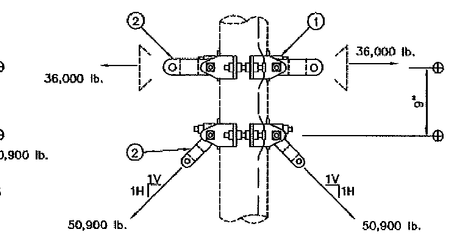
NO.	REVISION	DATE			
1, *	Items 2,3	03/98			TG-26

81

DWG. REF.	TG-36 A	B	C	D	E	DESCRIPTION	ITEM	DET.	CODE No.
1				1	2	Band,4Way Pole,ass'y w/1-1/4 thru rod	fv		
2				2	4	Links, Connecting, 2-3/8x3, w/1-1/16h	dg		



TG-36D



TG-36E

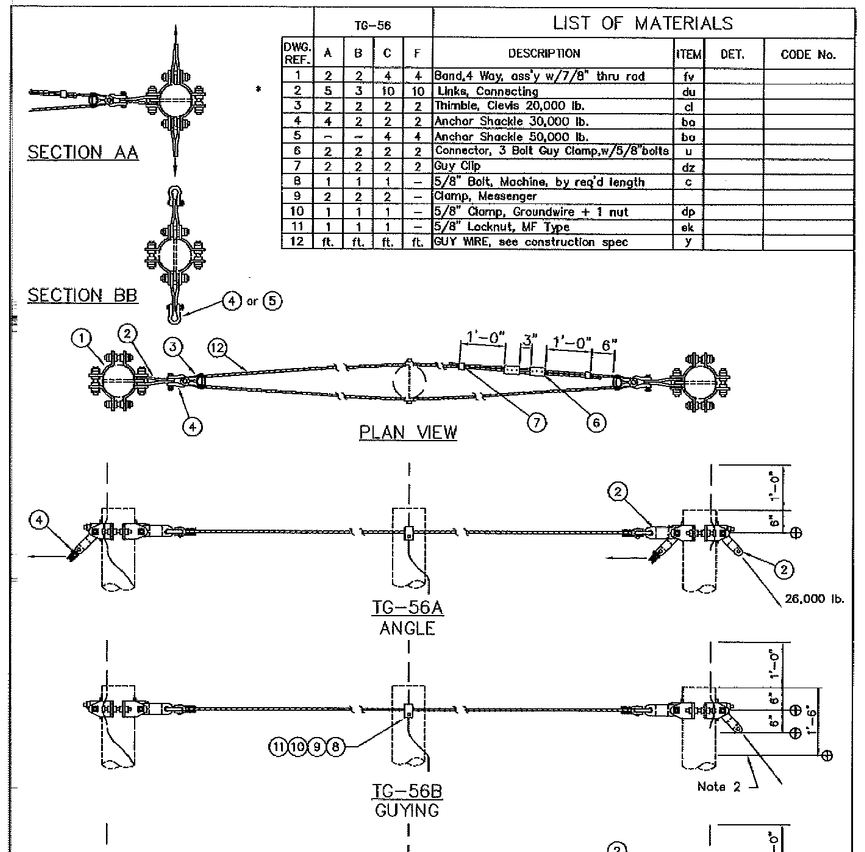
Notes:
1. The indicated loads are design maximum.
2. For guy slopes more than 1V to 1H the maximum vertical capacity should not exceed 36,000 lbs.
3. The lower work points (@) are for locations where two guy attachments are required.
4. A groundwire clamp is included with item 1, pole band assembly.
*5. Engineer shall check capacity of pole.
*6. Minimum pole diameter shall be 12".
*7. Antisplit bolt shall be added if required by the engineer.

GUY ATTACHMENTS
HEAVY DUTY POLE BANDS

NO.	REVISION	DATE			
1,*	Add notes 5,6,7	03/98			TG-36

86

DWG. REF.	TG-56 A	B	C	F	DESCRIPTION	ITEM	DET.	CODE No.
* 1	2	2	4	4	Band,4 Way, ass'y w/7/8" thru rod	fv		
* 2	5	3	10	10	Links, Connecting	du		
3	2	2	2	2	Thimble, Clevis 20,000 lb.	cl		
4	4	2	2	2	Anchor Shackle 30,000 lb.	ba		
5	--	--	4	4	Anchor Shackle 50,000 lb.	ba		
6	2	2	2	2	Connector, 3 Bolt Guy Clamp,w/5/8"bolts	u		
7	2	2	2	2	Guy Clip	dz		
8	1	1	1	--	5/8" Bolt, Machine, by req'd length	c		
9	2	2	2	--	Clamp, Messenger			
10	1	1	1	--	5/8" Clamp, Groundwire + T nut	dp		
11	1	1	1	--	5/8" Locknut, MF Type	ek		
12	ft.	ft.	ft.	ft.	GUY WIRE, see construction spec	y		



NOTES:
1. The indicated loads are design maximum.
2. The lower work point @ on TG-56B is for deadend and guy attachments when required. Connect the pole groundwire to the groundwire clamps on the pole bands.
3. When angled guying attachments are required below the OH/GW deadend for TG-56C or TG-56F, the lower pole band assembly shall not be considered as part of the deadend pole tie assembly.

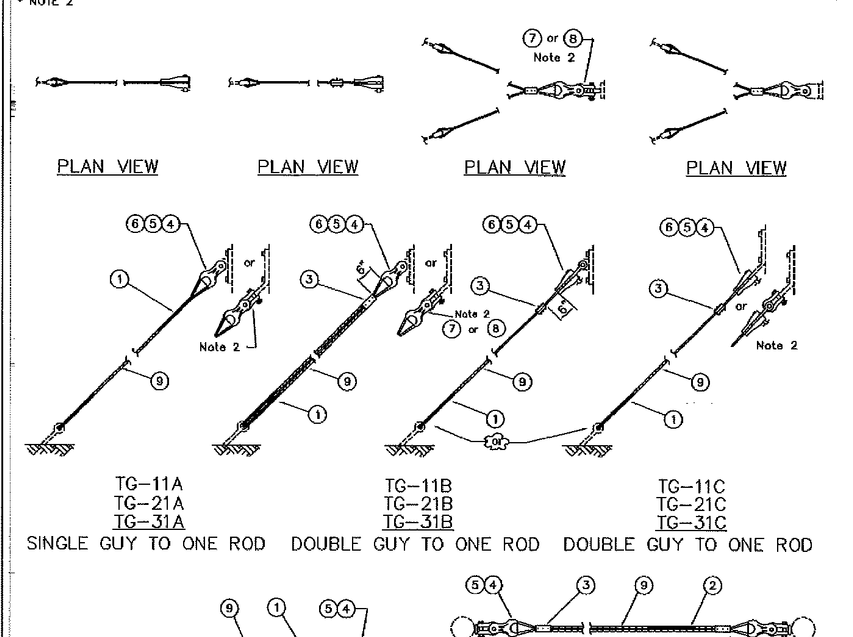
POLE TIE ASSEMBLIES
ANGLE, GUYING, & DEADEND POLE TIES
(MEDIUM DUTY POLE BANDS)

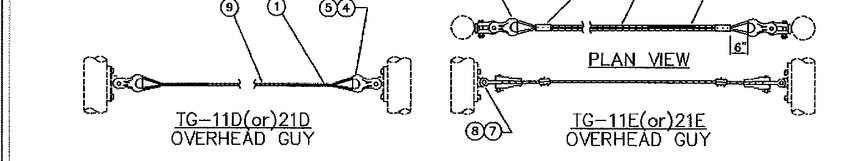
NO.	REVISION	DATE			
1,*	Dwg. Ref. 2	03/98			TG-56

93

DWG. REF.	TG-11 20,0000 lb. Max. A	B	C	D	E	TG-21 35,4000 lb. Max. A	B	C	D	E	TG-31 50,0000 lb. Max. A	B	C	D	E	DESCRIPTION	ITEM	DET.	CODE No.
1	2	2	2	--		2	2	2	--		2	2				Deadend, Factory Formed	u		
2	--	--	--	1		--	--	--	1		--	--				Splice, Factory Formed			
3	--	1	1	--	2	--	1	1	--	2	1	1				Connector, 3 Bolt Guy Clamp, w/5/8 bolts	u		
4	1	1	1	2	2	--	--	--	--	--	--	--				Thimble Clevis 20,000 lb. 5/8 pin	cl		
5	--	--	--	--	1	1	1	1	2	2	--	--				Thimble Clevis 40,000 lb. 3/4 pin	cl		
6	--	--	--	--	--	--	--	--	--	--	1	1				Thimble Clevis 50,000 lb. 7/8 pin	cl		
7	*	*	1*	--	2	--	--	--	--	2	--	--				Anchor Shackle 30,000 lb.	ba		
8	--	--	--	--	--	*	*	1*	--	--	--	1				Anchor Shackle 50,000 lb.	ba		
9	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.				GUY WIRE	y		

* NOTE 2





NOTES:
1. Guying assemblies are to be coordinated with the guy attachments. For example, if medium duty guy attachments are specified on the structure drawings, then medium duty guying assemblies are to be used.
2. Anchor shackles may be required to orientate the guy assembly to the guy attachment. If guy slopes are or than 1/1 add an anchor shackle when connecting the thimble clevis to a bent plate.
3. The capacity of a guy assembly is limited by either the strength limitation for TG-11D&E is 15,000 lbs.; for TG-21D&E, 25,000 lbs.
4. Type "C" Guy Assembly is for normal guying. Do not use for spread guying.

GUYING ASSEMBLIES
FACTORY FORMED WITH THIMBLE CLEVIS

NO.	REVISION	DATE			
	Reissued 03/98				TG-11,21,31

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
2	4-17-08	AS-BUILT
1	4-30-07	RE-ISSUED FOR CONSTRUCTION
0	4-20-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

MORTENSON

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TATANKA WIND ENERGY
NORTH DAKOTA

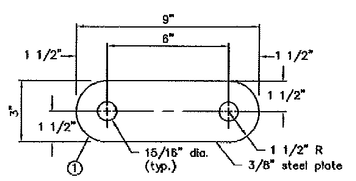
TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE ASSEMBLY DETAILS

0 1" 2"

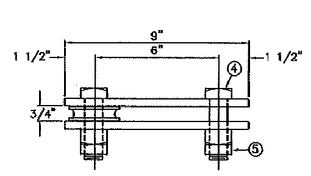
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SHEET
SD-05

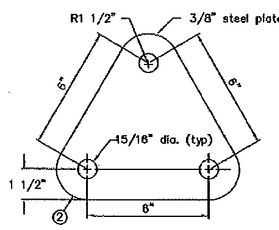
NOTES:
1. Type 2, Guy Link Assembly, is to be used when attaching two down guy assemblies to one guy attachment for spread guying such as head or back guying of the OHGW on tangent structures where the OHGW is located directly above the conductor.
2. Substitute one Type 2 Guy Link Assembly, TG-92, for two thimble clevises or for two Type 1 link assemblies.
3. Leave roller free to turn during adjustment of guys. Tighten nuts and locknuts after completion of adjustments.
4. Links are to be fabricated from ASTM-36 steel plate and hot dip galvanized per ASTM A-153 and A-123 requirements.
5. Type 1, Guy Link Assembly, is for normal guying.
6. Ultimate strength of link is 38,000 lbs.



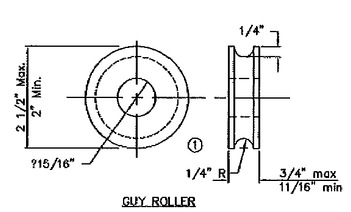
TYPE 1 LINK



LINK ASSEMBLY



TYPE 2 LINK
TG-92

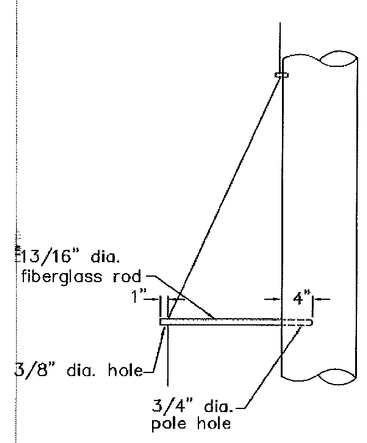


GUY ROLLER

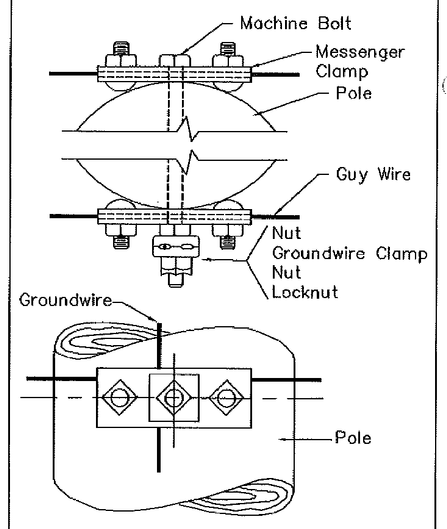
REQ'D		LIST OF MATERIALS			
DWG. REF.	TYPE 1	TYPE 2	DESCRIPTION	ITEM	DET.	CODE No.
1	1		Type 1 Link			
2		1	Type 2 Link			
3	1	2	Guy Roller			
4	2	3	Bolt Machine, 7/8" x 3"		r	
5	2	3	Locknut for 7/8" bolt, NF Type		nR	
6						

GUY LINK ASSEMBLIES

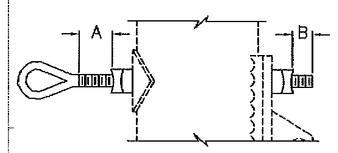
Reissued 03/98 | NO. | REVISION | DATE | TG-92



TD-9E



TD-9F

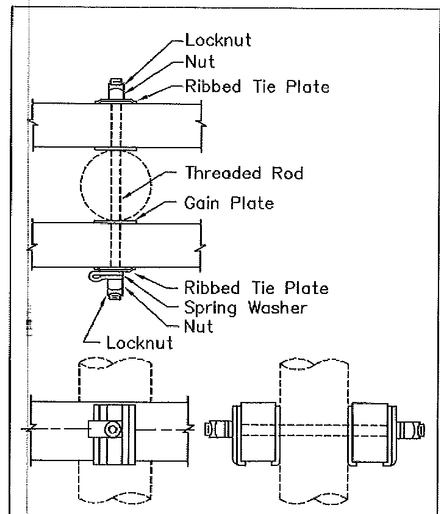


Dimension "A"=2" Minimum
Dimension "B"=1/2" Minimum
Dimension "A"+"B"=4"±1" Minimum

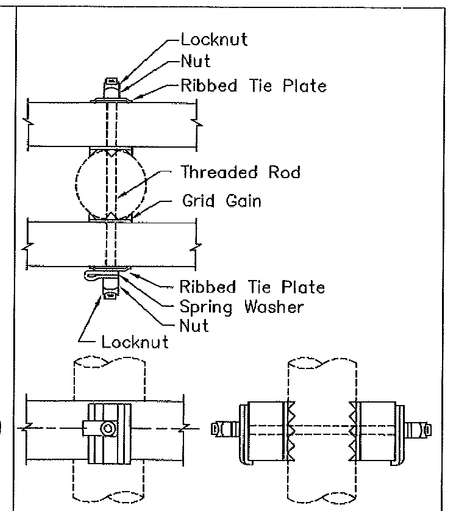
TD-9G

DETAILS
MISCELLANEOUS

Reissued 03/98 | NO. | REVISION | DATE | Aug., 1986 | Sheet 2 of 2 | TD-9



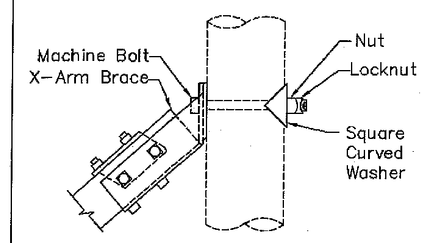
TD-15E



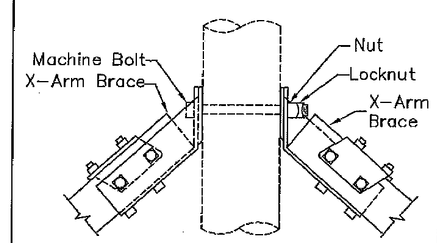
TD-15F

DETAILS
DOUBLE CROSSARM TO POLE

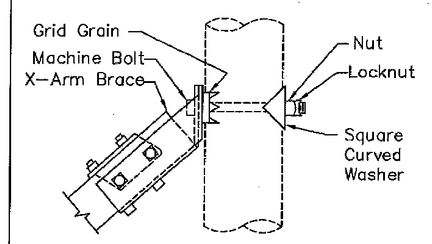
Reissued 03/98 | NO. | REVISION | DATE | SHEET 2 OF 2 | TD-15



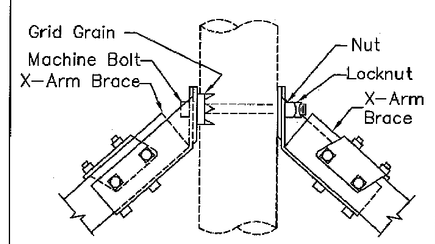
TD-17A



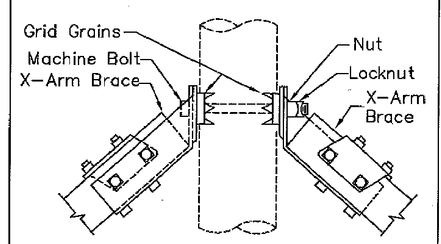
TD-17B



TD-17C



TD-17D



TD-17F

DETAILS
DOUBLE CROSSARM TO POLE

Reissued 03/98 | NO. | REVISION | DATE | Scale: | SHEET 1 OF 2 | TD-17

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
2	4-17-08	AS-BUILT
1	4-30-07	RE-ISSUED FOR CONSTRUCTION
0	4-20-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

MORTENSON

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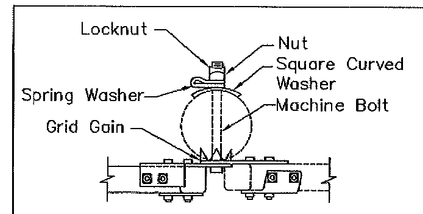
TATANKA WIND ENERGY
NORTH DAKOTA

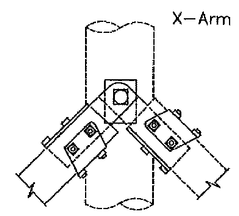
TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE ASSEMBLY DETAILS

0 1" 2"

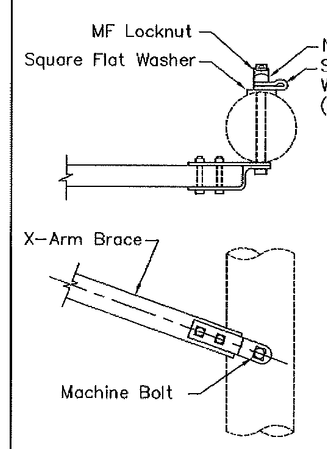
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SHEET
SD-06

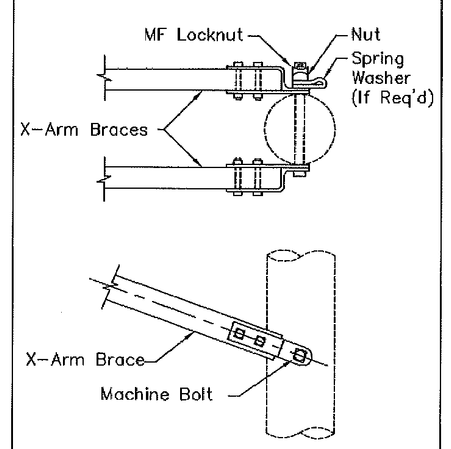




TD-17G
(SINGLE OR DOUBLE BRACE)



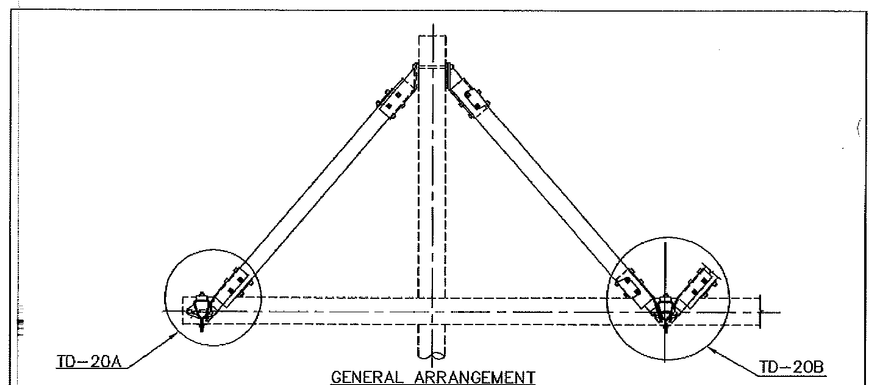
TD-17I



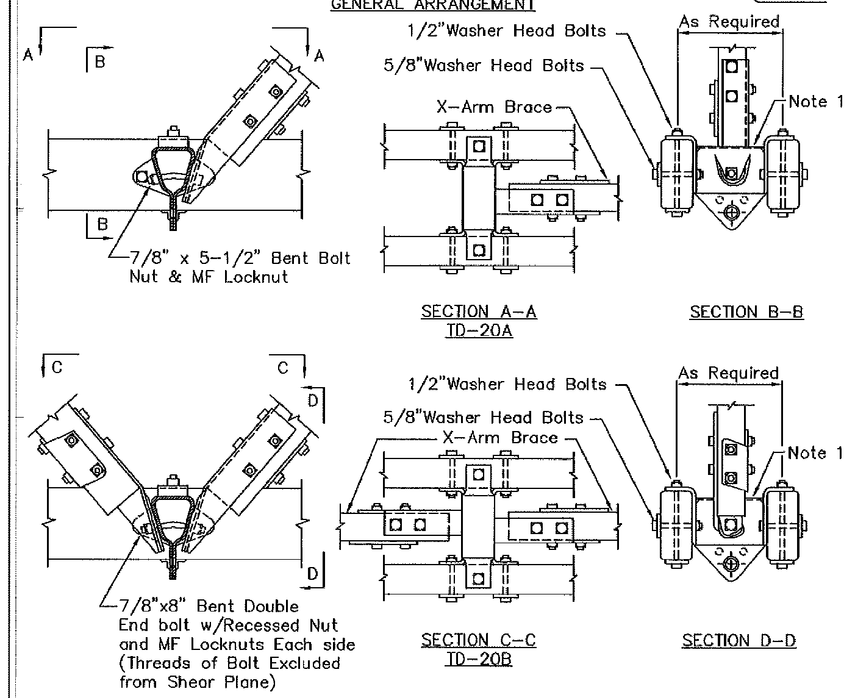
TD-17J

DETAILS
BRACE TO POLE CONNECTIONS

Reissued 03/98 | NO. | REVISION | DATE | SHEET 2 OF 2 | TD-17



GENERAL ARRANGEMENT



SECTION A-A
TD-20A

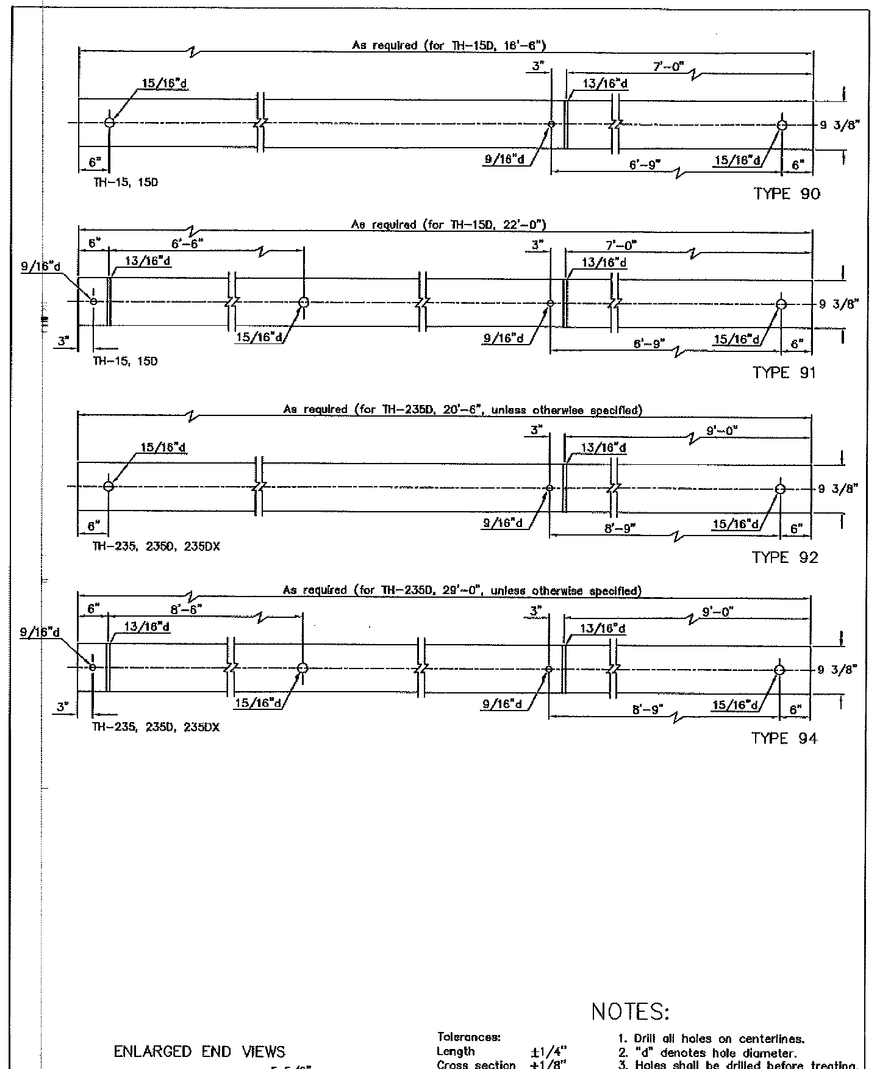
SECTION B-B

SECTION C-C
TD-20B

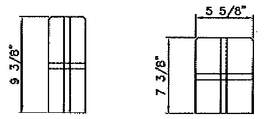
SECTION D-D

DETAILS
SPACER ASSEMBLY-CROSSARM BRACE

Reissued 03/98 | NO. | REVISION | DATE | Scale: | TD-20



ENLARGED END VIEWS

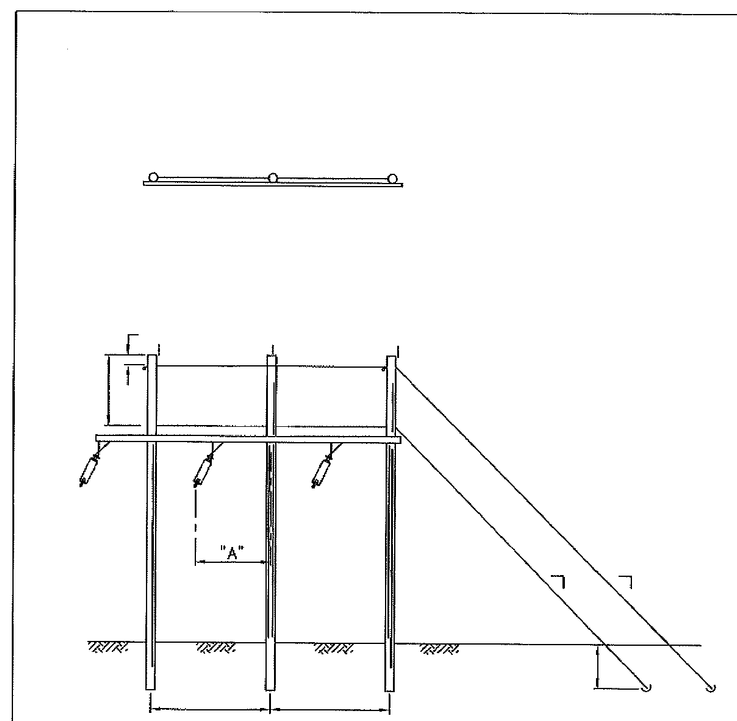


NOTES:
1. Drill all holes on centerlines.
2. "d" denotes hole diameter.
3. Holes shall be drilled before treating.

Tolerances:
Length ±1/4"
Cross section ±1/8"

TRANSMISSION CROSSARMS
LENGTH AS REQUIRED

Reissued 03/98 | NO. | REVISION | DATE | TCD-92



DESIGN CONDITIONS
RULING SPAN: 800'
CONDUCTOR: 795 T2 IBIS D.T.=11,500#
OHGW: 3/8" EHS D.T.= 4400#
OPGW
STRUCTURE TYPE: TH-232 GUY WIRE:
TH-232A 3/8" EHS

Line Angle	Guys Req'd	Anchors Req'd
10°	2	2

NOTES:
1. On the elevation and plan drawings, the engineer is to indicate guy slopes, guy arrangements, and dimensions necessary for construction.

DIMENSION "A" TABLE (60' Initial)

STRUCT. NO.	SHEET	ANGLE	DIM. "A"
59	8	9°16'02"	2.00'
60	8	9°17'02"	7.75'
63	8	8°53'07"	7.75'
64	8	8°56'32"	7.75'

GUYING GUIDE
3 POLE INTERMEDIATE ANGLE

Reissued 03/98 | NO. | REVISION | DATE | TMG-12

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
3	4-17-08	AS-BUILT
2	8-17-07	RE-ISSUED FOR CONSTRUCTION
1	4-30-07	RE-ISSUED FOR CONSTRUCTION
0	4-20-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

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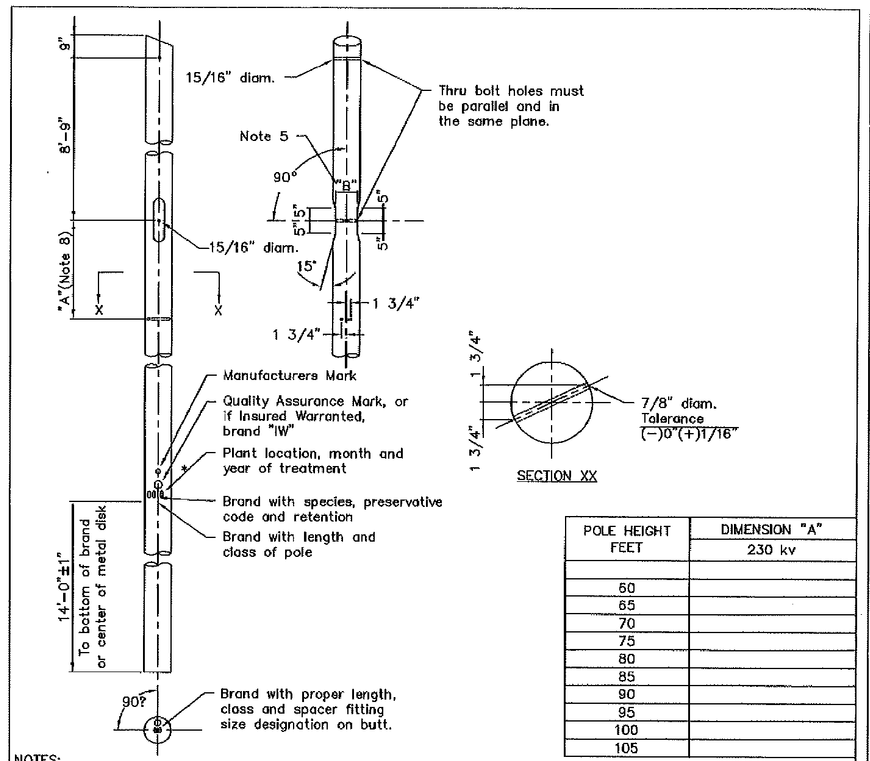
TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE ASSEMBLY DETAILS

0 1" 2"

FILENAME	SD-07.dwg
SCALE	NONE

SHEET
SD-07



POLE HEIGHT FEET	DIMENSION "A" 230 kv
50	
65	
70	
75	
80	
85	
90	
95	
100	
105	

NOTES:
1. * Poles and treatment shall conform to RUS Specifications on Wood Poles, Stubs, and Anchor Logs.
2. All poles treated full length must be bored (except where otherwise specified), roofed, and gained before treatment.
3. Refer to the construction specification to determine if roofs are to be flat or at an angle of 15°.
4. Gains are to be flat with their planes at right angles to the bolt holes.
5. Separation between double gains shall conform to Dimension "B" in the table (tolerance ±1/8).
6. * Refer to the construction specifications as to gaining of the poles when using adjustable spacers.
7. Crossarms may be bowed ±1/2".
8. Dimension "A" shall conform to the table (Engineer to insert proper dimensions).
9. The hole at Section XX may be bored prior to treatment or field drilled at contractor's option unless otherwise specified.
10. All field drilled holes in full length treated poles shall be pressure treated.
11. Poles in each structure shall be matched in size, strength and straightness.
12. This dimension is approximate and varies with X-Brace manufacturer. Check actual factory drawings of brace and fittings before drilling poles.

Circumference of Pole at Point of Gain Inches	Dimension "B" Inches	Spacer Fitting Size	Spacer Fitting Designation
21.0 – 21.9	6.5	7 1/2	A
22.0 – 23.5	7.0	7 1/2	B
23.6 – 25.1	7.5	7 1/2	C
25.2 – 26.7	8.0	9	D
26.8 – 28.2	8.5	9	E
28.3 – 29.8	9.0	9	F
29.9 – 31.4	9.5	10 1/2	G
31.5 – 33.0	10.0	10 1/2	H
33.1 – 34.5	10.5	10 1/2	I
34.6 – 36.2	11.0	12	J
36.3 – 37.7	11.5	12	K

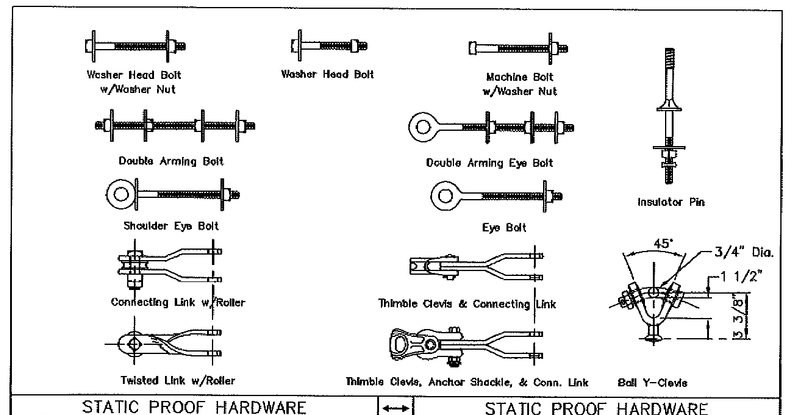
TRANSMISSION POLES

STRUCTURE TH–230

Rev 03/98*

TPF–50

116



STATIC PROOF HARDWARE DESCRIPTION	ITEM	↔	STATIC PROOF HARDWARE DESCRIPTION	ITEM
1/2" Washer Head Bolt w/Washer Nut	c	↔	1/2" Machine Bolt & (2) 1 3/8" Round Washer, 9/16" h.	a,d
1/2" Washer Head Bolt	c	↔	1/2" Machine Bolt & (1) 1 3/8" Round Washer, 9/16" h.	c,d
5/8" Washer Head Bolt w/Washer Nut	c			
5/8" Machine Bolt w/Washer Nut	c	↔	5/8" Machine Bolt & (2) 2 1/4" Sq. Flat Washer, 13/16" h.	a,d
5/8" Double Arming Bolt w/(4) Washer Nuts	n	↔	5/8" Machine Bolt & (1) 2 1/4" Sq. Flat Washer, 13/16" h.	c,d
5/8" Shoulder Eye Bolt w/Washer Nut	o	↔	5/8" Double Arming Bolt&(4)2 1/4"Sq Flat Washers,13/16"h.	n,d
5/8" Shoulder Eye Bolt	o	↔	5/8" Oval Eye Bolt & (2) 2 1/4" Sq Flat Washers,13/16" h.	a,d
		↔	5/8" Oval Eye Bolt & (1) 2 1/4" Sq Flat Washers,13/16" h.	a,d
3/4" Insulator Pins w/Washer Nut, & Locknut	f	↔	3/4" Insulator Pins /(1) 3" Sq Flat Washer, Nut, Locknut	f
3/4" Double Arming Eye Bolt w/(3) Washer Nuts	dy	↔	3/4" Double Arm'g Eye Bolt &(3)4:Sq Flat Washer ,13/16"h.	dy,d
3/4" Shoulder Eye Bolt w/Washer Nut	o	↔	3/4" Eye Bolt & (2) 4" Sq Flat washer, 13/16" h.	a,d
3/4" Shoulder Eye Bolt	o	↔	3/4" Eye Bolt & (1) 4" Sq Flat washer, 13/16" h.	a,d
3/4" Shoulder Eye Bolt w/Washer Nut	o	↔	3/4" Shoulder Eye Bolt & (1) 4" Sq Flat Washer, 13/16" h.	a,d

OTHER EQUIVALENT HARDWARE

(2)2"x3/8" Pole Band Conn. Links,w/Roller,7/8",Bolt,Locknut	↔	Thimble Clevis, 40k,&(2)2"x3/8" Pole Band Connecting Links	cl du
(2)2"x3/8" Pole Band Twisted Links,Roller,7/8",Bolt,Locknut	↔	Thimble Clevis, 40k, Anchor Shackle, and	cl ba
		(2) 2"x3/8" Pole Band Connecting Links	du
(2)2"x3/8" Pole Band Conn. Links, w/Roller,1",Bolt,Locknut	↔	Thimble Clevis, 50k, & (2) 3"x3/8" Connecting Links	cl du
30k Anchor Shackle w/Oval Eye Bolt	↔	30k Ball Y-Clevis	
30k Ball Hook	↔	30k Ball Y-Clevis	

Notes:
1. When specified by engineer, equivalent hardware may be substituted for hardware shown on the structure drawings.
2. All hardware shall bear the manufacturers symbol or identification mark in accordance with ANSI standards.
3. Bolts and nuts assembled shall meet the strength requirements of ANSI standards.
4. Unless otherwise specified, bolts come assembled with the following number of nuts:

Machine bolts	−1 Nut	Oval Eye Bolt	−1 Nut
Double Arming Eye Bolt	−3 Nuts	Washer Head Bolt	−1 Nut
Double Arming Bolt	−4 Nuts	Shoulder Eye Bolt	−1 Nut
Double End Bolt	−2 Nuts	Threaded Rod	−2 Nuts

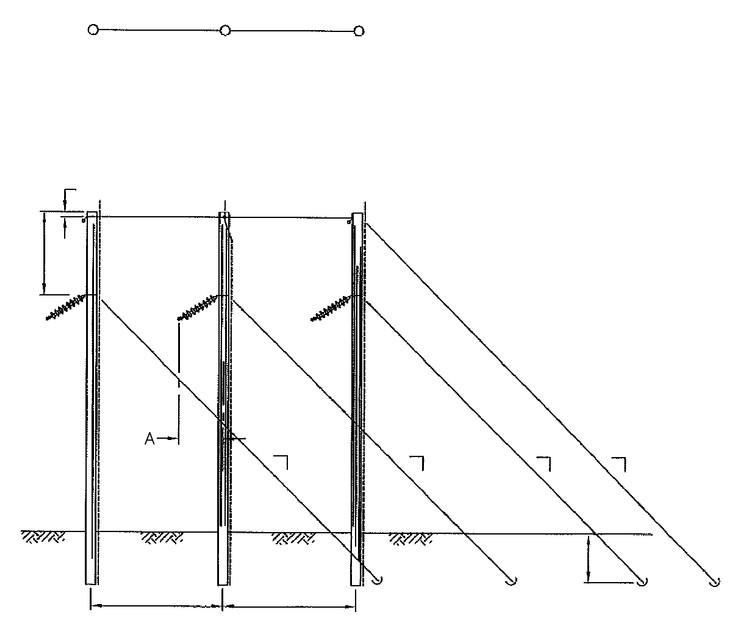
5. For 5/8" bolts, a 2 1/4" square flat washer is often specified on the structure drawings. The hole for this washer is shown to have a 13/16" diameter, A 2 1/4" square flat washer with a 11/16" diameter hole can also be used.
6. Connecting links and twisted links with rollers to be used with pole bands shall exceed the designed strength of the pole band. Links and rollers shall be obtained from the same supplier as the pole bands.

MISCELLANEOUS

INTERCHANGEABLE HARDWARE

Reissued 03/98 | NO. | REVISION | DATE

TM–121



DESIGN CONDITIONS

RULING SPAN: 700', 800'
CONDUCTOR: 795 T2 IBIS D.T.= 11,500#
OHGW: 3/8" EHS D.T.= 4400#
OPGW
STRUCTURE TYPE: TH–234 GUY WIRE: 3/8" EHS

Line Angle	Guys Req'd	Anchors Req'd
	7	7

DIMENSION "A" TABLE (60° Initial)

STRUCT. NO.	SHEET	ANGLE	DIM. "A"
3	1	26°20'55"	5'
13&17	2&3	45°00'00"	6.5'
20	3	40°15'44"	0'
47	6	13°3'57"	5'
52	7	16°16'40"	5'
53	7	15°45'22"	5'
10	2	39°46'11"	6.5'
46	6	9°12'52"	5'

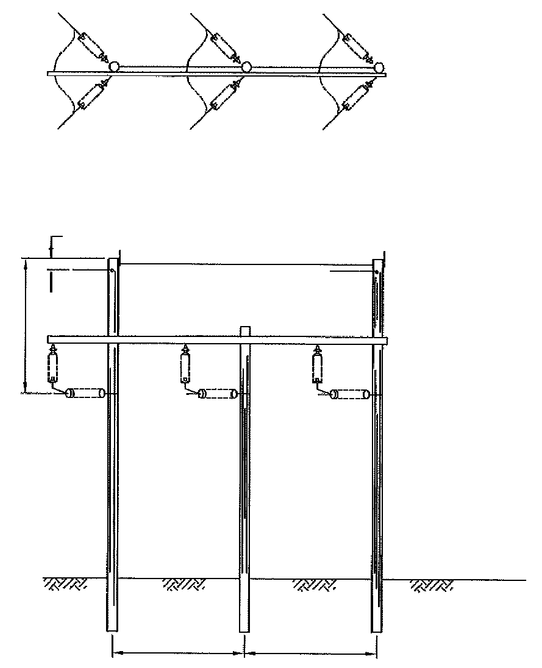
NOTES:
1. On the elevation and plan drawings, the engineer is to indicate guy slopes, guy arrangements, and dimensions necessary for construction.

GUYING GUIDE

3 POLE LARGE ANGLE

Reissued 03/98 | NO. | REVISION | DATE

TMG–14



DESIGN CONDITIONS

RULING SPAN: 700', 800'
CONDUCTOR: 795 T2 IBIS D.T.= 11,500#
OHGW: 3/8" EHS D.T.= 4400#
OPGW
STRUCTURE TYPE: TH–235 GUY WIRE: 3/8" EHS

Line Angle	Guys Req'd	Anchors Req'd
60°–90°	10	10

DIMENSION "A" TABLE (60° Initial)

STRUCT. NO.	SHEET	ANGLE	DIM. "A"
4	1	63°21'39"	0'
82	11	78°9'59"	0'
90	12	89°48'40"	

NOTES:
1. On the elevation and plan drawings, the engineer is to indicate guy slopes, guy arrangements, and dimensions necessary for construction.

GUYING GUIDE

3 POLE LARGE ANGLE DEADEND

Reissued 03/98 | NO. | REVISION | DATE

Aug., 1986

TMG–15

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
3	4–17–08	AS–BUILT
2	8–17–07	RE–ISSUED FOR CONSTRUCTION
1	4–30–07	RE–ISSUED FOR CONSTRUCTION
0	4–20–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

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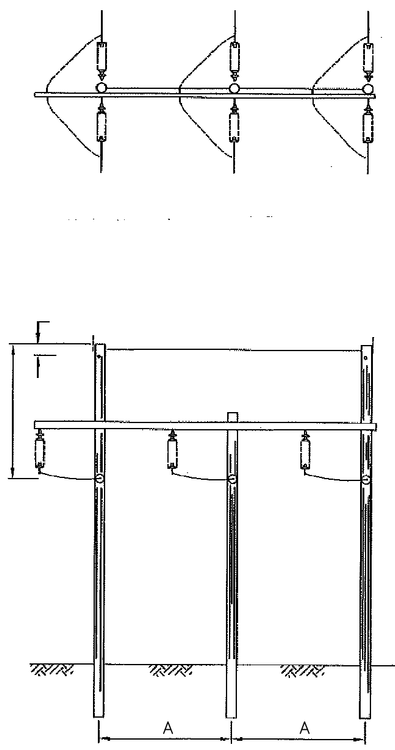
TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE ASSEMBLY DETAILS

0 1" 2"

FILENAME	SD–08.dwg
SCALE	NONE

SHEET SD–08



STR. #	DIM "A"
2	19'-6"
10	19'-6"
37	16'-0"
38	16'-0"

DESIGN CONDITIONS

RULING SPAN: 700', 800'
CONDUCTOR: 795 T2 IBIS D.T.= 11,500#
OHGW: 3/8" EHS D.T.= 4400#
OPGW
STRUCTURE TYPE: TH-235D GUY WIRE:
TH-235 SPEC 3/8" EHS

Guys Req'd	Anchors Req'd
10	10

NOTES:

1. On the elevation and plan drawings, the engineer is to indicate guy slopes, guy arrangements, and dimensions necessary for construction.

GUYING GUIDE

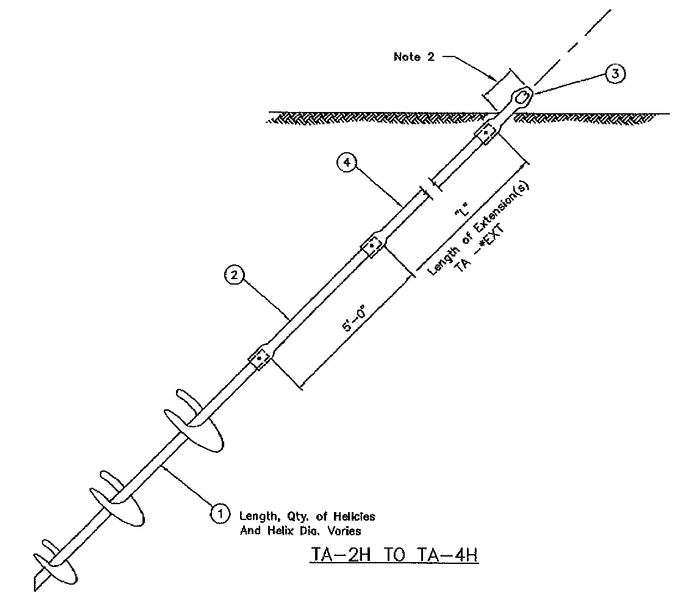
3 POLE TANGENT DEADEND

	NO.	REVISION	DATE
Reissued 03/98			

Aug., 1986

TMG-15D

DWG. REF.	QTY.	DESCRIPTION	ITEM	DET.	CODE No.
	1	Anchor, Helix Section	2		
*	2	Anchor, Ext. Shaft, 5 ft, 1 1/2" sq	2		
	3	Adapter, Guy, Twin eye	2		
*	4	TA-* EXT			



TA-2H TO TA-4H

NOTES:

1. Appropriate anchor unit and maximum holding power shall be specified on plan and profile drawings.
2. Recommended maximum projection after preloading is 8 inches. Projection may be increased to avoid overtorquing of the shaft. Final projection shall be approved by the engineer.
3. The entire anchor assembly shall be hot dipped galvanized in accordance with ASTM A153.
4. Contractor shall install screw anchors in accordance with manfacturer's recommendations.
5. Engineer shall consult manfacturer in selection of screw anchor.
6. * Anchor rod extension shaft beyond five feet is not a part of the anchor assembly unit. The extension shaft beyond five feet is included in UNIT TA-*EXT where the "*" represents the length of the extension shaft beyond 5 feet. For example, an installation requiring two 10 ft. extension shafts would be indicated by 2(TA-10EXT)
7. * Anchors shall be installed in line with the guys.

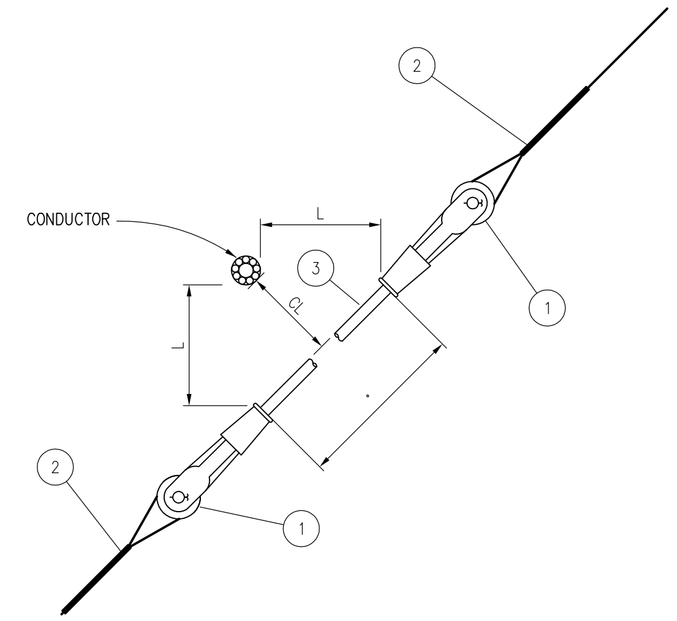
UNITS	ANCHOR TYPE
*TA-2H	DOUBLE HELIX
*TA-3H	TRIPLE HELIX
*TA-4H	QUAD HELIX

ANCHORS

POWER SCREW ANCHOR

NO.	REVISION	DATE
1,*	note 6,7,ltms 2,4	03/98

* TA-2H to 4H



ITEM	REQ.	DESCRIPTION
1	2	GUY ROLLER
2	2	DEADEND GRIP
3	1	GUY STRAIN INSULATOR, 20,000 LB.

VOLTAGE	(L) CONDUCTOR CLEARANCE TO GUY STRAND	GSI * LENGTH	(CL) MINIMUM CLEARANCE TO GUY STRAIN INSULATOR
46kV	19"	42"	11.5"
69kV	25"	54"	15.5"
115kV	42"	96"	24.25"
138kV	48"	96"	28.5"
161kV	60"	120"	33.0"
230kV	77"	144"	45.75"

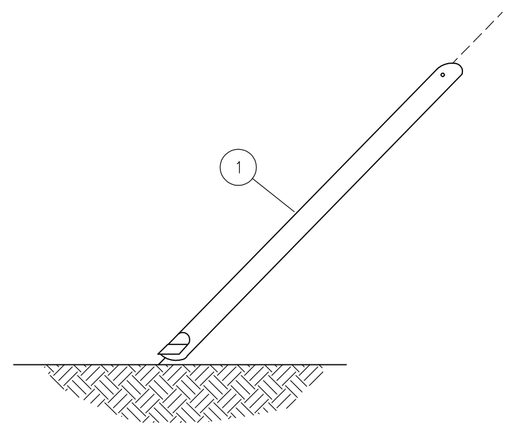
HDR

PROJECT TITLE: TATANKA WIND FARM 230KV TRANSMISSION LINE
SHEET TITLE: **GUY STRAIN INSULATOR**

PROJECT NUMBER: 48049
PROJECT MANAGER:
DATE: 4/20/07

REFERENCE SHEET: 1 OF 1
REFERENCE DOCUMENT: TMGSIB
EXHIBIT NUMBER: TMGSIB

ITEM	REQ.	DESCRIPTION
1	1	Guy Marker, 8' Min. Length (Yellow)



GUY MARKER

HDR

PROJECT TITLE: TATANKA WIND FARM 230KV TRANSMISSION LINE
SHEET TITLE: **GUY MARKER**

PROJECT NUMBER: 48049
PROJECT MANAGER:
DATE: 4/20/07

REFERENCE SHEET: 1 OF 1
REFERENCE DOCUMENT: TM-GM
EXHIBIT NUMBER: TM-GM

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
2	4-17-08	AS-BUILT
1	4-30-07	RE-ISSUED FOR CONSTRUCTION
0	4-20-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

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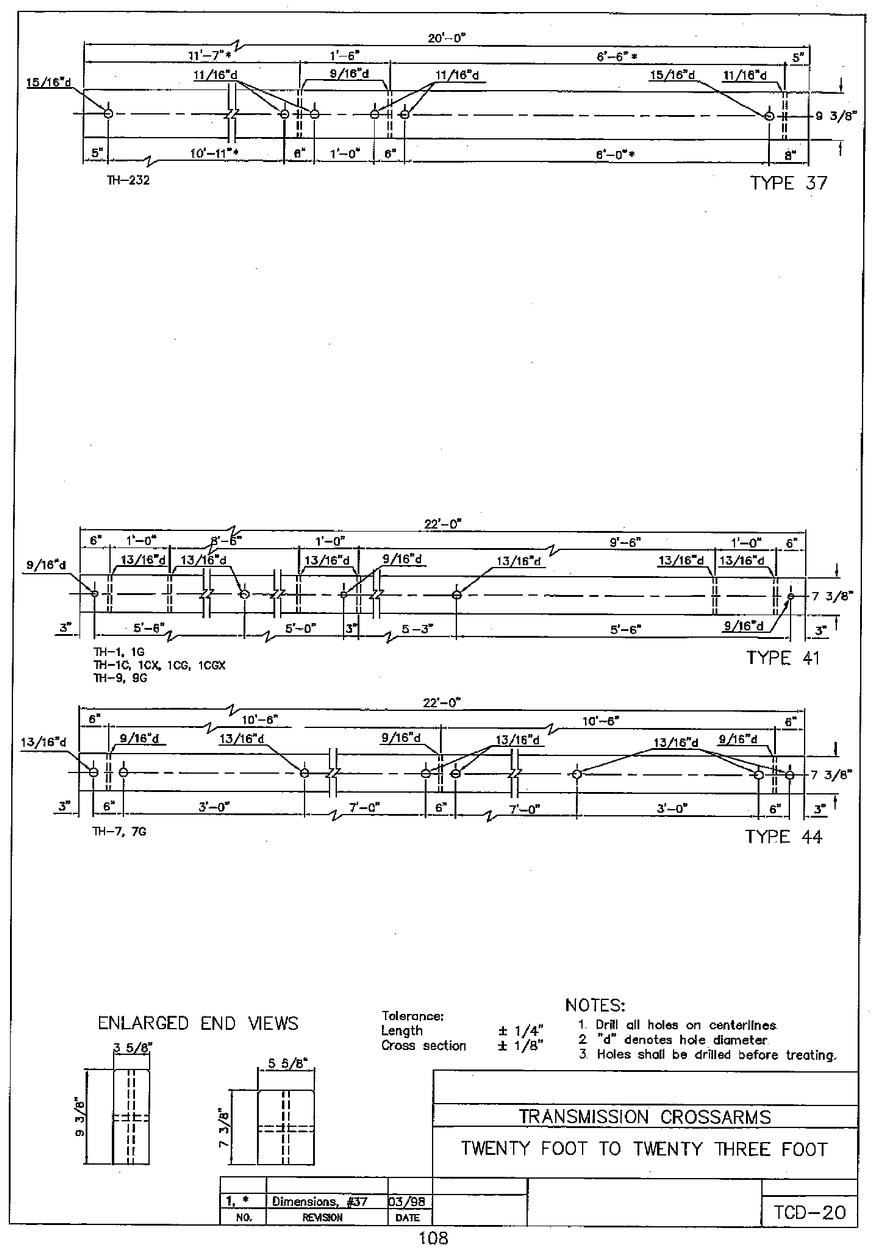
TATANKA WIND ENERGY
NORTH DAKOTA

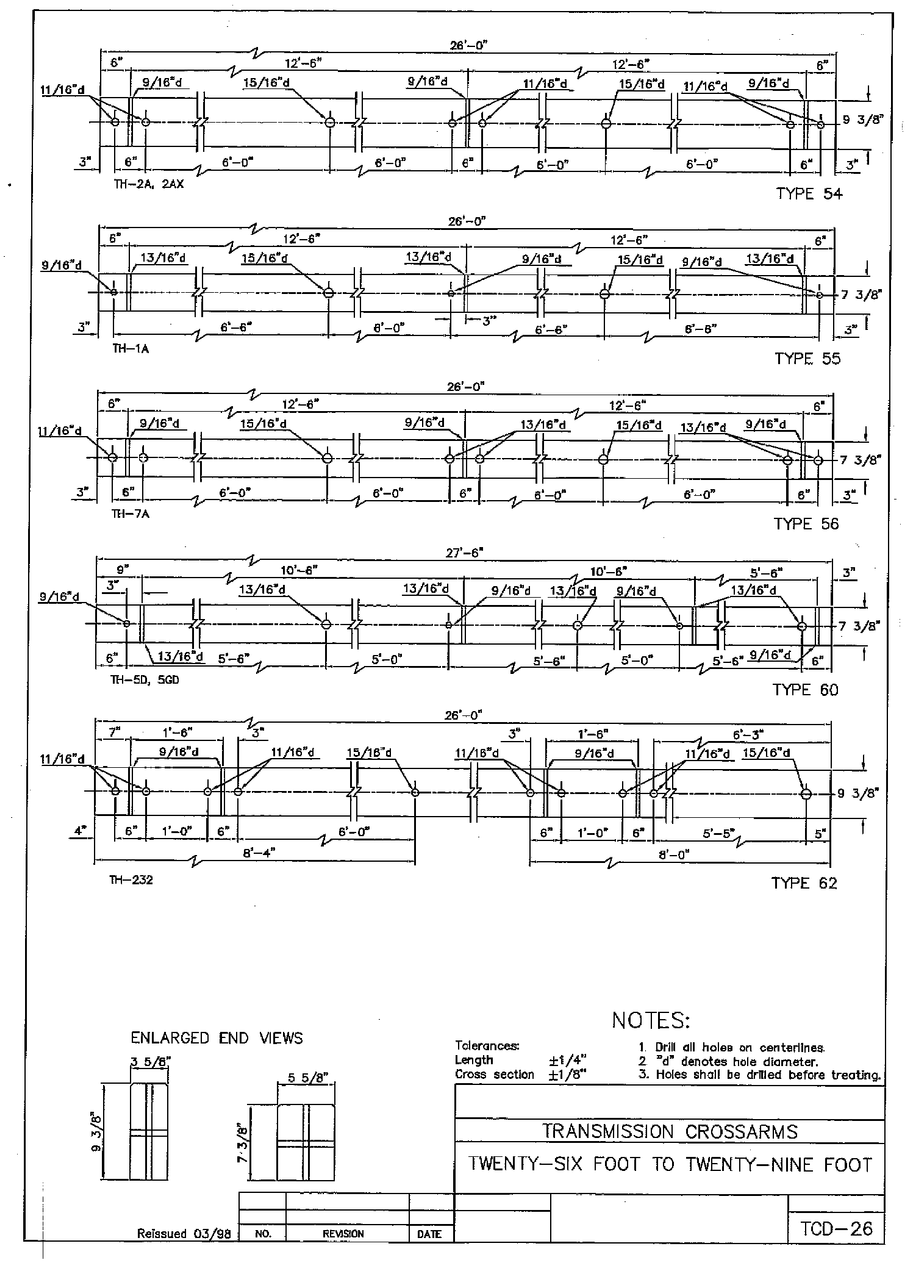
TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE ASSEMBLY DETAILS

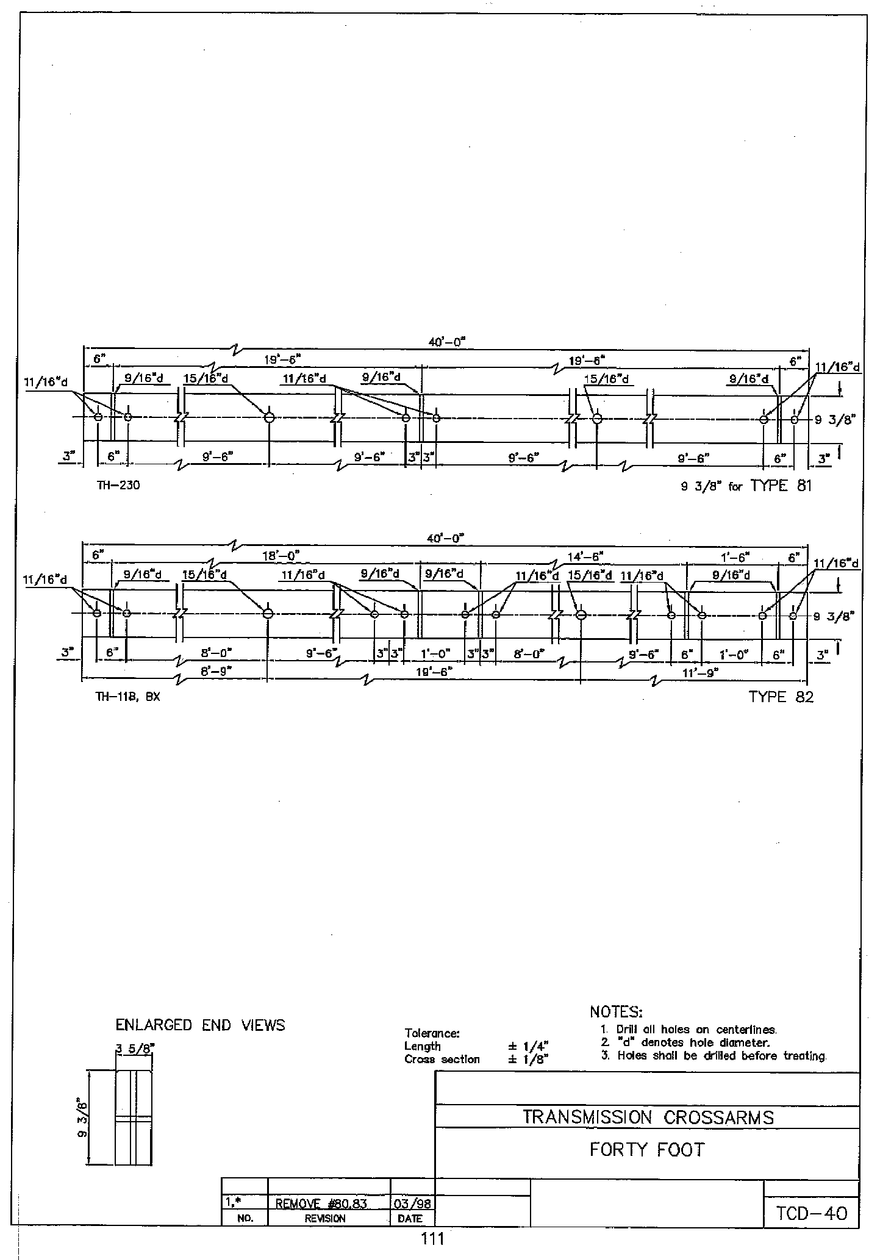
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SCALE	NONE

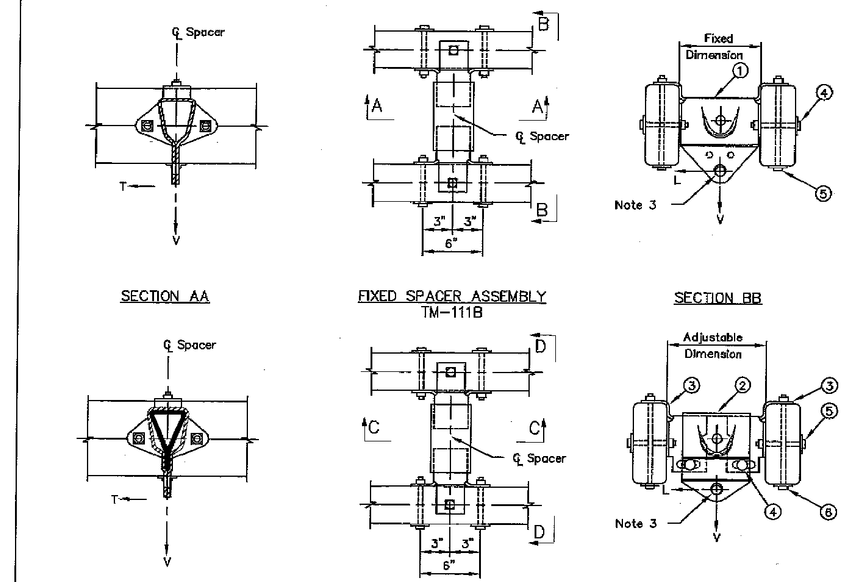
SHEET: **SD-09**







DWG REF.	TM-111 A	TM-111 B	LIST OF MATERIALS DESCRIPTION	ITEM	DET.	CODE No.
1	1	–	Fixed Spacer Body			
2	–	1	Center Spacer Section			
3	–	2	End Spacer Section			
4	–	2	5/8" Bolt, hex + MF locknut			
5	4	4	5/8" Bolt Washer Head, by req'd l.			
6	2	2	1/2" Bolt, Washer Head, by req'd l.			



Notes:
1. Details of hardware on typical manufacturers standard hardware providing same dimensions and strength will be acceptable.
2. Static proof hardware, threaded holes for fasteners, and washer head bolts shall be used.
3. The 1-1/4" diameter holes shall be reamed on both sides, suitable for self-locking ball hook and for insulator clearance.

* 4 Spacer Assembly shall meet the strength requirements in RUS Specifications T-7 and T-8. The spacer is to sustain the following independent ultimate loads:
A Vertical load – – – V = 14,000 lbs
B Transverse load – – – T = 5,000 lbs.
C Longitudinal load – – – L = 1,400 lbs.

MISCELLANEOUS ASSEMBLIES
X-ARM SPACER

1,* Revise Note 4. 03/98
NO. REVISION DATE
TM-111

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
1	4-17-08	AS-BUILT
0	4-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

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TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
STRUCTURE ASSEMBLY DETAILS

0 1" 2"

FILENAME	SD-10.dwg
SCALE	NONE

SHEET
SD-10

MATERIAL CONTRACT
AND SPECIFICATION
For

TATANKA WIND FARM

Acciona to Foot 230 kV Transmission Line

OPT-GW Fiber Optic Cable

Prepared by:

HDR, Inc.
2913 Millennium Circle
Billings, MT 59102-744

Revised

January 2007



ACCIONA TO FOOT 230 kV ELECTRIC TRANSMISSION LINE

OPT-GW FIBER CABLE

SPECIFICATION

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SECTION 1.0

PROPOSAL DATA SHEETS
for
ACCIONA TO FOOT 230 kV ELECTRIC TRANSMISSION LINE
OPT-GW FIBER OPTIC CABLE

1.0 Bid Request for Fiber Optic Cable

1.1 Twelve Fiber, Single Mode, 1310 nm, Optical Ground Wire (OPT-GW) Bid Data

1.1.1 Item Number ..... **OPT-GW AC-57/465**

1.1.2 Fiber Count **12**

1.1.3 Ruling Span, Feet **200, 700, 800**

1.1.4 Nominal Size ..... **3/8 EHS Equivalent**

1.1.5 Number of Buffer Tubes ..... **As Required**

1.1.6 Number of Fibers Per Tube ..... **As Required**

1.1.7 Rated Breaking Strength (RBS), Lbs ..... **16,214 Minimum**

1.1.8 Lay Direction of Outermost Layer ..... _____

1.1.9 Sectional Area, In^2
- a. *Stainless Steel Pipe* ..... _____
- b. *Aluminum Wire* ..... _____
- c. *Aluminum Pipe/Central Core* ..... _____
- d. *Total* ..... _____

1.1.10 Approximate Outside Diameter, In **0.465**

1.1.11 Approximate Weight
- a. *Lbs/Foot* **0.30**

1.1.12 Modulus of Elasticity ..... _____

1.1.13 Coefficient of Linear Expansion, (1/°C/ ..... _____

1.1.14 Rated Fault Current, (kA^2 Sec) ..... _____

1.1.15 Rated Continuous Current ..... _____

1.1.16 Calculated DC Resistance @ 20° C..... _____

1.1.17 Construction of OPT-GW Cable
- a. Aluminum Strands (Gauge/Number)
  - *Nominal Diameter, In*..... _____
  - *Number of Strands*..... _____
- b. Aluminum Pipe/Central Member
  - *Outside Diameter, In*..... _____
  - *Inside Diameter, In*..... _____
- c. Stainless Steel Tube/Central Member
  - *Outside Diameter, In*..... _____
  - *Inside Diameter, In*..... _____

1.1.18 Minimum Bending Radius
- a. *Dynamic, Under Tension, In*..... _____
- b. *Static, No Load, In*..... _____

1.1.19 Ratio, Actual Fiber Length to Cable Length..... _____

1.1.20 Crush Resistance, Lbs/In * ..... _____

1.1.21 Reel Size and Type
- a. *Reel Type (Steel or Wood)*..... _____
- b. *Maximum Reel Length, Ft*..... _____
- c. *Minimum Reel Length, Ft*..... _____

1.1.22 Quantity, MFt **78.900**

1.1.23 Bid Price, $/Mft..... _____

1.1.24 Field Consultation, $/Day..... _____

1.1.25 Cable Attachment Hardware (Estimated)**
- a. *Twenty (20) Deadend Assemblies*..... _____
- b. *One Hundred one (101) AGS Suspension Units*..... _____
- c. *Splice Boxes****..... _____
- c. *Tower Guide Clamps for Wood Poles (as required)*..... _____
- d. *Tower Guide Clamps for Steel Tower (as required)*..... _____
- e. *Vibration Dampers (As required)*..... _____
- *f. Splice Box Connector Kit for OPT-GW (If required)*..... _____
- g. *Splice Box Splice tray for 12 fibers/enclosure*..... _____
- h. *Furcation Tray (As required)*..... _____

- h. *Total*..... _____

* Temporary or Permanent Grounding Clamps

** See appendix A for typical Assembly Drawings

*** Splice Box Quantities shall be as follows:
Four (4) Alcoa OG03 or equal
Two (2) Alcoa SBo1 or equal (Substation Dead End Mount)

1.2 Optical Performance Data
(Reference Technical Section 3.3.3)

1.2.1 Core Diameter, Microns ..... _____

1.2.2 Cladding Diameter, Microns ..... _____

1.2.3 Concentricity Error, Microns ..... _____

1.2.4 Mode Field Diameter, Micro-Meter:
@ 1310 nm ..... _____
@ 1550 nm ..... _____

1.2.5 Cut Off Wavelength, nm ..... _____

1.2.6 Buffer Coating Diameter, Microns ..... _____

1.2.7 Guaranteed Maximum Attenuation in dB using a bi-directional TDR:
@ 1310 nm ..... _____
@ 1550 nm ..... _____

1.3 Alternatives and Exceptions

The *Engineer* will consider alternatives to the requirements of **SECTIONS 1.1.** If the *Subcontractor* wishes to bid any alternative units with exceptions to the requirements of the foregoing **SECTION 1.1**, the *Subcontractor* may do so as long as a separate typed page listing the alternative specifications is attached to this document and returned with the *Subcontractor's* bid.

1.4 Optical Cable Data

1.4.1 OPT-GW Glass Manufacturer for Bid Section 1.1 ..... _____

SECTION 2

GENERAL SPECIFICATIONS for ACCIONA TO FOOT 230 kV ELECTRIC TRANSMISSION LINE OPT-GW FIBER OPTIC CABLE

2.1 PURPOSE OF SPECIFICATIONS

These specifications are intended to outline the general requirements, standards of performance, specific cable, standards of materials and manufacturing, testing and guarantee related to the furnishing of single-mode fiber optic cables (lightguides) to be used within an overhead Ground Wire (OPT-GW) under these specifications.

These specifications also provide the *Subcontractor* with minimum standards of quality for materials to be used in the manufacture of optical cable (OPT-GW). All materials shall be first quality, newly manufactured, from the manufacturer's or the *Subcontractor's* stock. The Cable must provide protection for the optical fibers from installation, environmental and operational damages.

2.2 COMPLIANCE WITH NATIONAL STANDARDS

Unless otherwise indicated, all optical cable shall meet the applicable requirements of the most recent revision of the following standards, as well as any other standards referenced in these specifications and any other applicable national standards.

ANSI/IEEE 1138-1994	***Standard Construction of Composite Fiber Optic Overhead Ground Wire (OPGW) for Use on Electric Utility Power Lines***
	Standard Construction of Composite Fiber Optic Overhead Self supporting Wire (ADSS) for Use on Electric Utility Power Lines
ASTM B398-90	***Aluminum-Alloy 6201-T81 Wire for Electrical Purposes***

2.3 PROJECT DESCRIPTION

Approximately thirteen (13) miles of 230 kV transmission line is to be constructed between a new Substation (Acciona) to be located in South Dakota and an existing Montana-Dakota Utilities 230 kV line located in North Dakota. Construction shall include installation of approximately thirteen (13) miles of fiber optic cable (OPT-GW) along this entire length to provide communications and relaying protection between the two end points.

2.4 DEFINITION OF TERMS

2.4.1 *"Owner"*

M. A. MORTENSON COMPANY
700 Meadow Lane North
Minneapolis, MN 55442
Telephone: (763) 287-5660
FAX: (763) 287-5581

Correspondence with the Owner shall be directed to:
Attn: Mr. Michael Butts,
Estimator

2.4.2 *"Engineer"*

HDR Inc.
2200 Skyway
Butte, Montana 59701
Telephone: (406) 723-8309
FAX: (406) 652-2758

Correspondence with the Engineer shall be directed to:
Attn: Mr. Gary McWhorter
Project Engineer

2.4.2 "Subcontractor"

The firm(s), company(ies) or corporation(s) with whom the *Owner* has selected or may select for the purpose of supplying and installing materials.

2.5 Work and Materials to be Provided by Others

NONE

2.6 Bid Requirements and Data

2.6.1 Data to be Provided with Bid

a. A letter of bid transmittal which clearly states any exceptions taken by the *Subcontractor* to the Specifications, Proposal Data Sheets, and/or Terms and Conditions at the time of bid. The *Owner* shall ***not*** accept

the manufacturer's "Standard Conditions of Sale" or similar standard policies for purposes of stating exceptions to the specifications.

b. A detailed description of the *Subcontractor's* proposed guarantee.

c. The *Subcontractors* information on support hardware including manufacturer's names and catalog numbers for suspension clamps, deadend clamps, grounding assemblies, splices, terminations, protective devices and all other hardware required for installation of the cable. Pricing must be furnished for these items by the *Subcontractor* as requested in **SECTIONS 1.1.**

d. The *Subcontractor's* information on splicing procedures, any special tools required grips and accessories necessary for installation, and any other recommendations that are necessary and appropriate for the proper handling and installation of the cable. *Subcontractors* are encouraged to provide pricing for the purchase or rental of any special tools and equipment required to install the cable. It is in the *Subcontractors* best interests to provide as much test data as possible for hardware of a similar size and construction to the hardware required for this project.

e. Two (2) physical samples, not more than twelve (12) inches in length of the cable construction proposed by the *Subcontractor to be provided within five (5) days after award of the contract.*

f. The *Subcontractor* shall include a list of any exceptions taken to the specification requirements with reference to the applicable section.

2.6.2 Proposal Data Sheets

Proposal Data Sheets, included in **SECTION 1.0** of these specifications, ***shall*** be completed and submitted with the bid. ***Failure to provide the Proposal Data Sheets may result in the rejection of the Subcontractor's proposal.***

2.6.3 Substitutions and Exceptions

a. Where specifications identify cable by manufacturer name and/or model and type, products of equal quality and performance by other manufacturers may be substituted provided that such substitution is of equal design and quality.

b. The *Subcontractor* shall furnish descriptive information and data to demonstrate to the *Engineer* that the cable proposed is equal to that

originally specified. The *Subcontractor* shall be responsible for proving the equality of proposed substitutions.

c. The *Owner* and the *Engineer* shall have final authority regarding the acceptability of proposed substitutions of cable.

d. Approval of substitutions by the *Engineer* or the *Owner* shall not in any way excuse the *Subcontractor* of responsibility for providing workmanship and material equal to that specified.

2.6.4 Interpretations

Clarifications and interpretations shall be requested from the *Engineer* as soon as possible. The *Engineer* shall issue an opinion on all questions and provide any necessary written clarifications. The *Engineer's* interpretation shall be accepted as final.

2.6.5 Acceptance

Upon acceptance of a *Proposal*, the *Subcontractor* shall immediately supply to the *Engineer*, ***three (3)*** copies of the manufacturer's data sheets which completely identify all cable showing electrical and mechanical ratings, weight and physical construction for approval by the *Engineer* prior to proceeding with this order.

If requested by the *Subcontractor*, ***one (1)*** copy of the data sheets indicating the *Engineer's* review shall be returned to the *Subcontractor* within ***ten (10) days*** from the date of receipt.

2.6.6 Packaging of Optical Cable

The *Subcontractor* shall insure the following:

a. The cable shall be packaged with heavy fiberboard wrapping secured with steel banding over a moisture resistant paper barrier or by an equally suitable method and as further defined in **SECTION 3.1.2**.

b. Non-returnable wooden reels and returnable steel or aluminum reels shall be constructed to withstand the rigors of normal shipping, handling and stringing operations per National Electrical Manufacturers Association (NEMA) specifications.

c. Each reel shall be tagged with at least ***one (1)*** weather protected identification tag securely attached to the flange. All essential

information as defined in **SECTION 2.6.7** shall appear legibly on the tag.

d. Where practicable, all cable shall be packaged on the same size reels as further defined in the **SECTION 3.1.1, 3.1.2** and **3.1.3**.

2.6.7 Delivery

Bids shall include delivery F.O.B. ***Tatonka Wind Farm, Inc. Corner of 66th & State Line Road, McPhearson County South Dakota. Shipping papers and reels shall bear the following job reference:***

ACCIONA TO FOOT 230 kV ELECTRIC TRANSMISSION LINE	
Material Item #_____	Cable Length (Feet)_____
Purchase Order #_____	Cable Length (km)_____
Total Gross Weight_____	

Additional information shall be provided in a sealed weatherproof envelope and shall contain the *Subcontractor's* OTDR data including the attenuation of each fiber, the individual fiber lengths in kilometers, and the index of refraction to which the OTDR measurements are referenced. The *Subcontractor* shall provide additional copies of this data to the *Engineer* and the *Owner*. The *Subcontractor* shall assume all responsibility for the safe delivery of materials shipped F.O.B. destination.

2.7 Guarantee

The *Subcontractor* shall guarantee that all OPT-GW Fiber Optic Cable and Cable Attachment Hardware shall be free of defects and suitable for satisfactory operation at ratings specified by the *Subcontractor*.

2.8 Evaluation

The *Owner* shall evaluate bids, considering price, delivery, manufacturer's reputation, and other items in the evaluation of proposals.

2.9 Cable Quantities

*The **estimated*** OPGW cable quantity required in this specification is 78,900 feet. This cable is to be supplied on four reels.

The owner reserves the right to modify this quantity prior to shipment.

2.10 Award / Cancellation

Reel counts for bidding non-returnable wooden reels shall be based on an average length of 75% of the maximum reel capacity for OPT-GW Fiber Optic Cable. The *Owner* reserves the right to modify the remaining unreleased lengths from one type to another, or to cancel the remaining unreleased quantities.

The *Owner* also reserves the right to award separate order for individual material items (conductor and optional hardware) covered by this Specification. However, in no case shall the fiber optic cable order be split among manufacturers.

SECTION 3

TECHNICAL SPECIFICATIONS for ACCIONA TO FOOT 230 kV ELECTRIC TRANSMISSION LINE OPT-GW FIBER OPTIC CABLE

3.1 GENERAL

3.1.1 Reel Quantities

Minimum quantities on reels shall be 10,000 feet (3 km); **however as previously specified all OPGW cable is to be provided on four reels.**

The owner reserves the right to modify this quantity prior to shipment.

3.1.2 Acceptable Reel Sizes and Packaging

Both returnable steel or aluminum reels and non-returnable wooden reels shall have protective material wraps over the outer layer and internal wood lagging attached to the reel flanges. Reel sizes shall not exceed RMT 84.45. Both ends of the CABLE shall be accessible for testing without removal of the wood lagging.

3.1.3 Variation in Lengths

The allowable variation in lengths of individual section lengths shall be -0.0 km and +0.1 km. The allowable variation in the length of the total order for purposes of payment shall be -0.0% and +3.0%.

3.1.4 Material Safety Data Sheets

Material Safety Data Sheets (MSDS) shall be provided by the *Subcontractor* for any product containing chemicals or materials susceptible to generating chemical byproducts which could create a health hazard. If MSDS are necessary, the *Subcontractor* shall provide copies to the *Owner* and the *Engineer* with the cable engineering information and a separate copy shipped with the Cable.

3.1.5 Splice boxes

Splice Enclosures will be provided that accommodate wood pole mounting, steel deadend tower leg mounting or substation control house wall mounting. All enclosures will include splice trays for 12 fibers and will provide connector kits to accommodate both LOOSE TUBE and OPGW cables

3.2 MECHANICAL REQUIREMENTS

3.2.1 Material

Strand material for all OPT-GW shall be aluminum alloy per ANSI/IEEE Standard 1138-1994 (Para 5.1.2.1) and ASTM B398/B398M-1999.

3.2.2 Stranding

The diameter of round strands for all OPT-GW shall be 0.122 inches (AWG #11) or greater.

3.2.3 Rated Breaking Strength

The ultimate Rated Breaking Strength (RBS) of the OPT-GW Fiber Optic Cable shall be no less than the specified values defined in **SECTION 1.1**.

3.3 Design Criteria

3.3.1 Loading Criteria

The *Subcontractor* shall provide sag and tension data for each cable design for the ruling spans listed. OPT-GW sag and tension tables shall include the following design loading conditions plus the following additional conditions. The *Subcontractor* shall provide information for additional cases as requested. In addition, the *Subcontractor* shall provide cable stress-strain coefficients for use with Alcoa™ SAG10 software.

a. OPT-GW cable

- Tension at NESC Heavy Loading (Initial)

  27 % RBS (All Ruling Spans)

- 0° F, 1.5" Radial Ice, No Wind - **58 % RBS**
- 32° F, 0.5" Radial Ice, No Wind
- 60° F, No Radial Ice, 20.0 psf Transverse Wind
- -20° F, No Radial Ice, No Wind (Initial and Final)
- 0° F, No Ice, No Wind (Initial and Final)
- 30° F, No Ice, No Wind (Initial and Final)
- 60° F, No Ice, No Wind (Initial and Final)
- 90° F, No Ice, No Wind (Initial and Final)
- 120° F, No Ice, No Wind (Initial and Final)

In no case shall the design tensions exceed the following percentages of the Rated Breaking Strength (RBS):

- NESC Heavy Loading: 60% Initial Tension
- 60° F, No Wind: 33% Initial Tension
- 60° F, No Wind, No Ice: 10% Final Tension (Desirable)
  25% Final Tension (Maximum)

3.3.2 Fiber Strain

The cable shall be designed in such a way to eliminate fiber strain under all specified loading conditions.

3.3.3 Physical and Performance Specifications for Optics

The bare fiber shall be coated with a suitable material for protection from abrasion during subsequent handling or manufacturing. The central strength member of the fiber bundle shall be non-metallic. The cable shall use "Corning SMF-28 CPC Single Mode Optical Fiber @ 1310 nm" or equivalent. *Subcontractors'* cable shall be compatible with Bonneville's specification.

3.3.4 Vibration Control

The *Subcontractor* shall provide recommendations for vibration fatigue control hardware if required based on the tensions resulting from the design criteria as established in **SECTION 3.3.1**. If the tensions generated by this design criteria do not require the use of vibration control devices, information shall be provided on the tension threshold where these devices shall become necessary.

3.3.5 Variable and Cyclical Loading

The cable shall be designed such that variable and cyclical loads over an expected 50-year life shall not damage the cable or the individual fibers. The design shall take into account annual loadings at -20° F for ten days (240 hours) per year, 0.5" Radial Ice for one day per year, and 1.0" Radial Ice for one day per five years, plus cumulative vibration effects for weather conditions experienced in the northwest United States.

3.4 HARDWARE

3.4.1 General

The *Subcontractor* shall recommend support hardware that conforms to the testing requirements of ANSI/IEEE Standard 1138. The *Subcontractor* shall also provide information on the suspension, deadend and associated hardware items which the *Subcontractor* has accepted for use with their

product. This information shall include manufacturer names, catalog numbers, strength ratings, and laboratory test data including vibration certification tests.

3.4.2 Unacceptable Materials

Bolted type clamps without helically formed protective rods will not be accepted by the *Engineer* or the *Owner*.

3.4.3 Additional Test Data

Test data in addition to that required by ANSI/IEEE Standard 1138 shall be provided by the *Subcontractor* for the cable suspension assemblies for the maximum turning angle, not less than 20°, for which the suspension assembly has been designed. This data shall be based on tests conducted using the maximum design tensions as specified in **SECTION 3.3.1** and without damage to the cable or suspension assembly, nor degradation of the optical signal in excess of that allowed by ANSI/IEEE Standard 1138 (Para 4.2.1.3). The test data submitted to the *Engineer* and the *Owner* may consist of file test data on a similar cable size and construction. In addition, a written test procedure shall be provided with the *Subcontractor's* Proposal for testing the cable and hardware required by this Specification in the event the file test data is insufficient or non-existent.

3.4.4 Electrical Bonding

The *Subcontractor* shall provide information on additional requirements and approved hardware for electrical bonding at the attachment clamps.

3.5 QUALITY CONTROL & QUALITY ASSURANCE

The *Subcontractor* shall submit information on their quality control and quality assurance procedures and record keeping including traceability of cable and cable components. The *Subcontractor* shall provide to the *Engineer* and *Owner*, copies of certified quality control information for each reel of cable as previously specified.

STRINGING SAG TABLE USING INITIAL SAG RULING SPAN: 200.0 FEET (SLACK)

T-2 CONDUCTOR IBIS 2 - 397.5 KCMIL 26/ 7 STRANDING ACSR

NESC HEAVY LOAD ZONE MAX TENSION = 2000 LB

DESIGN: 1000. LB @ 0. DEG F, .50 IN ICE, 4.00 PSF WIND, INITIAL

H TENS (LBS)	851.	832.	815.	802.	789.	777.	766.	755.	744.	734.	728.
TEMP °F	0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
SAG SPAN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN
180.0	5- 3	5- 4	5- 6	5- 7	5- 8	5- 9	5-10	5-11	6- 0	6- 1	6- 2
207.0	6-11	7- 1	7- 3	7- 4	7- 6	7- 7	7- 8	7-10	7-11	8- 0	8- 1

STRINGING SAG TABLE USING INITIAL SAG RULING SPAN: 182.0 FEET (REDUCED)

T-2 CONDUCTOR IBIS 2 - 397.5 KCMIL 26/ 7 STRANDING ACSR

NESC HEAVY LOAD ZONE MAX TENSION = 7731 LB

DESIGN: 3732. LB @ 0. DEG F, .50 IN ICE, 4.00 PSF WIND, INITIAL

H TENS (LBS)	6642.	6092.	5543.	5001.	4475.	3975.	3513.	3100.	2744.	2446.	2201.
TEMP °F	0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
SAG SPAN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN
182.0	0- 9	0- 9	0-10	0-11	1- 1	1- 2	1- 4	1- 6	1- 8	1-11	2- 1

STRINGING SAG TABLE USING INITIAL SAG RULING SPAN: 700.0 FEET

T-2 CONDUCTOR IBIS 2 - 397.5 KCMIL 26/ 7 STRANDING ACSR

NESC HEAVY LOAD ZONE MAX TENSION = 11736 LB

DESIGN: 36.0 % ULT. @ 0. DEG F, .50 IN ICE, 4.00 PSF WIND, INITIAL

H TENS (LBS)	8031.	7676.	7335.	7009.	6700.	6409.	6135.	5879.	5640.	5418.	5212.
TEMP °F	0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
SAG SPAN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN
450.0	3- 6	3- 8	3-10	4- 0	4- 2	4- 4	4- 7	4- 9	4-11	5- 2	5- 4
475.0	3-11	4- 1	4- 3	4- 5	4- 8	4-10	5- 1	5- 3	5- 6	5- 9	6- 0
500.0	4- 4	4- 6	4- 8	4-11	5- 2	5- 5	5- 7	5-10	6- 1	6- 4	6- 7
525.0	4- 9	4-11	5- 2	5- 5	5- 8	5-11	6- 2	6- 5	6- 9	7- 0	7- 3
550.0	5- 2	5- 5	5- 8	5-11	6- 3	6- 6	6- 9	7- 1	7- 5	7- 8	8- 0
575.0	5- 8	5-11	6- 2	6- 6	6- 9	7- 1	7- 5	7- 9	8- 1	8- 5	8- 9
600.0	6- 2	6- 5	6- 9	7- 1	7- 5	7- 9	8- 1	8- 5	8- 9	9- 2	9- 6
625.0	6- 8	7- 0	7- 4	7- 8	8- 0	8- 5	8- 9	9- 2	9- 6	9-11	10- 4
650.0	7- 3	7- 7	7-11	8- 3	8- 8	9- 1	9- 6	9-10	10- 3	10- 9	11- 2
675.0	7-10	8- 2	8- 6	8-11	9- 4	9- 9	10- 2	10- 8	11- 1	11- 7	12- 0
700.0	8- 5	8- 9	9- 2	9- 7	10- 1	10- 6	11- 0	11- 5	11-11	12- 5	12-11
725.0	9- 0	9- 5	9-10	10- 4	10- 9	11- 3	11- 9	12- 3	12- 9	13- 4	13-10
750.0	9- 7	10- 1	10- 6	11- 0	11- 6	12- 1	12- 7	13- 2	13- 8	14- 3	14-10
775.0	10- 3	10- 9	11- 3	11- 9	12- 4	12-10	13- 5	14- 0	14- 7	15- 3	15-10
800.0	10-11	11- 5	12- 0	12- 6	13- 1	13- 8	14- 4	14-11	15- 7	16- 2	16-10
825.0	11- 8	12- 2	12- 9	13- 4	13-11	14- 7	15- 3	15-11	16- 7	17- 3	17-11
850.0	12- 4	12-11	13- 6	14- 2	14-10	15- 6	16- 2	16-10	17- 7	18- 3	19- 0
875.0	13- 1	13- 8	14- 4	15- 0	15- 8	16- 5	17- 1	17-10	18- 7	19- 5	20- 2
900.0	13-10	14- 6	15- 2	15-10	16- 7	17- 4	18- 1	18-11	19- 8	20- 6	21- 4
925.0	14- 7	15- 3	16- 0	16- 9	17- 6	18- 4	19- 1	19-11	20-10	21- 8	22- 6
950.0	15- 5	16- 2	16-11	17- 8	18- 6	19- 4	20- 2	21- 1	21-11	22-10	23- 9

STRINGING SAG TABLE USING INITIAL SAG RULING SPAN: 800.0 FEET

T-2 CONDUCTOR IBIS 2 - 397.5 KCMIL 26/ 7 STRANDING ACSR

NESC HEAVY LOAD ZONE MAX TENSION = 11736 LB

DESIGN: 36.0 % ULT. @ 0. DEG F, .50 IN ICE, 4.00 PSF WIND, INITIAL

H TENS (LBS)	7363.	7075.	6803.	6545.	6303.	6074.	5861.	5660.	5472.	5297.	5133.
TEMP °F	0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
SAG SPAN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN
550.0	5- 8	5-11	6- 1	6- 4	6- 7	6-10	7- 1	7- 4	7- 7	7-10	8- 1
575.0	6- 2	6- 5	6- 8	6-11	7- 3	7- 6	7- 9	8- 0	8- 4	8- 7	8-10
600.0	6- 9	7- 0	7- 3	7- 7	7-10	8- 2	8- 5	8- 9	9- 0	9- 4	9- 8
625.0	7- 4	7- 7	7-11	8- 2	8- 6	8-10	9- 2	9- 6	9-10	10- 2	10- 5
650.0	7-11	8- 3	8- 6	8-10	9- 3	9- 7	9-11	10- 3	10- 7	10-11	11- 4
675.0	8- 6	8-10	9- 2	9- 7	9-11	10- 4	10- 8	11- 1	11- 5	11-10	12- 2
700.0	9- 2	9- 6	9-11	10- 3	10- 8	11- 1	11- 6	11-11	12- 3	12- 8	13- 1
725.0	9-10	10- 2	10- 7	11- 0	11- 5	11-11	12- 4	12- 9	13- 2	13- 7	14- 1
750.0	10- 6	10-11	11- 4	11-10	12- 3	12- 9	13- 2	13- 8	14- 1	14- 7	15- 0
775.0	11- 2	11- 8	12- 1	12- 7	13- 1	13- 7	14- 1	14- 7	15- 1	15- 7	16- 1
800.0	11-11	12- 5	12-11	13- 5	13-11	14- 5	15- 0	15- 6	16- 1	16- 7	17- 1
825.0	12- 8	13- 2	13- 9	14- 3	14-10	15- 4	15-11	16- 6	17- 1	17- 7	18- 2
850.0	13- 6	14- 0	14- 7	15- 2	15- 9	16- 4	16-11	17- 6	18- 1	18- 8	19- 4
875.0	14- 3	14-10	15- 5	16- 1	16- 8	17- 3	17-11	18- 7	19- 2	19-10	20- 5
900.0	15- 1	15- 8	16- 4	17- 0	17- 8	18- 3	18-11	19- 7	20- 4	21- 0	21- 8
925.0	15-11	16- 7	17- 3	17-11	18- 7	19- 4	20- 0	20- 9	21- 5	22- 2	22-10
950.0	16-10	17- 6	18- 2	18-11	19- 8	20- 4	21- 1	21-10	22- 7	23- 4	24- 1
975.0	17- 8	18- 5	19- 2	19-11	20- 8	21- 5	22- 3	23- 0	23-10	24- 7	25- 5
1000.0	18- 7	19- 5	20- 2	20-11	21- 9	22- 7	23- 5	24- 3	25- 1	25-11	26- 9

STRINGING SAG TABLE USING INITIAL SAG RULING SPAN: 200.0 FEET (SLACK)

OPGW CATALOG #: GW1200 57 MM2/ 465

NESC HEAVY LOAD ZONE MAX TENSION = 1222 LB

DESIGN: 1222. LB @ 0. DEG F, .50 IN ICE, 4.00 PSF WIND, INITIAL

H TENS (LBS)	309.	303.	296.	290.	284.	279.	274.	269.	264.	260.	256.
TEMP °F	0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
SAG SPAN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN
180.0	4- 0	4- 1	4- 2	4- 3	4- 5	4- 6	4- 7	4- 8	4- 8	4- 9	4-10
207.0	5- 4	5- 5	5- 7	5- 8	5- 9	5-11	6- 0	6- 1	6- 3	6- 4	6- 5

STRINGING SAG TABLE USING INITIAL SAG RULING SPAN: 182.0 FEET (REDUCED)

OPGW CATALOG #: GW1200 57 MM2/ 465

NESC HEAVY LOAD ZONE MAX TENSION = 2945 LB

DESIGN: 1353. LB @ 60. DEG F, .00 IN ICE, .00 PSF WIND, INITIAL

H TENS (LBS)	2343.	2171.	2000.	1831.	1666.	1506.	1353.	1209.	1077.	959.	857.
TEMP °F	0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
SAG SPAN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN
182.0	0- 7	0- 7	0- 8	0- 9	0-10	0-11	1- 0	1- 1	1- 3	1- 4	1- 6

STRINGING SAG TABLE USING INITIAL SAG RULING SPAN: 700.0 FEET

OPGW CATALOG #: GW1200 57 MM2/ 465

NESC HEAVY LOAD ZONE MAX TENSION = 5209 LB

DESIGN: 10.41 FT SAG @ 60. DEG F, .00 IN ICE, .00 PSF WIND, FINAL

H TENS (LBS)	2746.	2623.	2505.	2392.	2285.	2184.	2089.	2000.	1916.	1839.	1766.
TEMP °F	0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
SAG SPAN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN
450.0	2-10	3- 0	3- 1	3- 3	3- 5	3- 7	3- 9	3-11	4- 1	4- 3	4- 5
475.0	3- 2	3- 4	3- 6	3- 8	3-10	4- 0	4- 2	4- 4	4- 6	4- 8	4-11
500.0	3- 6	3- 8	3-10	4- 0	4- 2	4- 5	4- 7	4-10	5- 0	5- 3	5- 5
525.0	3-10	4- 0	4- 3	4- 5	4- 8	4-10	5- 1	5- 3	5- 6	5- 9	6- 0
550.0	4- 3	4- 5	4- 8	4-10	5- 1	5- 4	5- 7	5- 9	6- 0	6- 4	6- 7
575.0	4- 7	4-10	5- 1	5- 4	5- 6	5-10	6- 1	6- 4	6- 7	6-11	7- 2
600.0	5- 0	5- 3	5- 6	5- 9	6- 0	6- 4	6- 7	6-11	7- 2	7- 6	7- 9
625.0	5- 5	5- 8	6- 0	6- 3	6- 6	6-10	7- 2	7- 6	7- 9	8- 1	8- 5
650.0	5-11	6- 2	6- 5	6- 9	7- 1	7- 5	7- 9	8- 1	8- 5	8- 9	9- 2
675.0	6- 4	6- 8	6-11	7- 3	7- 7	8- 0	8- 4	8- 8	9- 1	9- 6	9-10
700.0	6-10	7- 2	7- 6	7-10	8- 2	8- 7	8-11	9- 4	9- 9	10- 2	10- 7
725.0	7- 4	7- 8	8- 0	8- 5	8- 9	9- 2	9- 7	10- 0	10- 6	10-11	11- 4
750.0	7-10	8- 2	8- 7	9- 0	9- 5	9-10	10- 3	10- 9	11- 2	11- 8	12- 2
775.0	8- 4	8- 9	9- 2	9- 7	10- 0	10- 6	11- 0	11- 5	11-11	12- 6	13- 0
800.0	8-11	9- 4	9- 9	10- 3	10- 8	11- 2	11- 8	12- 2	12- 9	13- 3	13-10
825.0	9- 6	9-11	10- 4	10-10	11- 4	11-11	12- 5	13- 0	13- 7	14- 1	14- 8
850.0	10- 0	10- 6	11- 0	11- 6	12- 1	12- 7	13- 2	13- 9	14- 4	15- 0	15- 7
875.0	10- 8	11- 2	11- 8	12- 2	12- 9	13- 4	14- 0	14- 7	15- 3	15-10	16- 6
900.0	11- 3	11- 9	12- 4	12-11	13- 6	14- 2	14- 9	15- 5	16- 1	16- 9	17- 6
925.0	11-11	12- 5	13- 0	13- 8	14- 3	14-11	15- 7	16- 4	17- 0	17- 9	18- 6
950.0	12- 6	13- 1	13- 9	14- 5	15- 1	15- 9	16- 6	17- 2	17-11	18- 8	19- 6

STRINGING SAG TABLE USING INITIAL SAG RULING SPAN: 800.0 FEET

OPGW CATALOG #: GW1200 57 MM2/ 465

NESC HEAVY LOAD ZONE MAX TENSION = 5394 LB

DESIGN: 13.75 FT SAG @ 60. DEG F, .00 IN ICE, .00 PSF WIND, FINAL

H TENS (LBS)	2556.	2452.	2353.	2260.	2172.	2090.	2012.	1940.	1872.	1808.	1749.
TEMP °F	0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
SAG SPAN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN
550.0	4- 6	4- 9	4-11	5- 2	5- 4	5- 7	5- 9	6- 0	6- 2	6- 5	6- 7
575.0	4-11	5- 2	5- 5	5- 7	5-10	6- 1	6- 3	6- 6	6- 9	7- 0	7- 3
600.0	5- 5	5- 7	5-10	6- 1	6- 4	6- 7	6-10	7- 1	7- 4	7- 7	7-10
625.0	5-10	6- 1	6- 4	6- 7	6-11	7- 2	7- 5	7- 8	8- 0	8- 3	8- 6
650.0	6- 4	6- 7	6-10	7- 2	7- 5	7- 9	8- 0	8- 4	8- 7	8-11	9- 3
675.0	6-10	7- 1	7- 5	7- 8	8- 0	8- 4	8- 8	9- 0	9- 4	9- 7	9-11
700.0	7- 4	7- 8	7-11	8- 3	8- 7	8-11	9- 4	9- 8	10- 0	10- 4	10- 8
725.0	7-10	8- 2	8- 6	8-11	9- 3	9- 7	10- 0	10- 4	10- 9	11- 1	11- 6
750.0	8- 5	8- 9	9- 2	9- 6	9-11	10- 3	10- 8	11- 1	11- 6	11-10	12- 3
775.0	9- 0	9- 4	9- 9	10- 2	10- 7	11- 0	11- 5	11-10	12- 3	12- 8	13- 1
800.0	9- 7	10- 0	10- 5	10-10	11- 3	11- 8	12- 2	12- 7	13- 0	13- 6	13-11
825.0	10- 2	10- 7	11- 0	11- 6	11-11	12- 5	12-11	13- 5	13-10	14- 4	14-10
850.0	10- 9	11- 3	11- 9	12- 2	12- 8	13- 2	13- 8	14- 2	14- 9	15- 3	15- 9
875.0	11- 5	11-11	12- 5	12-11	13- 5	14- 0	14- 6	15- 1	15- 7	16- 2	16- 8
900.0	12- 1	12- 7	13- 2	13- 8	14- 3	14- 9	15- 4	15-11	16- 6	17- 1	17- 8
925.0	12- 9	13- 4	13-10	14- 5	15- 0	15- 7	16- 2	16-10	17- 5	18- 0	18- 8
950.0	13- 6	14- 0	14- 7	15- 3	15-10	16- 6	17- 1	17- 9	18- 4	19- 0	19- 8
975.0	14- 2	14- 9	15- 5	16- 0	16- 8	17- 4	18- 0	18- 8	19- 4	20- 0	20- 9
1000.0	14-11	15- 7	16- 2	16-10	17- 7	18- 3	18-11	19- 8	20- 4	21- 1	21- 9

STRINGING SAG TABLE USING INITIAL SAG RULING SPAN: 200.0 FEET (SLACK)

CONDUCTOR NOMINAL DIAMETER 3/ 8X 7 STRAND STEELEHS

NESC HEAVY LOAD ZONE MAX TENSION = 1178 LB

DESIGN: 5.11 FT SAG @ 60. DEG F, .00 IN ICE, .00 PSF WIND, FINAL

H TENS (LBS)	311.	304.	298.	292.	286.	280.	275.	270.	265.	261.	257.
TEMP °F	0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
SAG SPAN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN
180.0	3- 7	3- 8	3- 9	3-10	3-11	4- 0	4- 1	4- 2	4- 3	4- 3	4- 4
207.0	4- 9	4-10	4-11	5- 1	5- 2	5- 3	5- 4	5- 6	5- 7	5- 8	5- 9

STRINGING SAG TABLE USING INITIAL SAG RULING SPAN: 700.0 FEET

CONDUCTOR NOMINAL DIAMETER 3/ 8X 7 STRAND STEELEHS

NESC HEAVY LOAD ZONE MAX TENSION = 4415 LB

DESIGN: 10.20 FT SAG @ 60. DEG F, .00 IN ICE, .00 PSF WIND, FINAL

H TENS (LBS)	2118.	2046.	1977.	1911.	1848.	1788.	1731.	1677.	1625.	1576.	1530.
TEMP °F	0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
SAG SPAN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN
450.0	3- 4	3- 5	3- 6	3- 8	3- 9	3-11	4- 0	4- 2	4- 4	4- 5	4- 7
475.0	3- 8	3-10	3-11	4- 1	4- 2	4- 4	4- 6	4- 8	4- 9	4-11	5- 1
500.0	4- 1	4- 3	4- 4	4- 6	4- 8	4-10	5- 0	5- 2	5- 3	5- 5	5- 7
525.0	4- 6	4- 8	4-10	5- 0	5- 2	5- 4	5- 6	5- 8	5-10	6- 0	6- 2
550.0	4-11	5- 1	5- 3	5- 5	5- 8	5-10	6- 0	6- 2	6- 5	6- 7	6- 9
575.0	5- 4	5- 7	5- 9	5-11	6- 2	6- 4	6- 7	6- 9	7- 0	7- 2	7- 5
600.0	5-10	6- 1	6- 3	6- 6	6- 8	6-11	7- 2	7- 4	7- 7	7-10	8- 1
625.0	6- 4	6- 7	6- 9	7- 0	7- 3	7- 6	7- 9	8- 0	8- 3	8- 6	8- 9
650.0	6-10	7- 1	7- 4	7- 7	7-10	8- 1	8- 4	8- 8	8-11	9- 2	9- 6
675.0	7- 5	7- 8	7-11	8- 2	8- 5	8- 9	9- 0	9- 4	9- 7	9-11	10- 2
700.0	7-11	8- 3	8- 6	8-10	9- 1	9- 5	9- 8	10- 0	10- 4	10- 8	11- 0
725.0	8- 6	8-10	9- 1	9- 5	9- 9	10- 1	10- 5	10- 9	11- 1	11- 5	11- 9
750.0	9- 1	9- 5	9- 9	10- 1	10- 5	10- 9	11- 2	11- 6	11-10	12- 3	12- 7
775.0	9- 9	10- 1	10- 5	10- 9	11- 2	11- 6	11-11	12- 3	12- 8	13- 1	13- 5
800.0	10- 4	10- 9	11- 1	11- 6	11-10	12- 3	12- 8	13- 1	13- 6	13-11	14- 4
825.0	11- 0	11- 5	11- 9	12- 2	12- 7	13- 0	13- 6	13-11	14- 4	14- 9	15- 3
850.0	11- 8	12- 1	12- 6	12-11	13- 5	13-10	14- 3	14- 9	15- 3	15- 8	16- 2
875.0	12- 5	12-10	13- 3	13- 9	14- 2	14- 8	15- 2	15- 8	16- 1	16- 7	17- 2
900.0	13- 1	13- 7	14- 0	14- 6	15- 0	15- 6	16- 0	16- 6	17- 1	17- 7	18- 1
925.0	13-10	14- 4	14-10	15- 4	15-10	16- 5	16-11	17- 6	18- 0	18- 7	19- 2
950.0	14- 7	15- 1	15- 7	16- 2	16- 9	17- 3	17-10	18- 5	19- 0	19- 7	20- 2

STRINGING SAG TABLE USING INITIAL SAG RULING SPAN: 800.0 FEET

CONDUCTOR NOMINAL DIAMETER 3/ 8X 7 STRAND STEELEHS

NESC HEAVY LOAD ZONE MAX TENSION = 4531 LB

DESIGN: 14.20 FT SAG @ 60. DEG F, .00 IN ICE, .00 PSF WIND, FINAL

H TENS (LBS)	1911.	1856.	1803.	1752.	1704.	1658.	1615.	1574.	1534.	1497.	1461.
TEMP °F	0.	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.
SAG SPAN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN	FT-IN
550.0	5- 5	5- 7	5- 9	5-11	6- 1	6- 3	6- 5	6- 7	6- 9	6-11	7- 1
575.0	5-11	6- 1	6- 4	6- 6	6- 8	6-10	7- 0	7- 3	7- 5	7- 7	7- 9
600.0	6- 6	6- 8	6-10	7- 1	7- 3	7- 5	7- 8	7-10	8- 1	8- 3	8- 5
625.0	7- 0	7- 3	7- 5	7- 8	7-10	8- 1	8- 4	8- 6	8- 9	8-11	9- 2
650.0	7- 7	7-10	8- 0	8- 3	8- 6	8- 9	9- 0	9- 2	9- 5	9- 8	9-11
675.0	8- 2	8- 5	8- 8	8-11	9- 2	9- 5	9- 8	9-11	10- 2	10- 5	10- 8
700.0	8-10	9- 1	9- 4	9- 7	9-10	10- 2	10- 5	10- 8	10-11	11- 3	11- 6
725.0	9- 5	9- 9	10- 0	10- 3	10- 7	10-10	11- 2	11- 5	11- 9	12- 0	12- 4
750.0	10- 1	10- 5	10- 8	11- 0	11- 4	11- 7	11-11	12- 3	12- 7	12-10	13- 2
775.0	10- 9	11- 1	11- 5	11- 9	12- 1	12- 5	12- 9	13- 1	13- 5	13- 9	14- 1
800.0	11- 6	11-10	12- 2	12- 6	12-10	13- 3	13- 7	13-11	14- 3	14- 8	15- 0
825.0	12- 2	12- 7	13- 0	13- 4	13- 8	14- 1	14- 5	14-10	15- 2	15- 7	15-11
850.0	12-11	13- 4	13- 9	14- 1	14- 6	14-11	15- 4	15- 9	16- 1	16- 6	16-11
875.0	13- 9	14- 2	14- 6	14-11	15- 5	15-10	16- 3	16- 8	17- 1	17- 6	17-11
900.0	14- 6	14-11	15- 5	15-10	16- 3	16- 9	17- 2	17- 7	18- 1	18- 6	19- 0
925.0	15- 4	15- 9	16- 3	16- 9	17- 2	17- 8	18- 2	18- 7	19- 1	19- 7	20- 0
950.0	16- 2	16- 8	17- 2	17- 8	18- 1	18- 7	19- 1	19- 7	20- 2	20- 8	21- 2
975.0	17- 0	17- 6	18- 1	18- 7	19- 1	19- 7	20- 2	20- 8	21- 2	21- 9	22- 3
1000.0	17-11	18- 5	19- 0	19- 6	20- 1	20- 8	21- 2	21- 9	22- 4	22-10	23- 5

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
3	4-17-08	AS-BUILT
2	4-16-07	RE-ISSUED FOR CONSTRUCTION
1	4-30-07	RE-ISSUED FOR CONSTRUCTION
0	4-20-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	BILL BARNHART
PROJECT NUMBER	48069

MORTENSON

acciona

TATANKA WIND ENERGY
NORTH DAKOTA

TATANKA WIND FARM
230 KV TRANSMISSION LINE
SAG TABLES

0 1" 2"

FILENAME	ST-01.dwg
SCALE	NONE

SHEET ST-01

230 KV CONDUCTOR: 795 T/2 ACSR "IBIS-T/2"

SHIELD WIRE 3/8" EHS/OPGW

Tatanka Wind Farm
Acciona to Foot
230 kV Transmission Line

DRAWING NUMBER
REVISION NUMBER 3
REVISION DESCRIPTION AS-BUILT
ENGINEER: HDR, BY GARY MCWHORTER

STRUCTURE DATA					TRANSMISSION ASSEMBLIES																					
STRUC. NO.	STATION NUMBER	HORIZ. ANGLE	BACK SPAN	POLE H & C	POLE TOP ASSEMBLY	GROUND		GUYS		ANCHORS		MISC. ASSM.		POLE TOP TIE ASSEMBLY												REMARKS
						QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT		QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT				

GENERAL INSTRUCTIONS

Transmission Conductor: 795 T/2 IBIS (26/7) ACSR
Shield Wire; 3/8" EHS
Fiber Optic Ground wire: 12 fiber - 3/8 EHS Equivalent

Ruling Spans: 200', 700' & 800'

Guy Wire is 3/8" EHS.

All X-Braces to be installed 12' below crossarms. Bisector guys on TH-231 and TH-234 lower guy lead to be installed 1' above top X-Brace bolt. Conductor level TH-234 guys to be split lead guys.

Fiber Optic Splice cans to be installed minimum of seventeen feet (17') above ground. All Fiber Dead Ends and splices to have two hundred-fifty feet (250') of wire coiled and hung a minimum of twenty feet (20') above ground.

SS-02

230 KV CONDUCTOR: 795 T/2 ACSR "IBIS-T/2"

SHIELD WIRE 3/8" EHS/OPGW

Tatanka Wind Farm
Acciona to Foot
230 kV Transmission Line

DRAWING NUMBER
REVISION NUMBER 3
REVISION DESCRIPTION AS-BUILT
ENGINEER: HDR, BY GARY MCWHORTER

STRUCTURE DATA					TRANSMISSION ASSEMBLIES																			
STRUC. NO.	STATION NUMBER	HORIZ. ANGLE	BACK SPAN	POLE H & C	POLE TOP ASSEMBLY	GROUND		GUYS		ANCHORS		MISC. ASSM.		POLE TOP TIE ASSEMBLY										REMARKS	
						QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT		QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT		
1	0+00			STEEL DE	Sub Dead End																		Slack span from sub de tower	*Ruling Span 200' slack*
2	1+88		188	3-70/H1	TH-235D	3	TM-9A	10	TG-11B	10	TA-3H	10 4	TM-GM TM-GS1-B1	TG-56C										
3	8+42	26º 20' 55" LT	655	3-75/H1	TH-234	3	TM-9A	3 1	TG-11C TG-11B	7	TA-3H	7	TM-GM	TG-56A									OFFSET POLES 5.0' RT	*Ruling Span 700'*
4	11+68	63º 21' 39" LT	305	3-80/H1	TH-235	3	TM-9A	10	TG-11B	10	TA-3H	10 4	TM-GM TM-GS1-B1	TG-56C										
5	19+16		748	2-75/2	TH-230	2	TM-9A							TM-7D										*Ruling Span 700'*
6	26+42		726	2-70/2	TH-230	2	TM-9A							TM-7D										
7	32+88		646	2-75/2	TH-230	2	TM-9A							TM-7D										
8	38+28		540	2-75/2	TH-230	2	TM-9A							TM-7D										
9	45+54	4º 58' 20" RT	726	2-85/H1	TH-231	2	TM-9A	1	TG-11C	2	TA-3H	2	TM-GM	TM-7D									OFFSET POLES 5.0' LT Spec split guys to inside angle pole	
10	53+04	39º 46' 11" RT	752	3-75/H1	TH-234	3	TM-9A	3 1	TG-11C TG-11B	7	TA-3H	7	TM-GM	TG-56A									OFFSET POLES 6.5' LT	
11	58+65		564	2-70/2	TH-230	2	TM-9A							TM-7D										
12	64+24		559	2-75/2	TH-230	2	TM-9A							TM-7D										
13	70+04	45º 00' 00" LT	582	3-75/H1	TH-234	3	TM-9A	3 1	TG-11C TG-11B	7	TA-3H	7	TM-GM	TG-56A									OFFSET POLES 6.5' RT	
14	76+79		678	2-70/2	TH-230	2	TM-9A							TM-7D										
15	84+21		742	2-80/2	TH-230	2	TM-9A							TM-7D										
16	90+76		655	2-80/2	TH-230	2	TM-9A							TM-7D										
17	97+20	44º 59' 55" LT	647	3-75/H1	TH-234	3	TM-9A	3 1	TG-11C TG-11B	7	TA-3H	7	TM-GM	TG-56A									OFFSET POLES 6.5' RT	
18	104+49		732	2-75/2	TH-230	2	TM-9A							TM-7D										
19	109+07		457	2-75/2	TH-230	2	TM-9A							TM-7D										
20	113+89	40º 15' 44" RT	483	3-75/H1	TH-234	3	TM-9A	3 1	TG-11C TG-11B	7	TA-3H	7	TM-GM	TG-56A										
21	121+39	4º 55' 48" RT	749	2-85/H1	TH-231	2	TM-9A	1	TG-11C	2	TA-3H	2	TM-GM	TM-7D									OFFSET POLES 10' RT Spec split guys to inside angle pole	
22	128+25		686	2-95/1	TH-230	2	TM-9A							TM-7D										
23	136+82		857	2-80/2	TH-230	2	TM-9A							TM-7D										

230 KV CONDUCTOR: 795 T/2 ACSR "IBIS-T/2"

SHIELD WIRE 3/8" EHS/OPGW

Tatanka Wind Farm
Acciona to Foot
230 kV Transmission Line

DRAWING NUMBER
REVISION NUMBER 3
REVISION DESCRIPTION AS-BUILT
ENGINEER: HDR, BY GARY MCWHORTER

STRUCTURE DATA					TRANSMISSION ASSEMBLIES																			
STRUC. NO.	STATION NUMBER	HORIZ. ANGLE	BACK SPAN	POLE H & C	POLE TOP ASSEMBLY	GROUND		GUYS		ANCHORS		MISC. ASSM.		POLE TOP TIE ASSEMBLY										REMARKS	
						QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT		QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT			
24	143+15		633	2-80/2	TH-230	2	TM-9A							TM-7D											
25	149+39		625	2-70/2	TH-230	2	TM-9A							TM-7D											
26	156+74		734	2-70/2	TH-230	2	TM-9A							TM-7D										Install fiberoptic ground wire dead end and splice.	
27	163+49		675	2-85/2	TH-230	2	TM-9A							TM-7D											
28	170+36		687	2-85/2	TH-230	2	TM-9A							TM-7D											
29	174+11	3º 49' 23" RT	375	2-85/H1	TH-231	2	TM-9A	1	TG-11C	2	TA-3H	2	TM-GM	TM-7D										Spec split guys to inside angle pole	
30	181+62	3º 45' 20" LT	751	2-95/H1	TH-231	2	TM-9A	2	TG-11A	2	TA-3H	2	TM-GM	TM-7D											
31	190+55		893	2-75/2	TH-230	2	TM-9A							TM-7D											
32	197+36		681	2-85/2	TH-230	2	TM-9A							TM-7D											
33	205+01		765	2-80/2	TH-230	2	TM-9A							TM-7D											
34	212+21	3º 21' 59" LT	720	2-90/H1	TH-231	2	TM-9A	2	TG-11A	2	TA-3H	2	TM-GM	TM-7D											
35	221+66	3º 13' 58" RT	945	2-95/H1	TH-231	2	TM-9A	1	TG-11C	2	TA-3H	2	TM-GM	TM-7D										OFFSET POLES 0.58' RT Spec split guys to inside angle pole	
36	226+90		524	2-80/2	TH-230	2	TM-9A							TM-7D										OFFSET POLES 1.19' RT	
37	230+27		337	3-60/H1	TH-235D-SPEC	3	TM-9A	10	TG-11B	10	TA-3H	10 4	TM-GM TM-GS1-B1	TG-56C										Special 16' pole spacing. No static wires in crossing span Install fiber on arm below phases. Dead End static from South on middle pole OFFSET POLES 1.58' RT	*Ruling Span 700'*
38	232+09	3º 12' 37" RT	182	3-60/H1	TH-235D-SPEC	3	TM-9A	10	TG-11B	10	TA-3H	10 4	TM-GM TM-GS1-B1	TG-56C										Special 16' pole spacing. No static wires in crossing span Install fiber on arm below phases. Dead End static from North on middle pole. OFFSET POLES 1.8' RT	*Ruling Span 182' reduced*
39	235+68		359	105' H6 Steel	SBP-230																			Install both statics on Hughes static arms	*Ruling Span 800'*
40	239+67	3º 05' 40" LT	399	105' H6 Steel	SBP-230																			Install both statics on Hughes static arms	
41	242+80		313	110' H3 Steel	SBP-230																			Install both statics on Hughes static arms	

230 KV CONDUCTOR: 795 T/2 ACSR "IBIS-T/2"

SHIELD WIRE 3/8" EHS/OPGW

Tatanka Wind Farm
Acciona to Foot
230 kV Transmission Line

DRAWING NUMBER
REVISION NUMBER 3
REVISION DESCRIPTION AS-BUILT
ENGINEER: HDR, BY GARY MCWHORTER

STRUCTURE DATA					TRANSMISSION ASSEMBLIES																	
STRUC. NO.	STATION NUMBER	HORIZ. ANGLE	BACK SPAN	POLE H & C	POLE TOP ASSEMBLY	GROUND		GUYS		ANCHORS		MISC. ASSM.		POLE TOP TIE ASSEMBLY								REMARKS
						QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT		QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT	
42	246+08		328	110' H3 Steel	SBP-230																	Install both statics on Hughes static arms
43	249+30	0º 37' 18" RT	322	110' H6 Steel	SBP-230																	Install both statics on Hughes static arms
44	254+37		507	105' H6 Steel	SBP-230																	Install both statics on Hughes static arms
45	260+92	5º 04' 46" LT	655	2-95/H1	TH-231	2	TM-9A	2	TG-11A	2	TA-3H	2	TM-GM	TM-7D								OFFSET POLES 3.0' LT
46	268+76	9º 12' 52" LT	784	3-85/H1	TH-234	3	TM-9A	3 1	TG-11C TG-11B	7	TA-3H	7	TM-GM	TG-56A								OFFSET POLES 5.0' RT
47	276+26	13º 03' 57" RT	751	3-90/H1	TH-234	3	TM-9A	3 1	TG-11C TG-11B	7	TA-3H	7	TM-GM	TG-56A								OFFSET POLES 5.0' LT
48	280+65		439	2-90/1	TH-230	2	TM-9A							TM-7D								
49	290+73		1008	2-95/1	TH-230	2	TM-9A							TM-7D								
50	299+82		909	2-95/1	TH-230	2	TM-9A							TM-7D								
51	306+57		675	2-85/2	TH-230	2	TM-9A							TM-7D								Install fiberoptic ground wire dead end and splice.
52	314+86	16º 16' 40" RT	830	3-85/H1	TH-234	3	TM-9A	3 1	TG-11C TG-11B	7	TA-3H	7	TM-GM	TG-56A								OFFSET POLES 5.0' LT
53	322+42	15º 45' 22" LT	758	3-85/H1	TH-234	3	TM-9A	3 1	TG-11C TG-11B	7	TA-3H	7	TM-GM	TG-56A								OFFSET POLES 5.0' RT
54	329+89		747	2-80/2	TH-230	2	TM-9A							TM-7D								
55	338+23		835	2-95/1	TH-230	2	TM-9A							TM-7D								OFFSET POLES 1.07' LT
56	343+89		566	2-95/1	TH-230	2	TM-9A							TM-7D								OFFSET POLES 1.13' LT
57	352+40		850	2-85/2	TH-230	2	TM-9A							TM-7D								OFFSET POLES 0.7' LT
58	358+97		657	2-70/2	TH-230	2	TM-9A							TM-7D								
59	365+17	9º 16' 02" LT	620	3-85/1	TH-232A	3	TM-9A	2	TG-11A	2	TA-3H	2	TM-GM	TG-56A								OFFSET POLES 8.0' RT
60	372+47	9º 17' 02" RT	730	3-90/1	TH-232A	3	TM-9A	2	TG-11A	2	TA-3H	2	TM-GM	TG-56A								OFFSET POLES 7.75' LT
61	379+95		749	2-70/2	TH-230	2	TM-9A							TM-7D								
62	384+84		489	2-85/2	TH-230	2	TM-9A							TM-7D								

Ruling Span 800'

230 KV CONDUCTOR: 795 T/2 ACSR "IBIS-T/2"

SHIELD WIRE 3/8" EHS/OPGW

Tatanka Wind Farm
Acciona to Foot
230 kV Transmission Line

DRAWING NUMBER
REVISION NUMBER 3
REVISION DESCRIPTION AS-BUILT
ENGINEER: HDR, BY GARY MCWHORTER

STRUCTURE DATA					TRANSMISSION ASSEMBLIES																			
STRUC. NO.	STATION NUMBER	HORIZ. ANGLE	BACK SPAN	POLE H & C	POLE TOP ASSEMBLY	GROUND		GUYS		ANCHORS		MISC. ASSM.		POLE TOP TIE ASSEMBLY										REMARKS	
						QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT		QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT		
63	391+29	8º 53' 07" RT	645	3-85/1	TH-232	3	TM-9A	2	TG-11A	2	TA-3H	2	TM-GM	TG-56A									OFFSET POLES 7.75' LT	
64	398+77	8º 56' 32" LT	750	3-80/1	TH-232	3	TM-9A	2	TG-11A	2	TA-3H	2	TM-GM	TG-56A									OFFSET POLES 7.75' RT	
65	407+36		859	2-80/2	TH-230	2	TM-9A							TM-7D										
66	414+43		708	2-80/2	TH-230	2	TM-9A							TM-7D									OFFSET POLES 1.22' RT	
67	422+14		770	2-85/2	TH-230	2	TM-9A							TM-7D									OFFSET POLES 1.87' RT	
68	429+85		771	2-85/2	TH-230	2	TM-9A							TM-7D									OFFSET POLES 2.52' RT	
69	438+05		821	2-85/2	TH-230	2	TM-9A							TM-7D									OFFSET POLES 3.21' RT	
70	447+05		899	2-95/1	TH-230	2	TM-9A							TM-7D									OFFSET POLES 3.81' RT	
71	454+49		744	2-80/2	TH-230	2	TM-9A							TM-7D									OFFSET POLES 2.64' RT	
72	462+70		821	2-80/2	TH-230	2	TM-9A							TM-7D									Install fiberoptic ground wire dead end and splice. OFFSET POLES 1.37' RT	*Ruling Span 800'*
73	468+78		608	2-80/2	TH-230	2	TM-9A							TM-7D										
74	476+88		809	2-85/2	TH-230	2	TM-9A							TM-7D									OFFSET POLES 0.79' LT	
75	482+63		576	2-75/2	TH-230	2	TM-9A							TM-7D									OFFSET POLES 1.17' LT	
76	491+15		851	2-85/2	TH-230	2	TM-9A							TM-7D									OFFSET POLES 3.03' LT	
77	499+32		818	2-80/2	TH-230	2	TM-9A							TM-7D									OFFSET POLES 4.22' LT	
78	505+41		609	2-75/2	TH-230	2	TM-9A							TM-7D									OFFSET POLES 3.36' LT	
79	513+77		836	2-90/1	TH-230	2	TM-9A							TM-7D									OFFSET POLES 2.18' LT	
80	522+46		869	2-85/2	TH-230	2	TM-9A							TM-7D									OFFSET POLES 0.96' LT	
81	530+40	5º 47' 48" RT	794	2-85/H1	TH-231	2	TM-9A	2	TG-11A	2	TA-3H	2	TM-GM	TM-7D										
82	537+95	84º 27' 44" RT	755	3-85/H1	TH-235	3	TM-9A	10	TG-11B	10	TA-3H	10 4	TM-GM TM-GS1-B1	TG-56C										
83	545+15	5º 59' 09" RT	720	2-95/H2	TH-231	2	TM-9A	2	TG-11C	2	TA-3H	4	TM-GM	TM-7D									OFFSET POLES 5' RT Spec split guys to inside angle pole	*Ruling Span 800'*
84	554+67		951	2-90/1	TH-230	2	TM-9A							TM-7D										
85	564+29		963	2-85/2	TH-230	2	TM-9A							TM-7D										
86	570+83		653	2-70/2	TH-230	2	TM-9A							TM-7D										
87	578+75		792	2-90/1	TH-230	2	TM-9A							TM-7D										
88	587+31		856	2-90/1	TH-230	2	TM-9A							TM-7D										

Tatanka Wind Farm
Acciona to Foot
230 kV Transmission Line

230 KV CONDUCTOR: 795 T/2 ACSR "IBIS-T/2"
SHIELD WIRE 3/8" EHS/OPGW

DRAWING NUMBER
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ENGINEER: HDR, BY GARY MCWHORTER

STRUCTURE DATA					TRANSMISSION ASSEMBLIES																		
STRUC. NO.	STATION NUMBER	HORIZ. ANGLE	BACK SPAN	POLE H & C	POLE TOP ASSEMBLY	GROUND		GUYS		ANCHORS		MISC. ASSM.		POLE TOP TIE ASSEMBLY								REMARKS	
						QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT		QTY	UNIT	QTY	UNIT	QTY	UNIT	QTY	UNIT	
89	595+27		796	2-75/2	TH-230	2	TM-9A							TM-7D									*Ruling Span 800'*
90	601+21	89º 48' 40" LT	594	3-80/H1	TH-235	3	TM-9A	10	TG-11B	10	TA-3H	10 4	TM-GM TM-GS1-B1	TG-56C								Install fiberoptic ground wire dead end and splice.	
91	607+63		642	2-75/2	TH-230	2	TM-9A							TM-7D									
92	614+62		699	2-85/2	TH-230	2	TM-9A							TM-7D									
93	622+49		787	2-80/2	TH-230	2	TM-9A							TM-7D									
94	630+46		797	2-80/2	TH-230	2	TM-9A							TM-7D									
95	639+31		885	2-90/1	TH-230	2	TM-9A							TM-7D									
96	644+31		500	2-80/2	TH-230	2	TM-9A							TM-7D									
97	652+52		821	2-90/1	TH-230	2	TM-9A							TM-7D									
98	662+69		1016	2-85/2	TH-230	2	TM-9A							TM-7D									
99	670+41		772	2-85/2	TH-230	2	TM-9A							TM-7D									
100	679+84		943	2-85/2	TH-230	2	TM-9A							TM-7D									
101	686+17		633	3-70/H1	TH-235D	3	TM-9A	10	TG-11B	10	TA-3H	10 4	TM-GM TM-GS1-B1	TG-56C								Slack span from sub de tower	*Ruling Span 200'-slack*
102	688+24		207	STEEL DE	Sub Dead End																		

April 8, 2014

Mr. Wayne Dilling
Electrical Executive
M.A. Mortenson Company
700 Meadow Lane North
Minneapolis, MN 55422

RE: Tatanka Wind Power 230kV Transmission Line Facilities
National Electric Safety Code

Dear Mr. Dilling:

In accordance with professional engineering standard of care, HDR performed the engineering and design for the Tatanka Wind Power 230kV substations and transmission line in accordance with the 2002 National Electric Safety Code (NESC) that was in effect during the engineering and design phase of the project. The design was also in accordance with the 2007 version of the NESC that was published toward the end of the engineering and design phase.

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Sincerely,

William Barnhart II
Senior Vice President

HDR Engineering, Inc.
2913 Millennium Circle
Billings, MT 59102-7444
Phone: (406) 656-8100
Fax: (406) 652-2758
www.hdrinc.com

CONSTRUCTION SPECIFICATIONS

FOR

TATANKA WIND FARM
230 KV TRANSMISSION LINE

M.A. MORTENSON CO.
MINNEAPOLIS, MN

CONSTRUCTION SPECIFICATIONS

FOR

TATANKA WIND FARM
230 KV TRANSMISSION LINE

M.A., MORTENSON CO.
MINNEAPOLIS, MN.

PREPARED BY:

HDR ENGINEERS, INC.
PROFESSIONAL CONSULTING ENGINEERS
2913 MILLENNIUM CIRCLE
BILLINGS, MT, 59102

MAY, 2007

M.A. MORTENSON CO.
TATANKA WIND FARM 230 KV TRANSMISSION LINE

CONSTRUCTION SPECIFICATIONS

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Appendices

Appendix A - Southwire T2 (VR) Conductor installation guide

Appendix B - Inspection Reports

Appendix C – Structure Numbering

1-1 LANDOWNER RELATIONS

A. Contractor Agent

The Contractor shall develop and maintain, for the duration of this contract, a landowner relations program that will effectively incorporate and implement all provisions of this contract. The contractor shall appoint an employee who is qualified and authorized to supervise and enforce compliance with the maintenance and restoration of right-of-way provisions.

The Contractor's agent for landowner relations will inspect the right-of-way on a daily basis to assure that any damage is repaired the day it occurs. He will have in his possession fence posts, barbed wire, and a fence repair kit. The agent will be required to have a telephone and that telephone will be monitored during the noon hour each workday.

The Contractor's landowner relations agent will be present at the preconstruction conference. At that time he will be given a list of the landowners, with telephone numbers and addresses. The Contractor must contact each landowner prior to any construction or access to his property.

B. Access

1) The right-of-way for this project will be one hundred fifty feet (150), seventy-five (75) feet on either side of the transmission line centerline. Any damage resulting from normal construction activity will be the responsibility of M.A. Mortenson, as long as it occurs within this area during normal construction activity. Any damage occurring in this area due to operations carried out during adverse conditions will be the responsibility of the Contractor. Any crop damage, terrain damage, ruts or any other damage occurring outside the right-of-way will be the responsibility of the Contractor.

The activities of the Contractor are to be restricted to along the right-of-way. Access roads acceptable to the landowner will be discussed at the preconstruction conference.

Where additional access to the right-of-way across private property is desired, the owner and tenant or occupant shall be contacted to obtain permission for ingress and egress to the right-of-way. The Contractor shall make such arrangements, including obtaining releases for damage.

2) Where fences must be cut to allow access for the work, gates shall be installed as shown on the drawings, or as directed by M.A. Mortenson. The Contractor shall furnish all material and labor, per bid unit,

required for such installation. Existing fences are to be repaired to a condition that is better than that condition existing when the fence was opened or damaged. Types and details of gate construction shall be shown on the drawings or approved by M.A. Mortenson. Brace posts shall be installed at each fence cut to insure that adjacent fence spans will not become slack.

All Contractor-installed gates shall be kept closed and locked at all times. Leave all existing gates as you found them.

Gate units may include removal of the gate after construction of the line is complete. In such cases, the Contractor shall remove the gate and restore the fence. The Contractor shall furnish all labor and material required. If removal is required, gate material shall be disposed of in a manner acceptable to M.A. Mortenson.

3) The landowner will have authority to forbid access if, in his opinion, weather conditions are adverse to line construction activities. Do not travel on ranch roads or trails when they are so muddy that damage would result.

Do not litter.

Do not disturb domestic animals.

Conduct yourself as you would expect the landowner to conduct himself if he was your guest!

4) The Contractor's landowner relations agent shall contact each landowner prior to the commencement of construction activities on his land. Access and special problems will be discussed. M.A. Mortenson or the inspector will be notified of each landowner contact.

C. Restoration

1) The Contractor shall have a continuous cleanup program throughout construction. The Contractor shall restore the land that is crossed to its original condition. This restoration includes the removal of deep ruts and the disposal of foreign objects such as: stumps, chunks of concrete, pile cut-offs, etc. It also includes smoothing and reseeding damaged vegetation areas with vegetation similar to the original, cleaning out gullies and restoring terraces.

1-2 CLEARING

A. General Requirements

1) In preparing the right-of-way for construction, every precaution shall be taken to protect the environment. Only such vegetation shall be removed as is necessary to permit construction, operation, and maintenance of the transmission line. Care shall be taken to prevent denuding of ground cover and erosion of the soil.

2) Clearing units specified may cover full-width right-of-way clearing, selective clearing, tree-topping, spraying of herbicides, or other forms of right-of-way preparation. Only those areas shown on the drawings or specified by M.A. Mortenson shall be cleared in accordance with the applicable clearing units. M.A. Mortenson will mark isolated “danger” trees in the field.

B. Clearing Methods and Equipment

1) Unless otherwise specified, all timber to be cleared shall be felled and limbed. Brush shall be removed in a manner so as to reduce the overall impact on the root structure of the ground cover. If required, stumps shall be removed or treated with an acceptable herbicide.

2) Equipment shall be in good repair and appropriate for the types of clearing specified.

3) Chemical sprays or herbicides shall only be used with the approval of M.A. Mortenson, and only in areas so designated for their use. Herbicides shall be applied in accordance with the manufactures' recommendations. The chemical sprays and herbicides shall meet the environmental requirements of the governing agency. Spraying shall be performed in such manner, at such pressure, and under such wind conditions that drift of spray material to adjacent vegetation will be avoided.

1-3 STEEL POLE INSTALLATION

A. General

This section covers the installation of steel poles, arms and grounding complete and ready for conductor, OHSW/OPGW and associated support

hardware.

B. Materials and Staking

1) Steel poles and arms are galvanized steel and have been purchased to the Owner's specifications.

2) Weights and section lengths shown on the Assembly Drawings are estimates only. Actual weights and section lengths are to be determined by the pole manufacturer. Bid unit prices are to remain firm regardless of actual weights and section lengths furnished.

3) Pole locations and guy intersections with grade will be staked by the Contractor. Contractor shall protect all stakes during construction and any stakes which are disturbed during construction shall be re-staked by the Contractor at the Contractor's expense.

C. Installation

1) Direct embedded poles shall be set as follows:

a. Setting depths shall be as shown on Erection Drawings.

b. Pole holes shall be not less than 8 inches larger than the butt diameter of the pole and shall be at least as large at the bottom as at the top.

i. Backfill of each hole shall be pneumatically tamped and two tampers shall be used with each shoveler. Commencing at the bottom of the hole, both tampers shall be operated continuously. Above ground level, the backfill shall be extended to form a cone of earth one foot high with a 2 to 1 slope.

ii. All holes shall be dewatered and backfilled with native soil and all pole holes in rock shall be inspected by M.A. Mortenson before being backfilled. No organic substance shall be permitted in the backfill area. Care must be exercised to prevent damage to the pole and pole ground. All backfill material shall contain sufficient moisture (not to exceed 8%) to achieve maximum compaction density.

iii. The bottom of the pole hole shall be leveled and tamped undisturbed earth. Holes that are mistakenly over-excavated shall be backfilled with compacted rock backfill to the specified grade at no expense to the Owner.

iv. Excess excavated material shall be spread uniformly over the structure site and made ready for reseeding.

v. If the adequacy of the native soil materials is questionable, the Owner shall be notified prior to setting of poles so that special rock backfill if needed can be specified.

c) Setting tolerances shall be as follows:

i. Poles shall be set within 3" of specified centerline.

ii. Arm ends shall be within 2" of square to the line or bisector of line angle if any.

iii. Setting depth shall be within 3" of specified.

iv. Poles not to be raked shall be installed plumb. A pole is considered plumb if a plumb line from the center of the pole top falls within 3 inches of pole center at ground line.

2) Poles shall be assembled and erected strictly according to the manufacturer's instructions.

3) All joints in steel poles are either slip joints or bolted flange type. Jacking lugs are provided at all slip joints connections. Permanent marks are provided on all pole sections so that proper overlap can be determined. Hydraulic jacking devices or ratchet chain hoists may be used for pulling the sections together. Force shall be applied to both sides of the joint simultaneously. Care shall be taken to align all sections of the pole properly so that suspension poles will be plumb when erected. Any damage to the slip joints caused by improper alignment shall be repaired at the Contractor's expense. Angle and deadend poles may be cambered and shall be set so that the poles will stand plumb under an initial load at 60 degrees F, no wind conditions.

4) When erecting field assembled poles, the Contractor shall tie the sections together at the joints to prevent slipping during erection. The jacking nuts or lugs may be used for attaching this. Any such ties shall be removed after the poles structure is erected.

5) Care shall be taken in handling the poles to keep the damage to the pole surface to a minimum. After the poles have been erected, the Contractor shall repair any areas of surface damage as directed by Owner.

6) The arms shall be assembled and installed in accordance with the Erection Drawings.

7) Self-locking nuts shall be installed according to manufacturer's directions. Type MF locknuts, if used, shall be thoroughly tightened so that the concave surface deforms to match the face of the regular nut.

8) Grounding

   a) The grounding lead installed in the concrete foundation for base plated poles shall be attached to the grounding pad according to the Assembly Drawing.

   b) Embedded poles have no additional grounding unless ground rod installation is specified by the Owner.

   c) The Contractor shall measure and make a written report of ground resistance at each pole prior to installation of overhead shield wire. This cost is included in the grounding Bid Unit or the pole Bid Unit for embedded poles.

9) Crushed rock backfill foundation

   a) Crushed rock aggregate shall conform to the specifications shown on applicable drawings.

   b) Crushed rock backfill may be installed under guyed poles where additional soil bearing strength is required, as specified by M.A. Mortenson.

   c) Pole holes where this backfill is required shall be minimum one foot deeper than the standard depth specification. The

additional depth shall be filled with the specified aggregate while being tamped as described above. Poles shall be set directly on the crushed rock such that the pole ground line is at surface level.

d) M.A. Mortenson shall inspect and provide written approval of all crushed rock backfill prior to pole placement.

1-4 WOOD POLES

A. Pole Inspection, Handling and Distribution

1) All poles shall be visually inspected prior to framing to insure that they conform to the latest revision of ANSI 05.1-2002. M.A. Mortenson should be advised immediately of any nonconformance. The framing, boring, and gaining, if required, must agree with the pole framing details for the specific structures to be erected.

2) The pole lengths and classes shall agree with the pole units specified for the structures to be erected, as tabulated in the transmission construction units and shown on the plan and profile.

3) Poles shall be handled with care so as not to damage the wood or preservative treatment. Poles shall be lifted off the pole hauler at designated structure locations. Poles shall not be rolled or dragged along the ground. Lifting slings, or smooth pole grips shall be used and shall be fabricated from a material that protects the wood from damage. **Pole tongs that penetrate the wood are not allowed.**

4) If poles are stored after delivery, they shall be carefully arranged and placed on wide blocking to prevent crushing. No pole shall come in contact with standing water or the ground. No pole will have an unsupported length greater than 20 feet. The blocking shall be provided by the Contractor and included in his unit price.

5) The Contractor shall distribute extra heavy, choice, close-grained poles to angle, deadend, and crossing structures.

6) When ungained poles and adjustable spacer fittings are specified for multi-pole structures, the Contractor shall match the poles as approved by M.A. Mortenson.

7) Swivel point cant hooks rather than single penetrating hooks shall be used.

B. Field Drilling and Treating

1) All field-drilled holes shall be thoroughly treated with preservative compound approved by M.A. Mortenson. The Contractor shall include any required field drilling and treating in the unit cost for pole top assemblies.

2) Unused holes or holes that are misdrilled shall be plugged prior to erection using treated wood dowel pins, three inches in length. When a hole is misdrilled, M.A. Mortenson shall be notified. M.A. Mortenson will reject a pole if two or more misdrilled holes occur at a connection. If M.A. Mortenson rejects a pole due to misdrilling of holes, the Contractor shall replace the damaged pole at no additional cost to M.A. Mortenson.

3) Adjustable spacer fittings are indicated in the list of materials on the transmission line structure drawings. Adjustable spacers shall be used in all cases.

4) Poles shall be supplied with flat or 15 degree sloping roofs. Tops of poles shall not be cut except with the expressed approval of M.A. Mortenson. If cutting is deemed necessary, the pole top shall be cut off at a slope of 15 degrees, thoroughly treated with preservative approved by M.A. Mortenson, and covered with a mastic type cap.

5) Under no circumstances shall the butt of any pole be cut.

6) Douglas fir transmission poles will have a maximum permitted twist of grain of 1 complete twist in any 30 feet.

C. Excavation, Setting, and Backfill

1) Unless otherwise indicated, all poles shall be embedded to a minimum depth of ten percent of the pole length plus two feet, and not to exceed three inches deeper.

Pole setting depth for multi-pole structures shall be adjusted on sloping ground so that points of wire attachment are at the same elevation. For side slopes less than or equal to 2 feet, one pole shall be set high and the other set low or an equal amount. For side slopes greater than 2 feet, poles of different length will be used and setting depths adjusted a maximum of 1 foot high and low to achieve same elevation at point of wire support. Pole setting depths in rock may be reduced up to two feet with the approval of M.A. Mortenson. Excavations, which are partially earth and rock, shall not qualify for this setting depth reduction. Rock is defined as material requiring

blasting or impact equipment for excavation.

2) Pole holes shall be a minimum of eight inches wider than the butt diameter of the pole or eight inches wider than the outside diameter between the pole bearing plates. The excavated hole shall be at least as large at the bottom as at the top.

3) Accumulating water shall be removed from the hole prior to setting the pole. Any earth added to level the bottom of the holes should be tamped before the pole is set in the hole.

4) Pole backfill material shall be compactable and suitable for providing a dense supportive soil mass, free of voids, not frozen, and shall be approved by M.A. Mortenson. Where native soil is not suitable for backfill, the Contractor shall furnish suitable granular imported material for this purpose, which shall be paid for at the unit price for granular backfill for poles. If soil conditions are too dry, water must be added to the fill dirt until compaction is acceptable to M.A. Mortenson.

5) Poles shall be set plumb before backfill is placed and, after placing the backfill, the poles shall remain plumb. If the poles are out of plumb, the backfill shall be removed and replaced. Plumbing of poles by pulling the structures shall not be permitted. All deadend pole structures are to be raked transversely against the tension, six inches at the top.

6) Backfill shall be placed around the pole in layers not exceeding six inches in depth, with each layer mechanically tamped before the next layer is added. The backfill shall be compacted to a density equal to or greater than that of the surrounding undisturbed soil.

7) Each wood pole shall be backfilled from bottom to top **by one laborer shoveling fill and two others using pneumatic tampers.**

8) Native soil shall be banked up and tamped around the pole to a height of six inches above the natural grade, and shall slope away from the pole.

9) After completion of wire stringing, all poles shall be reinspected to assure that poles remain plumb and that backfill has not settled. All poles shall be adjusted as required.

At any pole location where backfill shows settlement, the backfill shall be retamped and the poles shall be readjusted. This work shall be done at no additional cost to M.A. Mortenson.

10) Setting tolerances shall be as follows:

a. Structures shall be set within 3" of specified centerline.
b. Each pole shall be within 3" of the correct location relative to the other poles at a structure.
c. Location of arms, braces and pole bands shall be within 1" of specified location shown on the drawings.
d. Setting depth of poles shall be within 3" of specified depth as adjusted for the slope.
e. Poles not to be raked shall be installed plumb. A pole is considered plumb if a plumb line from the center of the pole top falls within 3" of pole center at ground line. Pole plumbing shall not be allowed after compaction has begun.

11) Unless otherwise directed by M.A. Mortenson, surplus excavated soil shall be carefully spread and leveled on the surface of the ground near the structure and spread in a manner to minimize damage to grassed areas or other foliage.

12) The digging crew shall be no more than one location ahead of the tamping crew. Holes shall not be left uncovered.

13) If a large rock is encountered while auguring a hole, the structure may be moved in line as much as five feet, subject to M.A. Mortenson's approval.

14) The Contractor will locate all structure locations along center line. Pole stakes will be marked to indicate structure number and pole height. Suspension type line angles, tangent structures, and deadend structures will have the pole stakes located in the dig position.

1-5 POLE TOP ASSEMBLIES

A. Handling

1) The Contractor shall exercise care in the handling of all material. The Contractor shall not install any material found to be defective or damaged.

2) The Contractor shall furnish the necessary equipment to load and haul to the job site any material furnished by M.A. Mortenson. The Contractor shall bear the cost of all handling, such as loading, hauling, and unloading.

3) Do not place materials or equipment where it will be damaged by, or

cause damage to, vehicular traffic, livestock, persons, and property.

4) When bolts are furnished by M.A. Mortenson, it will be the Contractor's responsibility to determine what quantities and length will require exchange. The Contractor will pay invoice price differences.

B. Framing

1) The Contractor shall frame structures on flat or uniformly sloping terrain located at or near the structure site. Framing on rolling terrain where poles become unsupported should be avoided. If assembly on uniform terrain is not possible, the Contractor shall temporarily support the structure components to prevent racking during assembly.

2) All grid gain teeth shall be fully embedded into the surface to meet the approval of M.A. Mortenson. Grid gains shall be seated by a combination of tightening assembly bolts and hammering on wood blocking.

3) Fasteners shall be sized such that they extend not less than ½ inch or more than 2½ inches beyond the face of the last nut or locknut. Galvanized erection bolts shall not be cut off. Where bolts are not of proper length due to variations in the material, the Contractor shall replace the fasteners with ones of proper length at no cost to M.A. Mortenson.

4) Spring washers shall be installed where specified. The curved portion of the spring washer shall be installed upright to facilitate inspection of wood shrinkage in the future. Spring washers shall be flattened when the connection is made.

5) Double crossarms, when installed, shall not bow by more than plus or minus ½ inch per arm. The Contractor shall use adjustable spacer fittings. Field gaining of the pole will not be acceptable.

6) Pole bands shall be sized for the poles upon which they are to be mounted and must fit securely on the poles. Pole bands shall be securely tightened around the pole with even spacing between vangs. Where pole bands are not of proper size due to variations in the wood, the Contractor shall replace the bands where required to meet this specification. The additional cost to replace bands shall be included in the Contractor's unit costs for pole top assemblies.

7) Where cross-braces are specified, the lower holes through the pole shall be field drilled, the hole shall pass through the center of the pole, and the holes shall be thoroughly treated with preservative compound

approved by M.A. Mortenson. The heads of machine bolts shall be toward the center of the structure. Cross-brace location is specified in the structure drawings.

8) Guying attachments, where specified, shall be oriented as shown on transmission line structure drawings and as shown on the guying attachment drawings. Pole bands, if specified, shall be installed complete with through bolts, shear blocks, links, grounding clips, and all items indicated on the project drawings.

9) Tangent structures with single crossarms shall be erected with crossarms on alternating sides of the poles. On unusually long spans, the poles shall be set so that the crossarms are on the side of the pole away from the long span.

Spring washers are to be installed on all bolts with the following exceptions:

a. Crossarm eyebolts for insulator attachments.

1-6 GUYS AND ANCHORS

A. Guys and anchors shall be installed at locations shown on the drawings or specified by M.A. Mortenson.

The Contractor will locate all anchors with a stake in the anchor eye location. Stakes will be marked to indicate type of anchor.

B. Anchor rods shall be installed in line with the guy wire and installed so that not less than eight inches of rod (including eye) remains out of the ground after guy tension is applied. This does not apply to screw anchors.

C. Anchors placed in a pre-dug hole shall be approved by M.A. Mortenson before backfilling. The holes shall be backfilled and tamped in the same manner as is required for wood pole backfilling. Only suitable native soil or approved imported granular material shall be used for anchor backfill.

D. Where required by M.A. Mortenson, anchors shall be tested to 50 percent of their ultimate rated capacity. All materials and labor required for testing of the anchors shall be furnished by the Contractor and included in the unit costs for testing anchors.

Anchors will be held at the following tensions for 1 minute when tests are required:

TA-3H.....12,000 LB.

E. Power installed screw anchors shall be installed with the appropriate size and type of equipment in accordance with M.A. Mortenson's requirements and manufacturer's recommendations. M.A. Mortenson's representative shall witness all installations. The installation drive end assembly must be provided by the anchor manufacturer. No homemade installation tools will be used.

The Contractor will have a calibrated hydraulic pressure gauge installed on the anchor installation vehicle. This instrumentation is available from the anchor manufacturers and is necessary to determine anchor holding strength from installation torque.

The contractor will install anchors to the appropriate torque as shown on drawing TA-3H, power installed screw anchors.

If the appropriate installation torque cannot be attained with a single 7-foot rod, additional 3½-foot rod extensions shall be added to attain the specified torque.

F. If the standard 6,000 ft.lb. Helix assemblies cannot be installed due to soil conditions, a 10,000 ft.lb. Glacial till anchor will be substituted and, depending on the soil conditions, either a 10 inch or 6 inch Helix with the 1 inch high strength rod will be used.

Plate or log anchors may be substituted for screw anchors with M.A. Mortenson's approval.

G. Guys shall be installed and attached to the structures as shown on the transmission line structure drawing before conductors or overhead ground wires are strung. Each guy shall be re-tensioned after the conductor and overhead ground wires are installed to plumb the poles and to equalize tensions in the guys. If slack guys are found, they shall be re-adjusted so that all guys in any structure have approximately equal tension. The final tension in the guys and the plumb of the poles shall meet the approval of M.A. Mortenson.

1-7 GROUNDING AND BONDING

A. Reference to Drawings

All structures shall be grounded as shown on the Plan and Profile drawings and the Transmission Line Structure drawings and subject to the following provisions.

B. Structure Grounding

1) Sufficient grounding must be installed at each structure to achieve a resistance of 15 ohms or less. M.A. Mortenson may perform ground resistance measurements at each structure and require that additional grounding, in the form of ground rods or counterpoise, be added to that already provided by the basic structure grounding assemblies.

2) Where structure grounding tests are performed by M.A. Mortenson, the Contractor will notify M.A. Mortenson after the structure is erected, but before the overhead ground wire is installed.

3) Staples on downlead shall be 2 feet apart, except for a distance of 8 feet above ground and 8 feet from top of pole where they shall be 6 inches apart.

C. Bonding and Ground Wire

1) The pole ground wire shall be continuous and not spliced from top of pole to the pole butt grounding assembly. Should damage occur during erection of the structures, the pole ground wire may be spliced with M.A. Mortenson's approval.

2) Hardware shall be bonded to the pole ground wire as shown on the drawings. The ground wire shall clear any unbonded hardware by at least three inches.

3) On structures with horizontal post insulators, the pole ground wire will be bonded to the base of the insulator, not stood off on a strut.

1-8 INSULATORS AND HARDWARE

A. Reference to Drawings

Insulator and hardware assemblies shall be fully assembled and installed as shown on the Drawings. Items of hardware and insulators shall be inspected for missing parts and defects before installation. Defective or missing pieces shall be replaced.

B. Handling and Storage

1) Insulators and hardware shall be stored in their appropriate shipping containers until installation. They shall be properly supported and stacked so as not to damage the individual items. They shall be blocked up off the ground so that they cannot come in contact with the

ground or standing water.

2) Insulators shall be carefully handled to prevent damage to the porcelain skirts or non-ceramic weathersheds, pins, galvanizing, and cotter keys. A cradle or other suitable device shall be used to hoist any insulator strings whenever the quantity exceeds six units per string.

3) Insulators that are cracked, chipped, or damaged in any way shall be replaced with sound units. The cost for replacement of previously accepted units shall be borne by the Contractor.

4) All insulators shall be wiped clean with a clean, soft, nonabrasive cloth, as approved by M.A. Mortenson at the time of installation.

C. Installation

1) All connections shall be made in accordance with the Drawings. Bolts shall be torqued to the manufacturer's specifications and recommended torque values. Cotter keys where required shall be fully inserted.

2) Cotter key eyes on insulators and hardware items shall be oriented toward the structure, or in such a way as to facilitate easy removal during hot line maintenance.

3) Pins and bolts shall be oriented with the head upright wherever possible.

4) Pin-type insulators shall be tight on the pins. On tangent construction, the top groove must be in line with the conductor after tying in.

1-9 CONDUCTORS AND OVERHEAD GROUND WIRES

A. General

1) All conductors and overhead ground wire installation work shall be done in accordance with the ***manufacturer's*** recommendations, Southwire's T2 (VR) conductor Installation Guide is attached for reference in installing the conductor on this project. The IEEE Standards 524, "Guide to the Installation of Overhead Transmission Line Conductors," shall be used as reference. If there is a discrepancy between the guide and the manufacturer's recommendation, the Contractor should follow the manufacturer's

recommendation. The following provisions are for tension stringing of conductors and overhead wires.

2) It is very important to avoid damaging the wire or the associated fittings in any way. It shall be the Contractor's responsibility to protect the wire and fittings against damage. If the wire and associated materials are damaged due to Contractor's mishandling, negligence, or faulty equipment, the Contractor shall replace the damaged sections, including furnishing of necessary materials, in a manner satisfactory to M.A. Mortenson and at no additional cost to M.A. Mortenson. All sections of wire that are damaged by the application of grips shall be replaced.

3) Traveling grounds as required by O.S.H.A. Section 1926.955 (d) (1-4) must be in use at all times during construction. The Hi-line Model No. JT77TA or equal will be used.

B. Handling and Storage

1) Prior to installation, reels of wire shall be stored blocked-up off the ground and adequately supported so as to avoid damage to reel, protective covering, and wire. Wire and reels shall be kept free of standing water, excessive dust, and mud, and stored no closer than 50 feet from an energized portion of a substation or transmission line. The conductor must be covered.

2) Protective covering shall be removed at the job site and the outside layer of each reel shall be examined by the Contractor and M.A. Mortenson to be sure that the wire is in good condition and that no nails, staples, or other sharp objects, which could damage the wire during unreeling, protrude on the inside of the reel heads.

3) Identification tags and markers shall be retained on the reels. When required, the Contractor shall record on forms, supplied by M.A. Mortenson, the reel number, length of wire, net weight, and the structure numbers where the wire was installed.

4) In general, conductor reels should not be rolled. They should be lifted or transported by a reel dolly. If they do need to be rolled to a location where they can be easily handled, they should be rolled in the direction that would tend to tighten rather than loosen the conductor on the reel.

C. Tools and Equipment

1) Tools and equipment for wire work shall be of the proper size and type

for the job and shall be in good working condition. Sheaves, tensioners, pullers, wire grips, compressors, and dies shall be properly sized for the specific wires to be installed. All tools and equipment shall receive the written approval of M.A. Mortenson prior to their use.

M.A. Mortenson and the stringing foreman will inspect all equipment prior to commencement of the stringing operation.

2) Stringing blocks shall be neoprene lined, free running, and of the proper diameter and groove size for the wire being pulled.

3) Tensioner bullwheels shall be neoprene lined and of the proper size and design recommended by the conductor manufacturer.

4) The following table contains required dimensions of stringing and tensioning equipment (ANSI/IEE) Std. 524-l980.

a. Required Bullwheel and Sheave diameters:

		Sheave Diameter	
Conductor Size	Bullwheel Diameter	Typical	Arduous Terrain
1/0 6/1 ACSR	36"	8"	12"
4/0 6/1 ACSR	36"	8"	12"
336.4 26/7 ACSR	36"	8"	14"
397.5 26/7 ACSR	36"	8"	16"
477 26/7 ACSR	36"	12"	18"
556.5 26/7 ACSR	48"	12"	21"
636 26/7 ACSR	48"	12"	21"
795 26/7 ACSR	48"	16"	24"
954 45/7 ACSR	48"	16"	24"
1192 45/7 ACSR	60"	21"	28"
1272 45/7 ACSR	60"	21"	28"
1590 45/7 ACSR	60"	24"	30"
1780 84/19 ACSR	72"	28"	34"
2156 26/7 ACSR	72"	28"	34"

NOTE: Diameters are to the bottom of groove.

IEEE STD. 524-1980, page 23, defines bullwheel groove dimensions and page 26 defines sheave groove dimensions.

Sheaves at large angles will have a diameter adequate for arduous terrain.

D. Guard Structures

1) Guard structures shall be furnished and installed by the Contractor, where required, to prevent the conductor or overhead ground wires which are being pulled from coming into contact with existing overhead electric supply lines, communication lines, roads, highways, and railroads crossed by the transmission line. All labor and materials required shall be furnished by the Contractor and included in the unit cost for wire.

2) If not part of the right-of-way agreement previously executed, permission to install guard structures on private property or public highway right-of-way shall be obtained by the Contractor with the assistance of M.A. Mortenson.

3) After completion of all wire work, the Contractor shall remove the guard structures, fill and tamp all pole holes, and restore the right-of-way and access to its original condition.

E. Stringing

1) The method of installing the conductor and the overhead ground wire shall be as designated by M.A. Mortenson. When controlled tension stringing is specified, it shall be performed in accordance with IEEE Standard 524, "Guide to the Installation of Overhead Transmission Line Conductors," and subject to the manufacturer's concurrence. The stringing method shall be as denoted with an “X” below:

Tension stringing____X_____

Contractor's choice, subject to provisions below_____

2) The precise stringing procedure that the Contractor intends to use shall be submitted to M.A. Mortenson for review and approval prior to any wire work. This procedure shall include a description of all major pieces of equipment to be used, number of crews, composition, and responsibilities of each crew, proposed equipment set-up, locations of all splices, and locations and descriptions of temporary snubs and anchors.

3) Extreme care shall be exercised during the wire stringing operation to avoid damage to conductor or overhead ground wire strands. If damage is found, the stringing shall be stopped. Damage is defined as any deformity on the wire that can be detected by sight or touch. Kinked, twisted, abraded, "bird-caged", or flattened wire will not be allowed to remain on the line. Any wire so damaged shall be repaired

or replaced by the Contractor at his own expense, and to the satisfaction of M.A. Mortenson.

4) The Contractor shall continuously inspect the wire as it leaves the reels. If the wire has an accumulation of dirt, oil, grease or any other foreign substance, such substance shall be removed as the wire leaves the reels during stringing operation by a method approved by M.A. Mortenson.

5) Wire tension during stringing shall be high enough to ensure that the wire does not drag across the ground, underbrush, trees, towers, fences, guard structures, or any other surface other than the stringing sheaves. A stringing tension of not less than 50 percent, nor more than 80 percent of the initial sagging tension, should be used.

6) No more than two reels of wire per phase may be pulled at a time. Full tension compression splices shall not be pulled through the stringing blocks.

7) When stringing wire on H-frame structures, the center phase shall always be pulled first. The outside phases shall be pulled alternately in successive pulls. If all three phases are strung in one pull, the middle phase shall lead the other phases by not less than 100 feet.

8) The return wave method of checking the sag will be used at a minimum of two locations. It is important that all three phase wires are sagged evenly and accurately. A simple method is to attach ropes to all three conductors and accurately sag one of the phase wires. It is then possible to match the sags of the other phases to the first phase by inducing waves in each and matching impulses by holding the ropes close together.

   Satisfactory results cannot be obtained when the conductor is in motion. The movement of conductor due to wind or men working on the line makes it difficult to accurately count the number of return waves.

9) During stringing, the conductor will not be dragged on the ground, driven over with vehicles, or allowed to come in contact with any fences. Fences should be removed or well covered during the stringing operation. The stringing operation should not begin unless weather reports indicate that wind and weather will allow adequate time to sag and clip in all structures.

10) Sagging tables will be provided to the Contractor prior to conductor stringing.

11) Sag reports will be prepared by the stringing foreman for each sag.

F. Sagging

1) Wires shall be sagged to the proper tensions in accordance with the initial stringing sag and tension tables as shown on the contract drawings. Sags shall be checked by sighting with target and transit, as indicated in the IEEE Standard 524, or by the return wave method. Sags shall be within a tolerance of +3 and -0 inches of the specified values.

2) In hilly or mountainous terrain, the offset clipping method may be required in order to insure equalized tensions and plumbing of insulators on suspension structures. Calculations for offset clipping/sag corrections shall be done and values for sagging shall be furnished by M.A. Mortenson.

3) The Contractor shall select the length of each sag and the sag-checking spans, subject to the review and approval of M.A. Mortenson. The Contractor's sagging method shall result in uniform tensions throughout the sag and the allowable sag and tolerances must not be exceeded.

4) The Contractor shall budget the stringing time such that a reel of wire is sagged within 72 hours after the start of the stringing operation. If this is not possible in isolated areas, M.A. Mortenson shall be consulted regarding the necessity of using creep correction factors with the specified chart sags.

5) The Contractor shall make any necessary adjustments in the wires or clamps at any time during the construction period to insure that the wire is at the proper tension, sags are within tolerance, suspension insulator strings and overhead ground wire assemblies hang plumb, at no additional cost to M.A. Mortenson.

The air temperature at the time and place of stringing shall be obtained from a certified etched-glass thermometer. The temperature at which the conductor is sagged and the spans in which sags are measured, shall be recorded and the information given to M.A. Mortenson.

G. Clipping, Deadending, and Splicing

1) The Contractor shall be cognizant of, and take into consideration, the

strength limitations of all structures in so far as the application of temporary wire stringing loads. All temporary back snubs and pull-downs on structures other than strain structures shall be carefully planned and meet the approval of M.A. Mortenson.

2) Use of wire reels shall be carefully planned to minimize the number of full tension splices. There shall never be more than one compression fitting per phase in any span and no splice shall be located within ten feet of a conductor support. Splices shall not be located over major highway and railroad crossings.

3) Compression deadends and splices shall be installed in accordance with the manufacturer's recommendations. Conductor strands within the splice area shall be carefully cleaned with a steel brush, cotton rags, and solvents. Special care shall be exercised in making compression fittings to insure use of proper die size, accurate cutting of wire, complete insertion of the cable strands, and pressing to produce a straight, uniform fitting.

   ALCOA, Fargo, or equal, alloy-type compression connectors will be used at joints and deadends of conductor larger than 4/0, 6/1, ACSR. Installation instructions, Page 0-CA16 of the ALCOA conductor accessory catalog, are a part of this specification.

   The Contractor will furnish a 60-ton press, with a properly sized motor and a portable head, with the proper dies, to make up all the above deadend connections. A standard hydraulic compression head will be used to make up all splices.

   A conductor trimmer of the correct size for the conductor being used, the Rigid No. 87 ACSR cable trimmer, or equal, will be required at all compression connections.

4) After completion of pressing operations, the Contractor shall clean the wire and fittings of excess grease and compounds. All burrs and die flash marks shall be removed with emery cloth.

5) U-bolts on suspension clamps and strain deadend clamps shall be evenly torqued to the manufacturer's recommended values. Keeper plates shall be in place and properly seated. Conductor strands within the area of the fittings shall be clean. The acceptable cleaning method is use of a steel brush, cotton rags, and solvents.

6) Wires shall be clipped into suspension clamps within not less than three hours, and not more than 72 hours, after the start of each individual wire pulling operation. Cables shall be lifted from the

sheaves using standard suspension clamps or plate hooks eight inches larger to provide adequate support for the cables without damaging individual strands or kinking the wire.

7) With pin-type insulators, the conductors shall be tied in the top groove of the insulator on tangent poles and on the side of the insulator away from the strain at angles.

H. Jumpers

1) Jumpers shall be installed as shown on the drawings. The cost of installation of these items shall be included with the bid units for installing conductors. All jumpers shall be installed in accordance with the manufacturer's recommendations.

2) Jumper wire loops shall be made up to present a smooth, uniformly curving appearance. Excess length of conductor from the wire stringing operation should be used to make up the jumper loops.

I) Temporary Grounds

1) During the wire work, the Contractor shall take all necessary steps to insure proper temporary grounding of the structures, cables, and equipment. All applicable federal, state, and local safety regulations shall be strictly adhered to.

2) A record of all temporary conductor grounds shall be kept to insure that they are all removed and the line can be safely energized at the end of the construction period.

J) Reels and Excess Conductor

1) When wire is furnished by M.A. Mortenson, the Contractor shall be responsible for salvaging the wire reels and all excess conductor and overhead ground wire. All such wire shall be inventoried, placed on non-returnable reels, and returned to M.A. Mortenson or disposed non-returnable as directed by M.A. Mortenson.

2) Returnable reels shall be shipped back to the wire fabricators in accordance with M.A. Mortenson's instruction. Non-returnable wooden reels shall be disposed of in a manner meeting the approval of M.A. Mortenson.

3) All costs associated with the receiving, handling, shipping, placement on nonreturnable reels, or disposal of excess wire and reels shall be in the labor costs for installation of wire units.

K. Construction and Restoration on State Lands

1) All construction and restoration must be completed within 30 calendar days of commencing construction on said State land.

1-10 STRUCTURE NUMBERING

1) A structure number shall be installed on every structure per sketch # SK-01 in Appendix C.

APPENDIX A

Appendix A - Southwire T2 (VR) Conductor installation guide

Southwire®

VR™ CONDUCTOR INSTALLATION GUIDE

1.0 *INTRODUCTION*

This guide provides recommendations on procedures and equipment used during VR™ conductor installation. VR™ conductor can be installed using techniques and equipment similar to that used when installing standard round conductor. These general guidelines, together with those suggested in the IEEE Guide to the Installation of Overhead Transmission Line Conductors (IEEE 524™ –2003), will provide the basic information required to install VR™ conductor.

2.0 *VR™ CONDUCTOR STRINGING METHODS*

There are several stringing methods available for VR™ conductors; however the method chosen must be appropriate for the installation requirements. A brief description of these stringing methods is described below.

2.1 Slack Method

The VR™ conductor reels are mounted on stands or jacks and are free to rotate with only enough braking force to prevent overrun, backlash or loops. The VR™ conductor is pulled off the reel by a vehicle that stops at each structure where the conductor is lifted and placed in a traveler mounted on the structure.

2.2 Layout Method

This method is similar to the slack method except the lead end of the VR™ conductor is tied off and the reel is mounted on a vehicle which travels down the line paying out the conductor as it goes.

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2.3 Semi-Tension Method

This method follows the general procedure of tension stringing, except no tensioner is used. Minimal ground clearance is maintained by applying slight braking force to the conductor payout reel. Caution: The reels are not designed to withstand elevated tensions or high braking forces; therefore the conductor tension must be kept sufficiently low to prevent damage to the conductor or reel.

2.4. Tension Stringing Method

The tension stringing method is the most common installation method. This method consisting of a pulling line threaded through a stringing sheave on each structure of the pulling section and connected to a swivel and pulling grip attached to the leading end of the conductor to be installed. The conductor is pulled through the sheaves of the stringing section as the pulling rope is wound onto the drum of a drum type puller, located at the pulling end of the stringing section. The pulling tension is regulated by the bullwheel tensioner located at the conductor pay out end of the stringing section between the conductor reel and the first structure. Only minimum braking force is applied to the payout reel to prevent over-run in the event of a sudden stop. This installation method keeps the conductor clear of the ground and other obstructions that could damage the conductor. Pulling tension should never exceed the sagging tension for the installation.

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2.4.1 Tension Stringing Equipment

Tensioners



When tension stringing VR™ conductor, a multi-groove tandem bullwheel tensioner is recommended. The alignment of the bullwheels should be offset by approximately ½ the groove spacing to allow proper tracking of the conductor around the bullwheels. Either the offset or tilted type bullwheel configuration shown above may be used. The two primary considerations when selecting a bullwheel tensioner are groove radius and bullwheel bottom of groove diameter. Proper groove radius and bullwheel diameter are specified in IEEE 524. The maximum conductor diameter for VR™ cable is twice the diameter of one component conductor.

- The groove radius must be large enough so that the conductor, when laid flat, will fit into the bottom third of the groove.

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VR™ CONDUCTOR INSTALLATION GUIDE

- The bullwheel sheave diameter must be large enough to avoid excessive bending of the conductor. The recommended minimum bullwheel bottom of groove diameter should not be less than 35 times the maximum conductor diameter.
- The two-tensioner bullwheels must be closely synchronized to minimize conductor assembly separation as it traverses the bullwheels. Also, the tensioner's braking system must allow for smooth, consistent tensioning of the conductor from stop to full payout speed and back to stop.
- For standard VR™ conductor (individual conductors with a right hand direction of lay and a left hand direction of lay for the twisted assembly) the direction of wrap across the bullwheel should be from left to right.
- One (1) or two (2) wraps of the conductor around the bullwheel should be sufficient for normal pulls. No more than three (3) wraps on the bullwheel are recommended for typical installations.

2.4.2 Tension Stringing

Proper positioning of the stringing equipment is crucial for a good installation. The tensioner should be aligned with the sheave at the first structure and in line with the pull section. It is recommended that the angle of the conductor between the ground and sheave at the first structure be approximately 15 degrees, and should never exceed 25 degrees. Practically speaking, the tensioner should be positioned back from the first pole or structure a distance of three or four times the vertical height of the entrance stringing sheave. For example, for a 15 degree angle, if the first sheave is at a height of 25 feet then the tensioner should be set back at least 100 feet from the structure. This practice will minimize the bending radius of

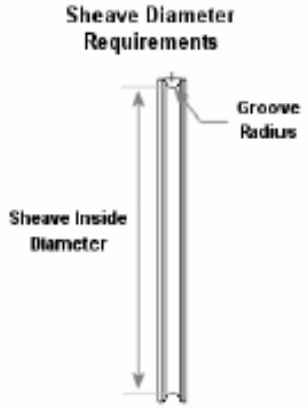
Southwire

VR™ CONDUCTOR INSTALLATION GUIDE

the conductor and contact force between the conductor and the sheave, reducing the tendency of the conductor to separate.

The payout reel should be positioned in line with and behind the tensioner. The conductor payout reel should be positioned 50 to100 feet behind the tensioner to allow the conductor to adjust from the circular wrap on the reel to a straight orientation before entering the bullwheel tensioner. Care should be taken to avoid excessive bending around small fairlead rollers on the tensioner. The braking tension on the payout reel should be set only high enough to prevent overrun when the pull is stopped. Excessive payout tension may distort or damage the conductor. If a guide roller is required to guide the conductor over other reels or obstructions, the guide roller or sheave should have a bottom grove diameter approximately 14 times the maximum diameter of the conductor.

3.0 SHEAVE REQUIREMENTS



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The recommended minimum sheave bottom groove diameter should be 14 times the maximum diameter of the VR™ conductor. The entrance sheave and angle sheaves, for angles greater than 15°, should be larger. Proper size will be evident by smooth passage of the conductor through the sheaves, minimizing conductor bending and damage. Unlined sheaves are preferred.

- Minimum groove radius: 0.55 times the maximum diameter of VR™ conductor.
- As discussed previously, the groove radius must be large enough so that the conductor, when laid flat, will fit into the bottom third of the groove.

Refer to IEEE 524™ –2003 for more sheave related recommendations.

4.0 STRINGING VR™ CONDUCTOR

The conductor is shipped from the manufacturing plant with two metal band clamps on each end of the conductor. One clamp is near the end of the conductor and another clamp is located five (5) to ten (10) feet from the ends. It is important to keep both clamps on each end of the conductor during stringing to prevent relative movement of the component conductors, which may cause bagging. The conductor pulling grip (Kellem grip) should be installed over the banded cable. If the pulling grip will not fit over the conductor band clamps, additional band clamps should be installed on the conductor before the clamps installed at the factory are removed.

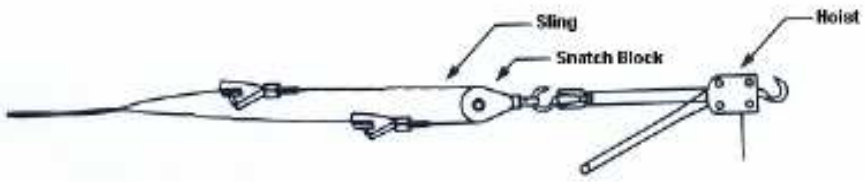
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VR™ CONDUCTOR INSTALLATION GUIDE

5.0 TENSIONING VR™ CONDUCTOR

During tensioning and or mid span splicing of VR™ conductors an equalizer sling must be used to maintain equal tension in each conductor.

- Separate grips must be placed on each of the component conductors. The two grips are then connected through a snatch block with a sling, as shown below:



- Pulling is done against the snatch block. This pulling assembly is often called an equalizer sling. This insures that both conductors take an equal share of the pulling load, which prevents unequal tension and helps maintain the relative positions of the component conductors. This will also tend to correct any change in relative component conductor position that may have occurred during the stringing process.

6.0 SAGGING VR™ CONDUCTOR

Presently accepted sag methods for standard conductors are satisfactory for VR™ conductor. Use sag values supplied by the Utility or by Southwire Company.

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VR™ CONDUCTOR INSTALLATION GUIDE

7.0 DEADENDING

There are a variety of different styles of deadend hardware available. Bolted type quadrant and compression type deadend clamps work well. However, always consult with the accessory manufacturer for the correct selection and installation procedure for the hardware.

8.0 SPLICING

VR™ conductor is joined by separately splicing the component conductors, with approximately 5 feet between the splices. Care should be taken to maintain equal tension on the component conductors to prevent them from separating.

9.0 INSTALLATION PRECAUTIONS

VR™ conductor consists of two component conductors twisted together with a lay between 8 feet and 10 feet. However, the lay may vary due to twist migration and conductor rotation during installation. In extreme situations this may result in separation of the component conductors, commonly called a bag. This rotation may be caused by factors including installation method, sheave diameter, tension and pole spacing. It is helpful to identify the point where bagging first begins to correct the source of the problem.

Slight separation of the component conductors is normal as it is paid off the reel and sometimes during stringing. Tension equalization between the conductors during the stringing operation should correct the problem.

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VR™ CONDUCTOR INSTALLATION GUIDE

If conductor bagging remains after stringing, these bags can typically be worked out during conductor tensioning. With the equalizer sling attached, bump the VR™ conductor with a rope to cause relative conductor movement. This should allow the bags to pull out.

In the event of major conductor bagging, bags can be cut out and the component conductor spliced.

This publication is a collection of items of general information related to the subject of VR ™ conductor. It is not intended to be nor should it be used as authority for design, construction, use or installation. The design, construction, use and installation of VR ™ conductor should only be undertaken by competent professionals in light of currently accepted design and engineering practices.

While great care has been employed to ensure that the applications, tables, standards and references and other information contained herein are free of errors, absolutely no warranties, either expressed or implied, are made as to the accuracy or completeness of any such tables and formulas contained herein.

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APPENDIX B

Inspection Reports

STR. NO.	STR. TYPE	CORRECTION NEEDED	DATE CORRECTED

HDR	Engr:	Scale: None	CLEAN UP LIST	File: CLEAN UP	Rev. 0
	Dwn:	Date:		Sheet 1 of 1	
	Chkd:	Plot:		CLEAN UP LIST	
	App:	Proj. No:			

Inspection Report **Inspection of Conductor Stringing Equipment**

DRUM PULLER: Reel size_____ in x _____ in Length of pulling line _____ft. Pulling line material and strength _____

Comments _____

BULLWHEEL TENSIONER: Diameter of bullwheel _____in. Groove diameter _____in. Groove depth _____ in.

General condition of tensioner _____

REEL STRAND: _____

TRAVELERS: Sheave Diameter: conductor_____ in. Groove diameter: conductor _____ in. Groove depth: conductor_____ in.

O.H.G.W._____ in. O.H.G.W. _____in. O.H.G.W._____ in.

Sheave inspection: Travelers passing inspection: conductor_____ Travelers failing inspection: conductor_____

O.H.G.W._____ O.H.G.W._____

Type of sheave lining: _____

HYDRAULIC COMPRESSOR: Manufacturer_____ Model No._____

Compression rating_____ tons

Comments _____

COMPRESSION DIES:

Conductor: Manufacturer _____ Cat. No._____

O.H.G.W. Manufacturer _____ Cat. No._____

Comments _____

Project:

Inspector:

Contractor's Foreman:

Date:

HDR	Engr:	Scale: None	**INSPECTION REPORT** CONDUCTOR STRINGING EQUIPMENT	File: IR-SE	Rev. 0
	Dwn:	Date:		Sheet 1 of 1	
	Chkd:	Plot:		IR-SE	
	App:	Proj. No:			

Inspection Report													**Structure Framing**		
													Inspector:_____		
Structure No.															
Structure Type															
Pole Height & Class															
Pole Spacing															
Pole Top to Arm Distance															
Arm to X-Brace Distance															
Hardware Complete															
Ground Wire Complete															
Excess Holes Treated & Plugged															
X-Brace Installation															
Pole Bearing Plates															
Date															
Weather:															
Comments:															
Structure Framing Complete															

HDR	Engr:	Scale: None	**INSPECTION REPORT** STRUCTURE FRAMING	File: IR-SF	Rev. 0
	Dwn:	Date:		Sheet 1 of 1	
	Chkd:	Plot:		IR-SF	
	App:	Proj. No:			

Inspection Report | **Sag Report**

Date_____ Time _____

Level or inclined span_____

Method of sagging; Return waves, Target, or Angle of sight_____

Ruling Span_____

Location of Puller_____

Location of Tensioner_____

Conductor size, type and stranding:_____

_____

O.H.G.W. size, type and stranding:_____

_____

Reel numbers used: Conductor:_____

_____;O.H.G.W._____

Location of sleeves_____

Guys properly adjusted_____

Structures clipped in within time frame____

_____

Comments_____

_____

_____
(Contractor's stringing foreman)

_____
(Owner's inspector)

PRIMARY SAG LOCATION: (2/3 sag section length away from puller)

Sag between structures_____ and _____

Wind speed and direction_____ temperature_____

Length of span between conductor supports:

Slope distance_____ Vertical spacing _____ Vertical span _____

Span measurements by: _____

	CONDUCTOR	O.H.G.W
Sag in inches		
Time for return waves		

Temperature at end of sagging_____ Number of return waves _____

SECONDARY SAG LOCATION: (1/3 of sag section length away from puller)

Sag between structures_____ and _____

Wind speed and direction_____ temperature_____

Length of span between conductor supports:

Slope distance_____ Vertical spacing _____ Vertical span _____

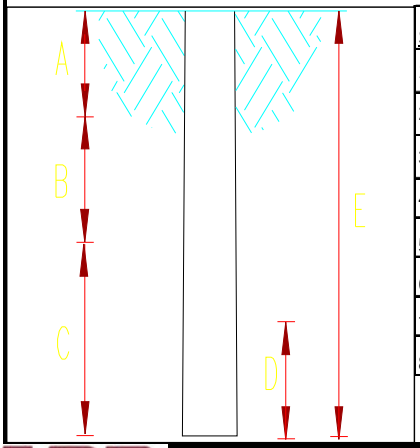
Span measurements by: _____

	CONDUCTOR	O.H.G.W
Sag in inches		
Time for return waves		

Temperature at end of sagging_____ Number of return waves _____

HDR	Engr:	Scale: None	**INSPECTION REPORT** SAG REPORT	File: IR-SR	Rev. 0
	Dwn:	Date:		Sheet 1 of 1	
	Chkd:	Plot:		IR-SR	
	App:	Proj. No:			

Inspection Report										Structure Setting				
STRUCTURE NO.														
STRUCTURE TYPE														
POLE HEIGHT & CLASS														
DEPTH OF TOPSOIL "A"														
SOIL CLASS NO. & DEPTH "B"														
SOIL CLASS NO. & DEPTH "C"														
SOIL CLASS NO. & DEPTH "D"														
AGGREGATE BACKFILL USED														
STRUCTURE PLUMB														
STRUCTURE IN CANT														
SETTING DEPTH "E"														
BOTTOM OF HOLE TAMPED														

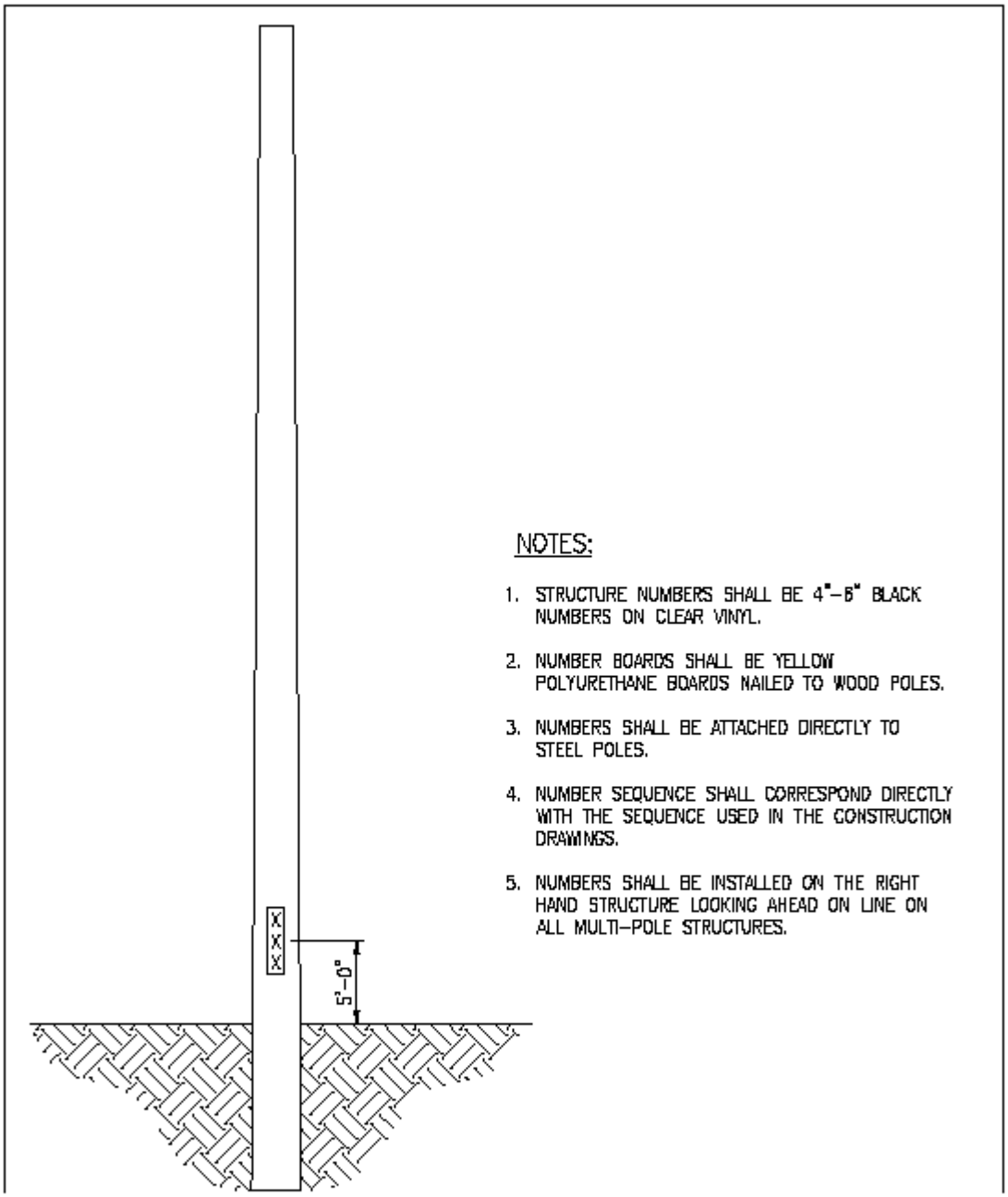


SOIL CLASS NO. DESCRIPTION	COMMENTS:
1. BEDROCK	
2. HARDPAN, SLATE, SANDSTONE	
3. VERY HARD CLAY, SHALE	
4. DENSE SAND, COMPACT GRAVE & SADN	
5. LOOSE SAND & GRAVEL	
6. STIFF CLAY, MEDIUM SAND	
7. LOOSE SAND	
8. VERY LOOSE SAND, SILT, TOPSOIL	

HDR	Engr:	Scale: None	**INSPECTION REPORT** STRUCTURE SETTING	File: IR-SS	Rev. 0
	Dwn:	Date:		Sheet 1 of 1	
	Chkd:	Plot:		IR-SS	
	App:	Proj. No:			

APPENDIX C

Structure Numbering



NOTES:

1. STRUCTURE NUMBERS SHALL BE 4"–6" BLACK NUMBERS ON CLEAR VINYL.
2. NUMBER BOARDS SHALL BE YELLOW POLYURETHANE BOARDS NAILED TO WOOD POLES.
3. NUMBERS SHALL BE ATTACHED DIRECTLY TO STEEL POLES.
4. NUMBER SEQUENCE SHALL CORRESPOND DIRECTLY WITH THE SEQUENCE USED IN THE CONSTRUCTION DRAWINGS.
5. NUMBERS SHALL BE INSTALLED ON THE RIGHT HAND STRUCTURE LOOKING AHEAD ON LINE ON ALL MULTI–POLE STRUCTURES.

HDR

PROJECT TITLE: TATANKA WIND FARM
230KV TRANSMISSION LINE

SHEET TITLE: **STRUCTURE NUMBERING**

PROJECT NUMBER: MAM–48069

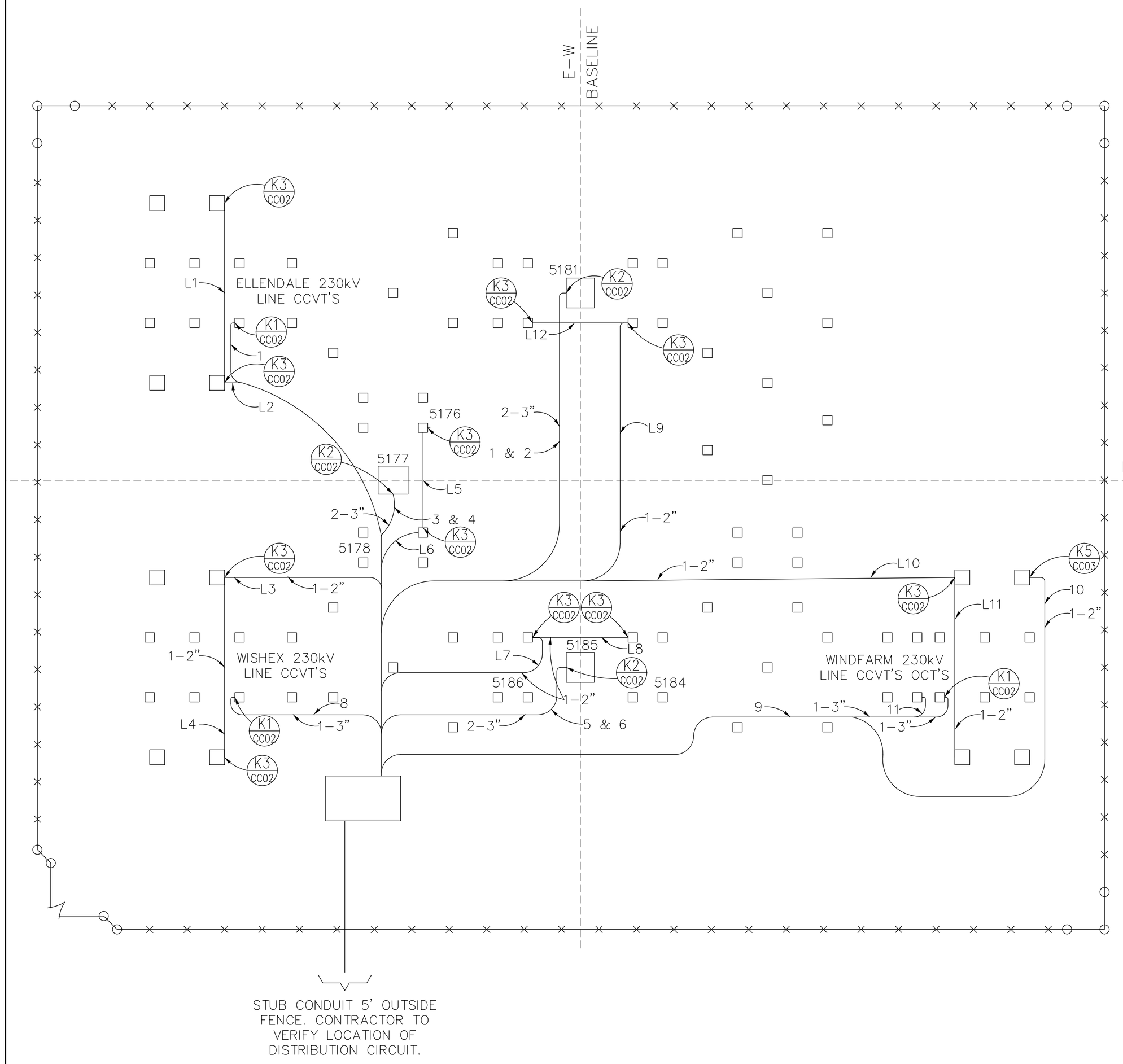
PROJECT MANAGER: S. HEREIM

DATE: 6/4/07

REFERENCE SHEET: 1 OF 1

REFERENCE DOCUMENT: SK–D1.DWG

DRAWING NUMBER: SK–D1



NOTES:

1. CONDUITS 1, 2, 3, 4, 5, & 6 SHALL HAVE RISER LOCATION AT 230KV BREAKERS VERIFIED WITH BREAKER MFG. DRAWINGS FOR ACTUAL CONTROL CABINET LOCATION.

CONDUIT SCHEDULE

CONDUIT ID	CONDUIT SIZE	CONDUIT LENGTH	TO	FROM
L1	2"	50'	L2 JB	L1 JB
L2	2"	130'	CONTROL HOUSE	L2 JB
L3	2"	95'	CONTROL HOUSE	L3 JB
L4	2"	50'	L3 JB	L4 JB
L5	2"	25'	L6 JB	L5 JB
L6	2"	80'	CONTROL HOUSE	L6 JB
L7	2"	70'	CONTROL HOUSE	L7 JB
L8	2"	30'	L7 JB	L8 JB
L9	2"	100'	CONTROL HOUSE	L9 JB
L10	2"	50'	L11 JB	L10 JB
L11	2"	205'	CONTROL HOUSE	L10 JB
L12	2"	30'	L9 JB	L12 JB
1	3"	175'	CONTROL HOUSE	PCB 5181
2	3"	175'	CONTROL HOUSE	PCB 5181
3	3"	80'	CONTROL HOUSE	PCB 5177
4	3"	80'	CONTROL HOUSE	PCB 5177
5	3"	90'	CONTROL HOUSE	PCB 5185
6	3"	90'	CONTROL HOUSE	PCB 5185
7	3"	140'	CONTROL HOUSE	ELLENDALE 230kV LINE CCVT'S
8	3"	60'	CONTROL HOUSE	WISHEX 230kV LINE SOUTH
9	3"	215'	CONTROL HOUSE	WINDFARM 230kV LINE CCVT'S
10	2"	270'	CONTROL HOUSE	WINDFARM 230kV LINE OPGW
11	3"	215'	CONTROL HOUSE	WINDFARM 230kV LINE OCT
12	3"	100'	CONTROL HOUSE	DISTRIBUTION CIRCUIT
13	3"	100'	CONTROL HOUSE	DISTRIBUTION CIRCUIT

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

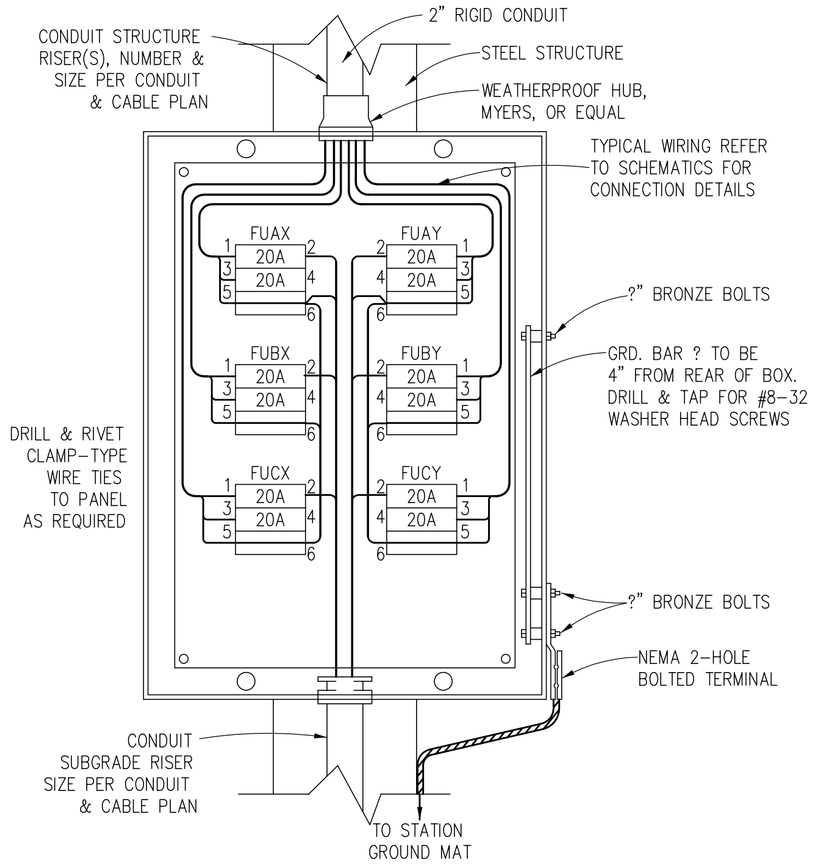
TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION CONDUIT PLAN

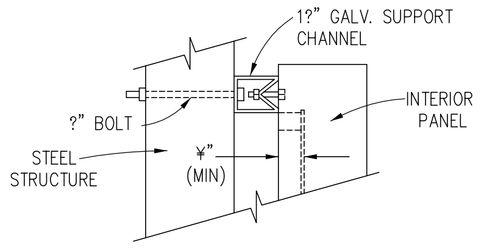
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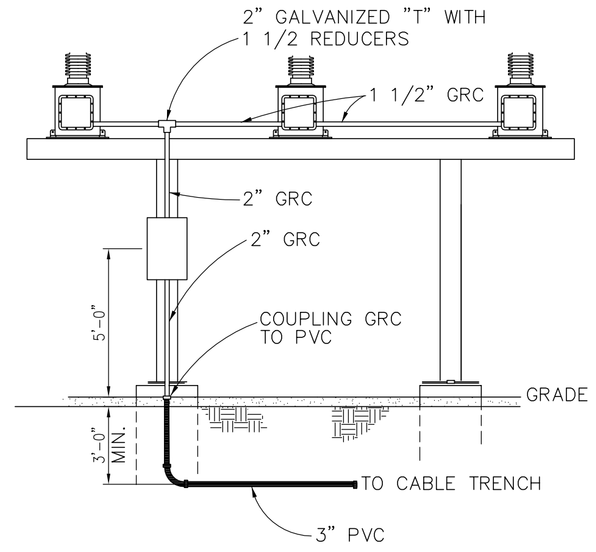
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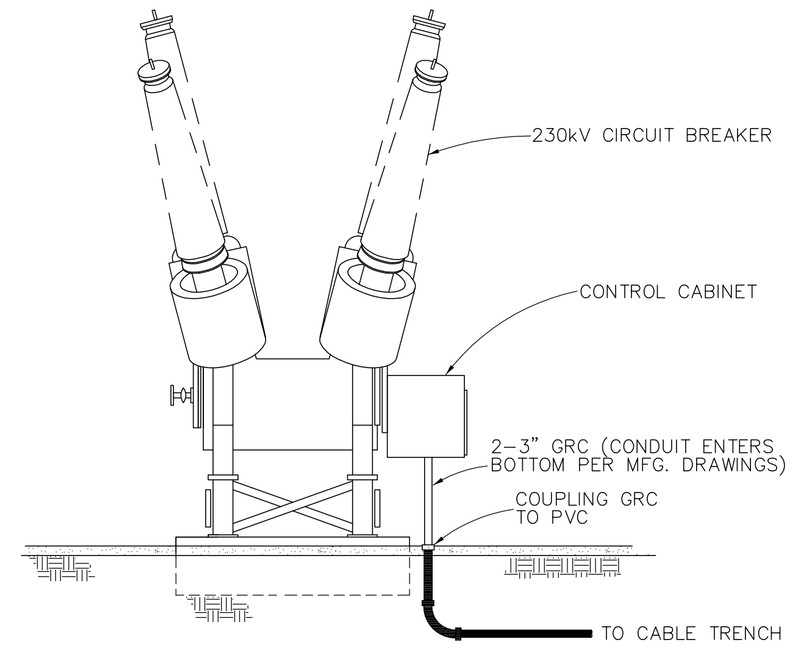
MATERIAL LIST	
QUANITY	DESCRIPTION
1	NEMA 3R JUNCTION BOX. 20 X 20 X 8 W/HINGED DOOR, AND ANSI #61 GRAY FINISH. HOFFMAN A20R208HCR, WITH A20P20 INTERIOR PANEL.
6	3P, 30A, 250V REJECTION FUSE BLOCK, WITH SCREW TERMINALS & SPRING REINFORCED CLIPS, FOR RK5 FUSES TAYLOR 20318R
12	FUSES, 250V, 20A, x2", BUSSMAN TYPE NON
1	GROUND BAR, ?" x 1?" x 10" CU. BAR.
AS REQ'D	1?" GALV. SUPPORT CHANEL WITH HARDWARE; POWER-STRUT, OR EQUAL.
AS REQ'D	WIRE TIES, CONDUIT DEVICES AND MTG. HARDWARE.



230KV BUS CCVT JUNCTION BOX MOUNTING DETAIL
MATERIAL ITEM X

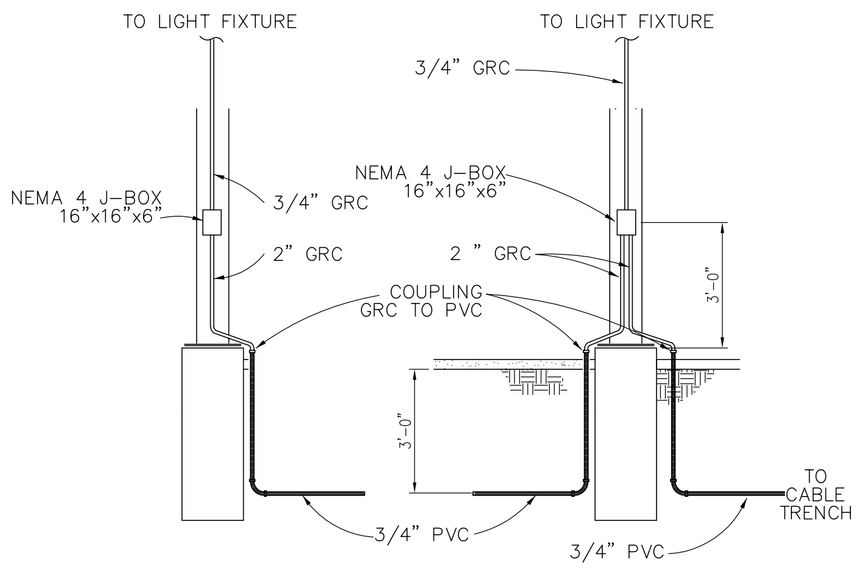


CCVT CONDUIT DETAIL K1 CC01
N.T.S.

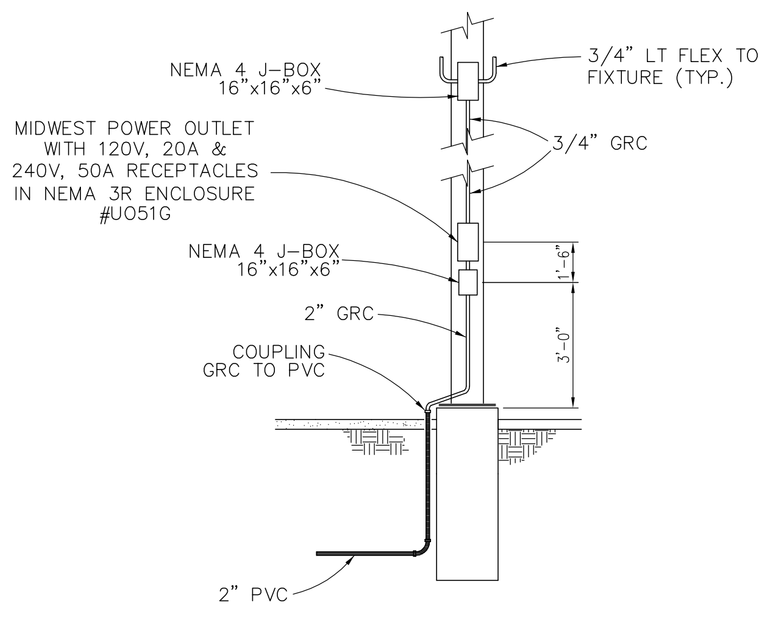


230kV CIRCUIT BREAKER CONDUIT DETAIL K2 CC01
N.T.S.

(TYPICAL)



LIGHT FIXTURE CONDUIT DETAIL K3 CC01
N.T.S.



120V & 240V RECEPTACLE W/LIGHT FIXTURE K4 CC01
N.T.S.

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HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

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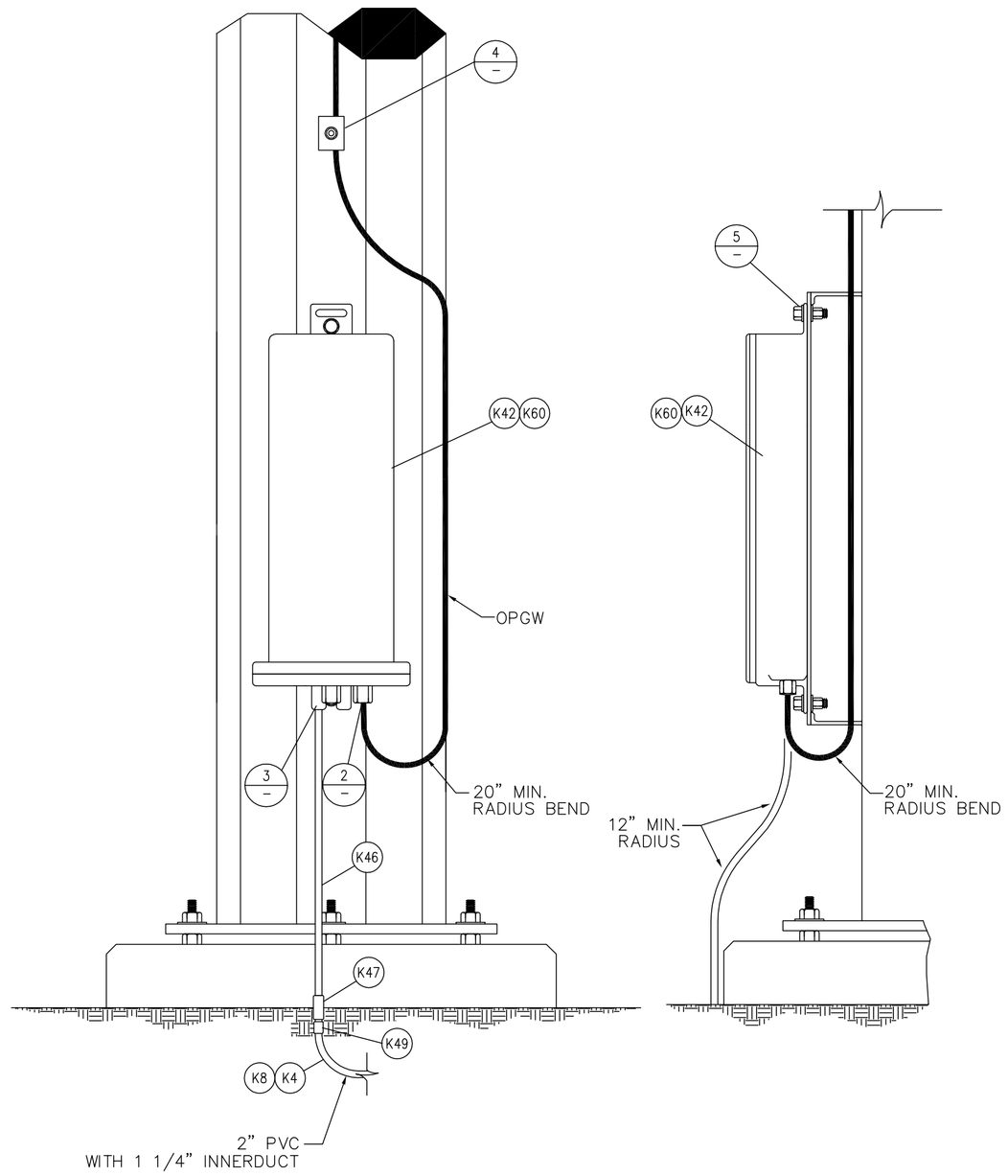
TATANKA WIND ENERGY

230KV INTERCONNECT SUBSTATION CONDUIT DETAILS K1 THROUGH K4

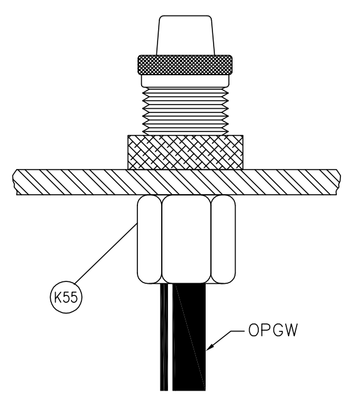
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SCALE	NONE

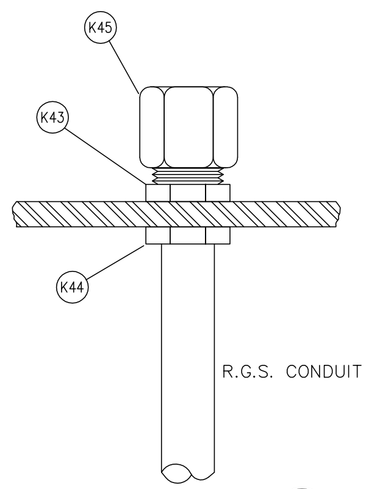
SHEET CC-02



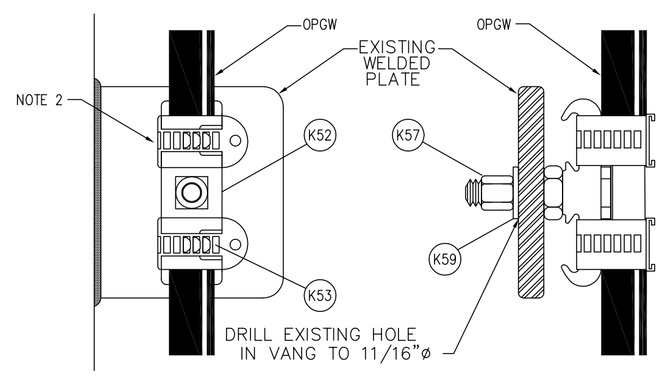
OPGW SPLICE BOX DETAIL K5 (CC01)
N.T.S.



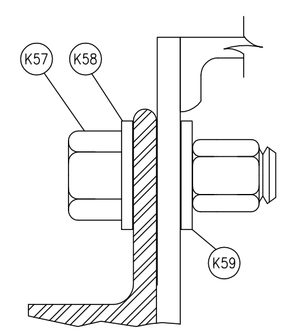
DETAIL 2 — OPGW ENTRY CONNECTOR ASSEMBLY



DETAIL 3 — CONDUIT ATTACHMENT



DETAIL 4 — OPGW – POST CONNECTOR



DETAIL 5 — SPLICE BOX ATTACHMENT

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HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
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0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

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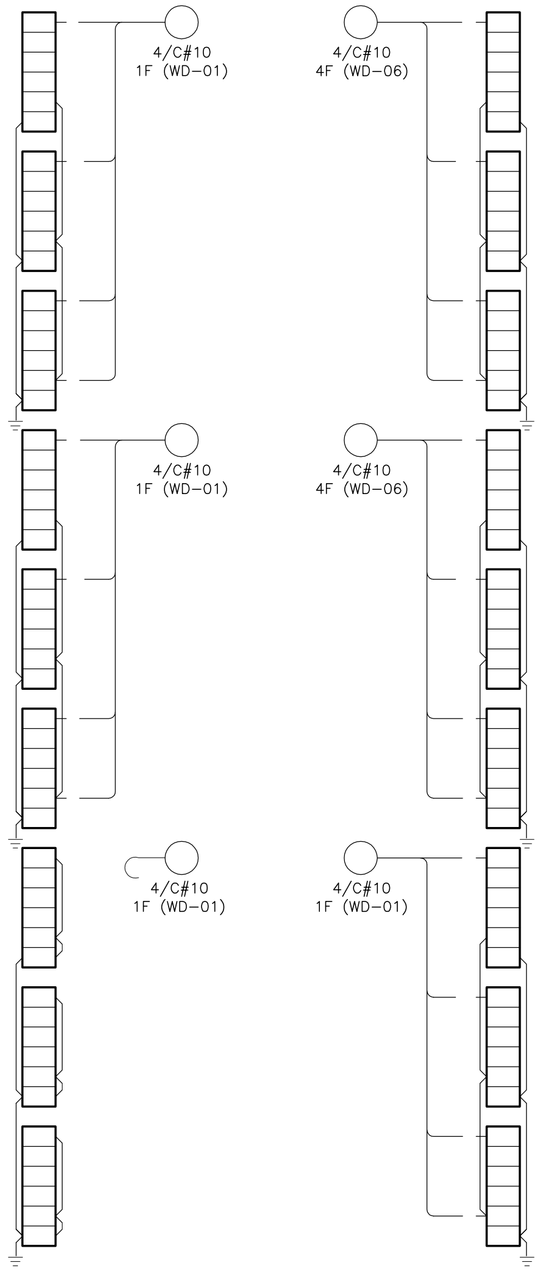
TATANKA WIND ENERGY

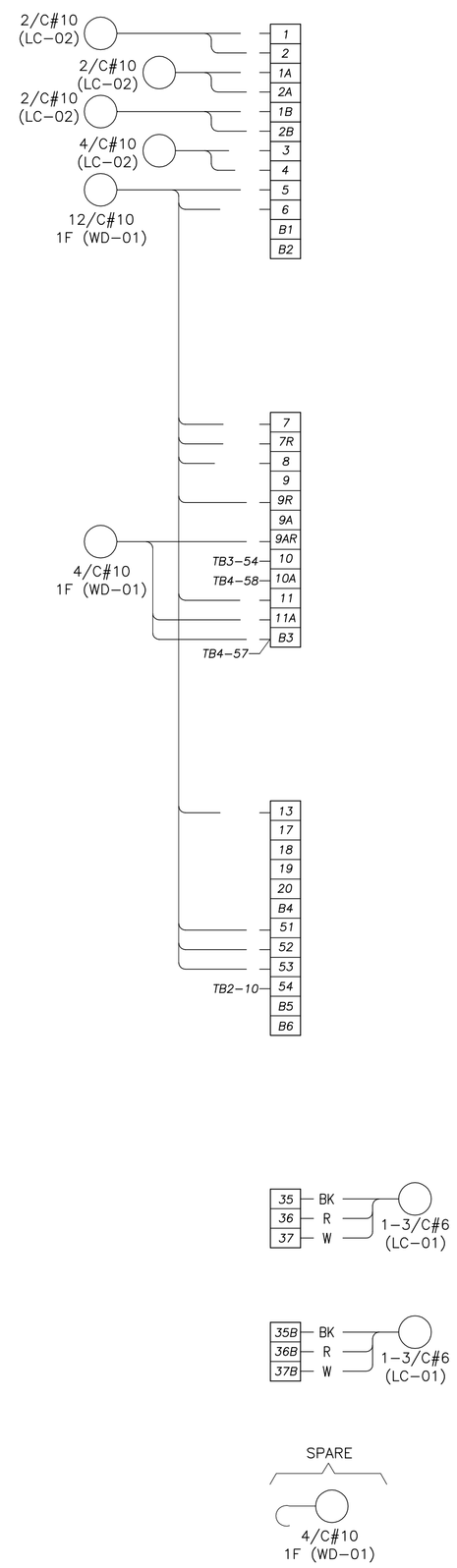
230/34.5kV PROJECT SUBSTATION
CONDUIT DETAIL K5

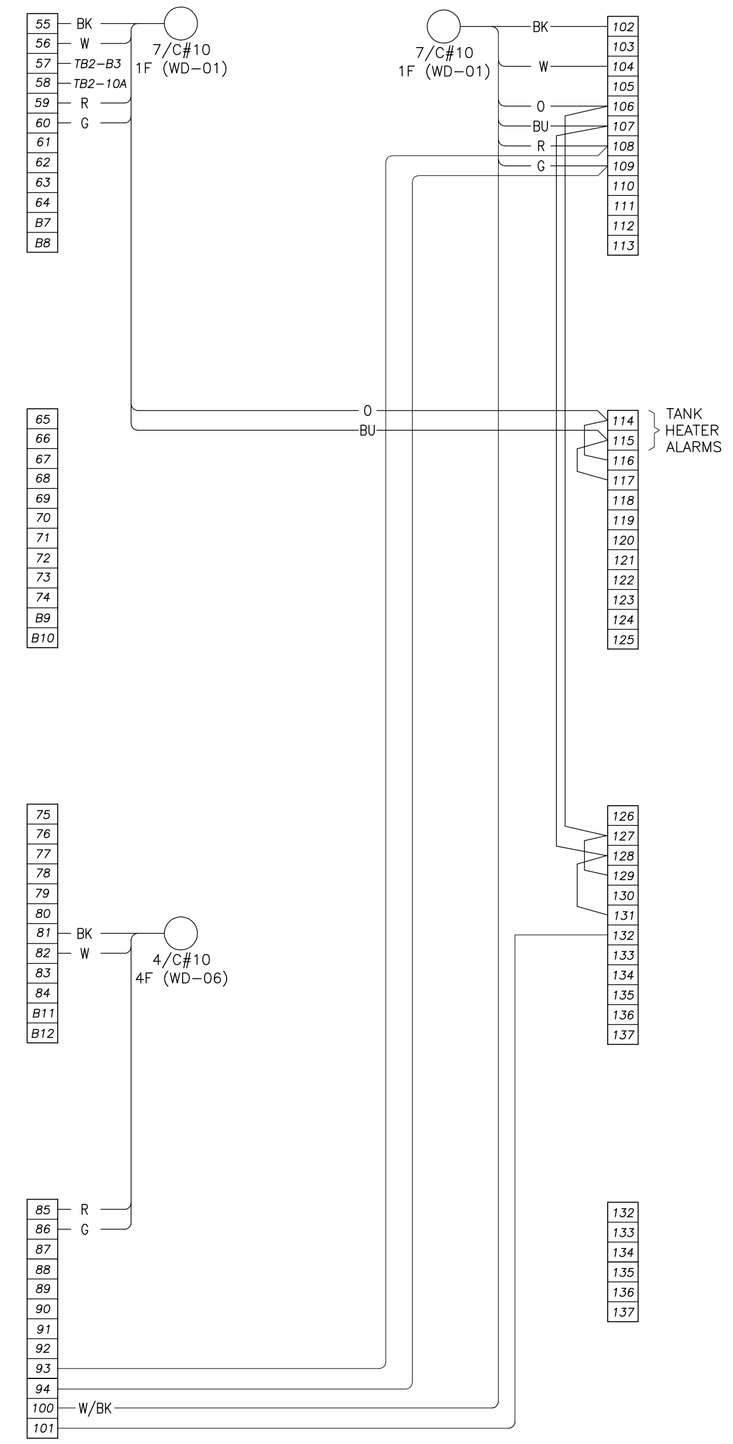
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FILENAME	TWEND-CC-03
SCALE	NONE

SHEET
CC-03







1200 AMP MULTI-RATIO CT'S		
CURRENT RATIO	TURNS RATIO	SECONDARY TAPS
100-5	20-1	X2-X3
200-5	40-1	X1-X2
300-5	60-1	X1-X3
400-5	80-1	X4-X5
500-5	100-1	X3-X4
600-5	120-1	X2-X4
800-5	160-1	X1-X4
900-5	180-1	X3-X5
1000-5	200-1	X2-X5
1200-5	240-1	X1-X5

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
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A	10-12-07	REVISED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

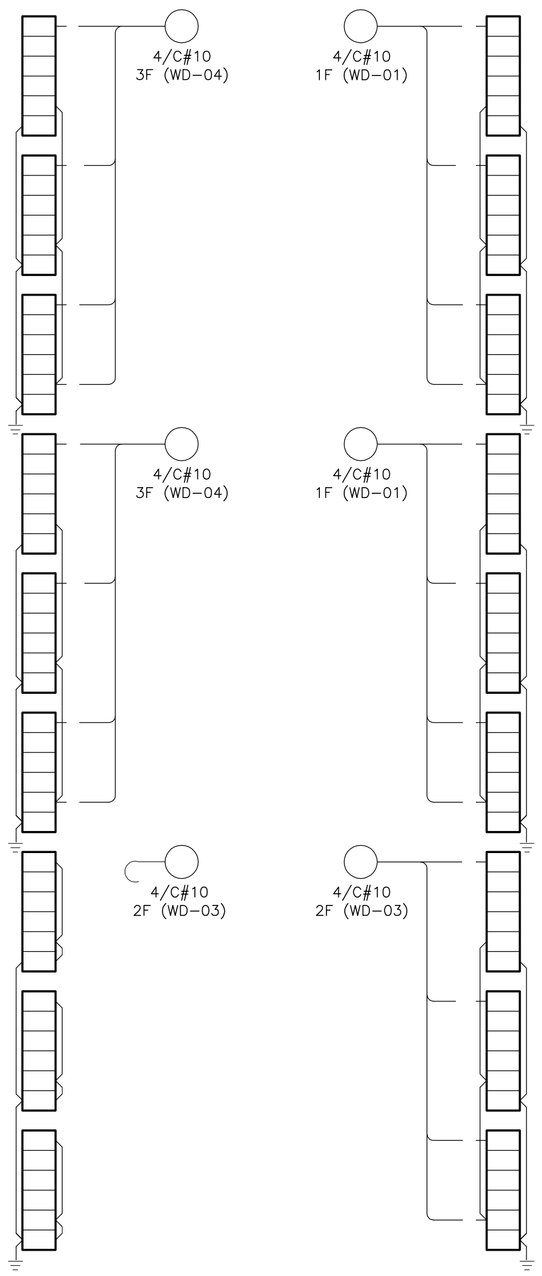
TATANKA WIND ENERGY

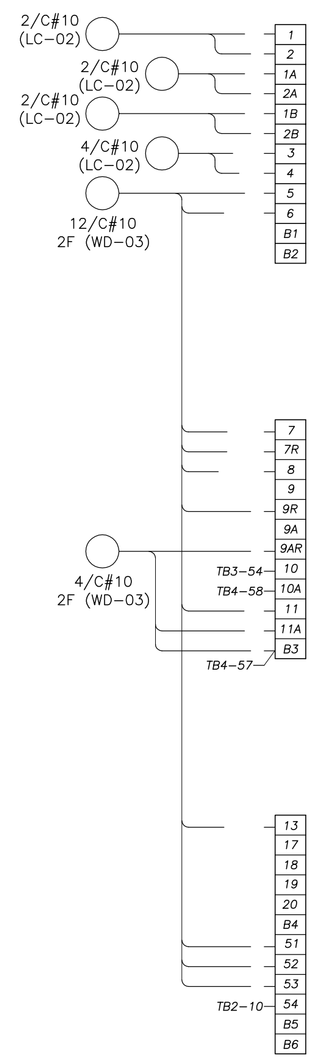
230kV INTERCONNECT SUBSTATION
CB 5181
CONNECTION DIAGRAM

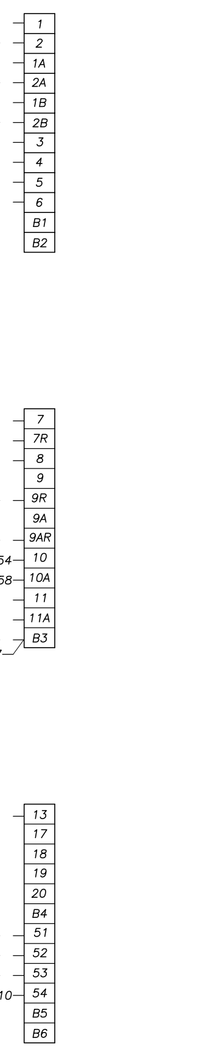
0 1" 2"

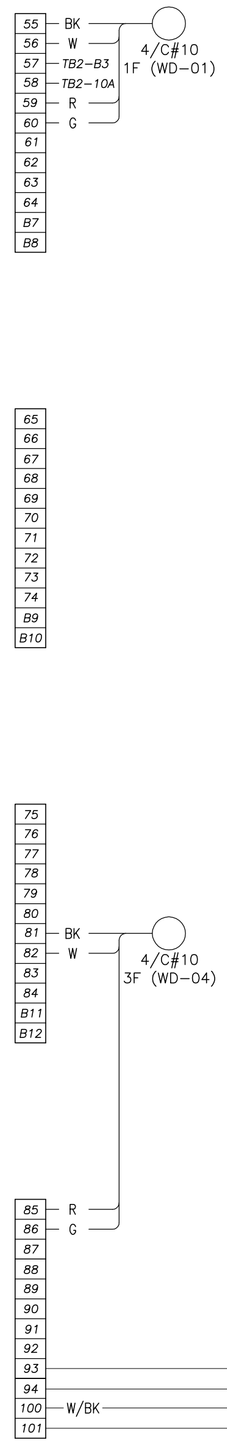
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SCALE	NONE

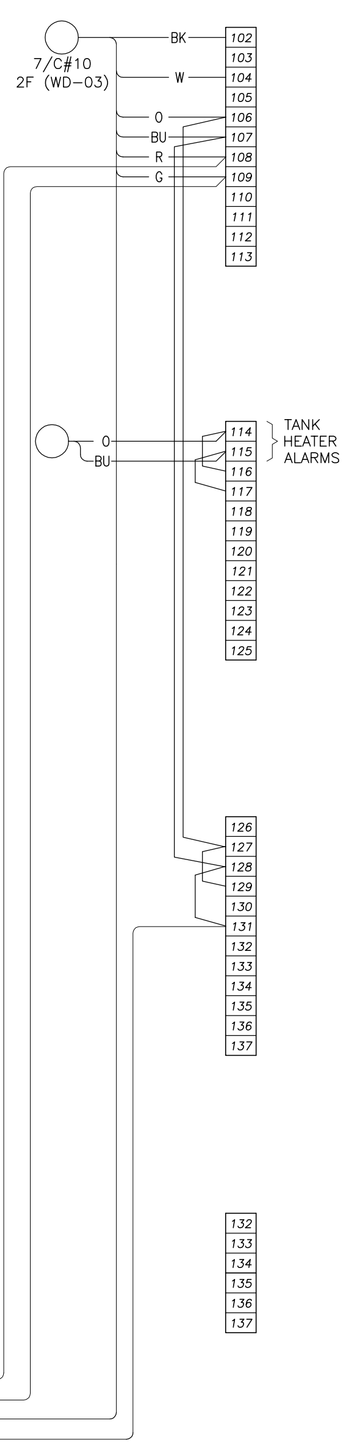
SHEET
CD-01











1200 AMP MULTI-RATIO CT'S		
CURRENT RATIO	TURNS RATIO	SECONDARY TAPS
100-5	20-1	X2-X3
200-5	40-1	X1-X2
300-5	60-1	X1-X3
400-5	80-1	X4-X5
500-5	100-1	X3-X4
600-5	120-1	X2-X4
800-5	160-1	X1-X4
900-5	180-1	X3-X5
1000-5	200-1	X2-X5
1200-5	240-1	X1-X5

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	REVISED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

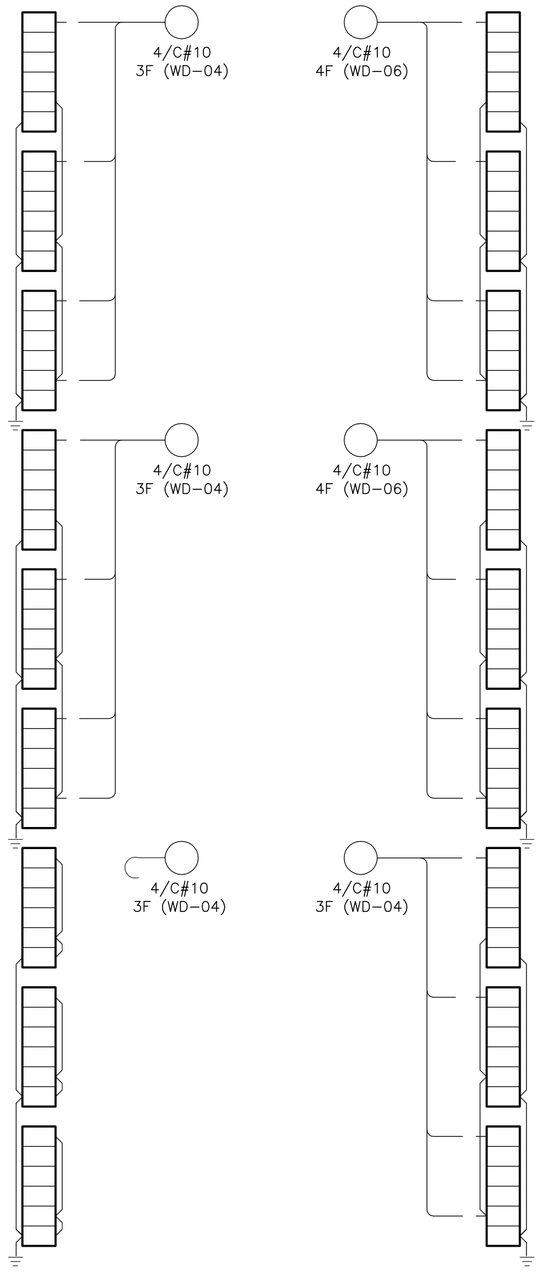
TATANKA WIND ENERGY

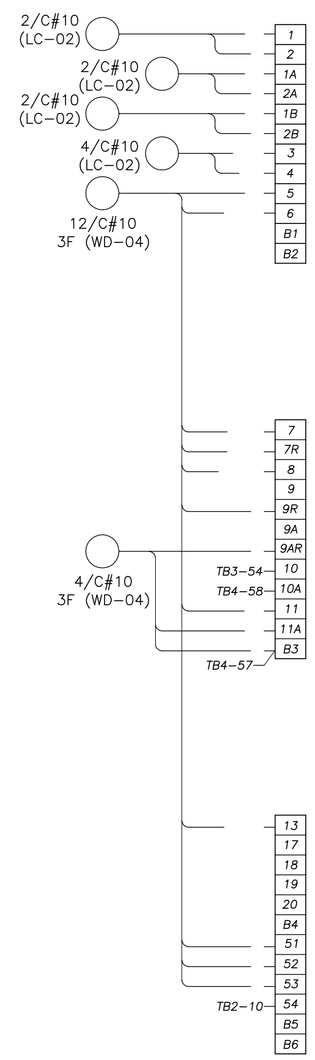
230kV INTERCONNECT SUBSTATION
CB 5177
CONNECTION DIAGRAM

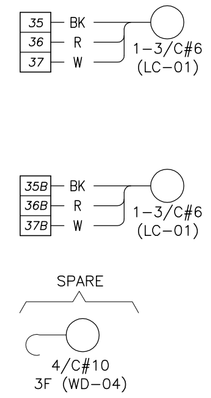
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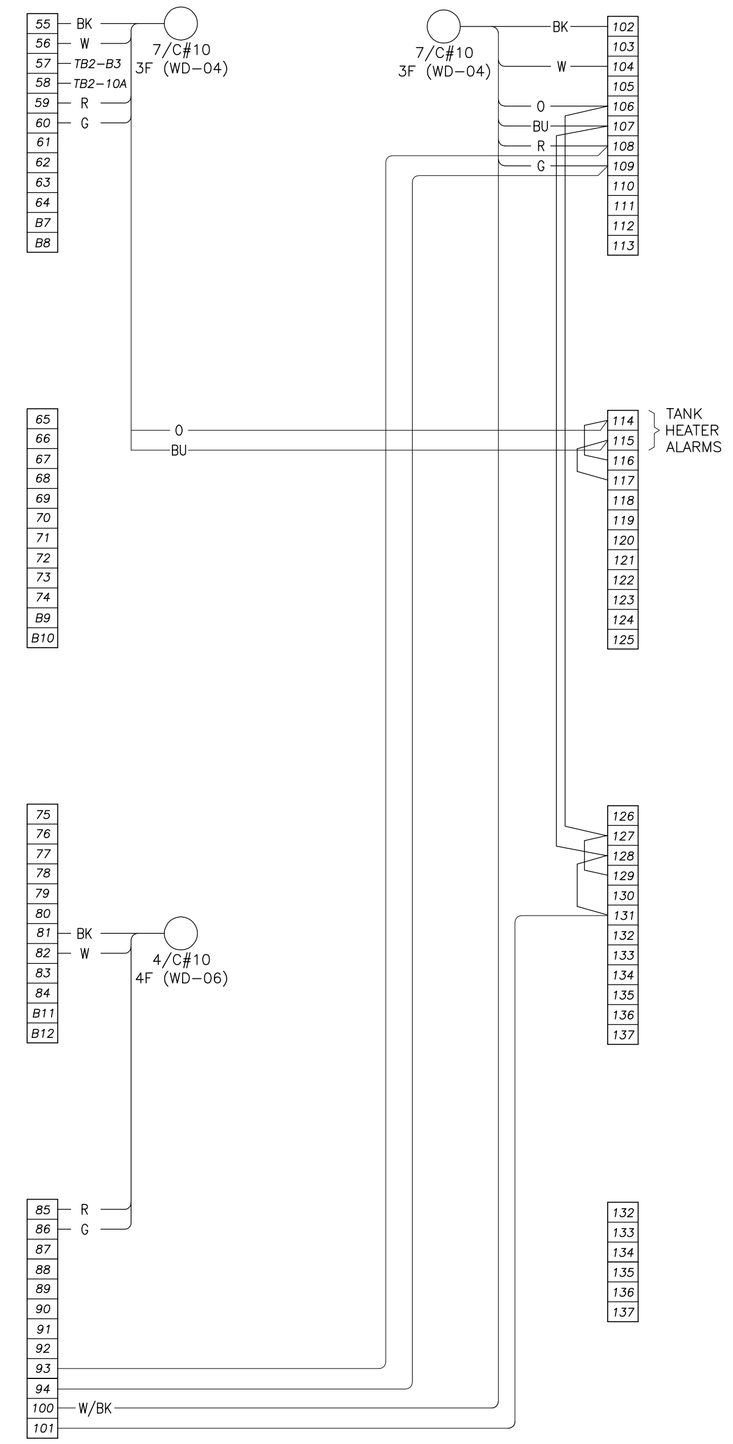
FILENAME	TWEND-CD-02.DWG
SCALE	NONE

SHEET
CD-02









1200 AMP MULTI-RATIO CT'S		
CURRENT RATIO	TURNS RATIO	SECONDARY TAPS
100-5	20-1	X2-X3
200-5	40-1	X1-X2
300-5	60-1	X1-X3
400-5	80-1	X4-X5
500-5	100-1	X3-X4
600-5	120-1	X2-X4
800-5	160-1	X1-X4
900-5	180-1	X3-X5
1000-5	200-1	X2-X5
1200-5	240-1	X1-X5

MORTENSON®

HDR Engineering, Inc.

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PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

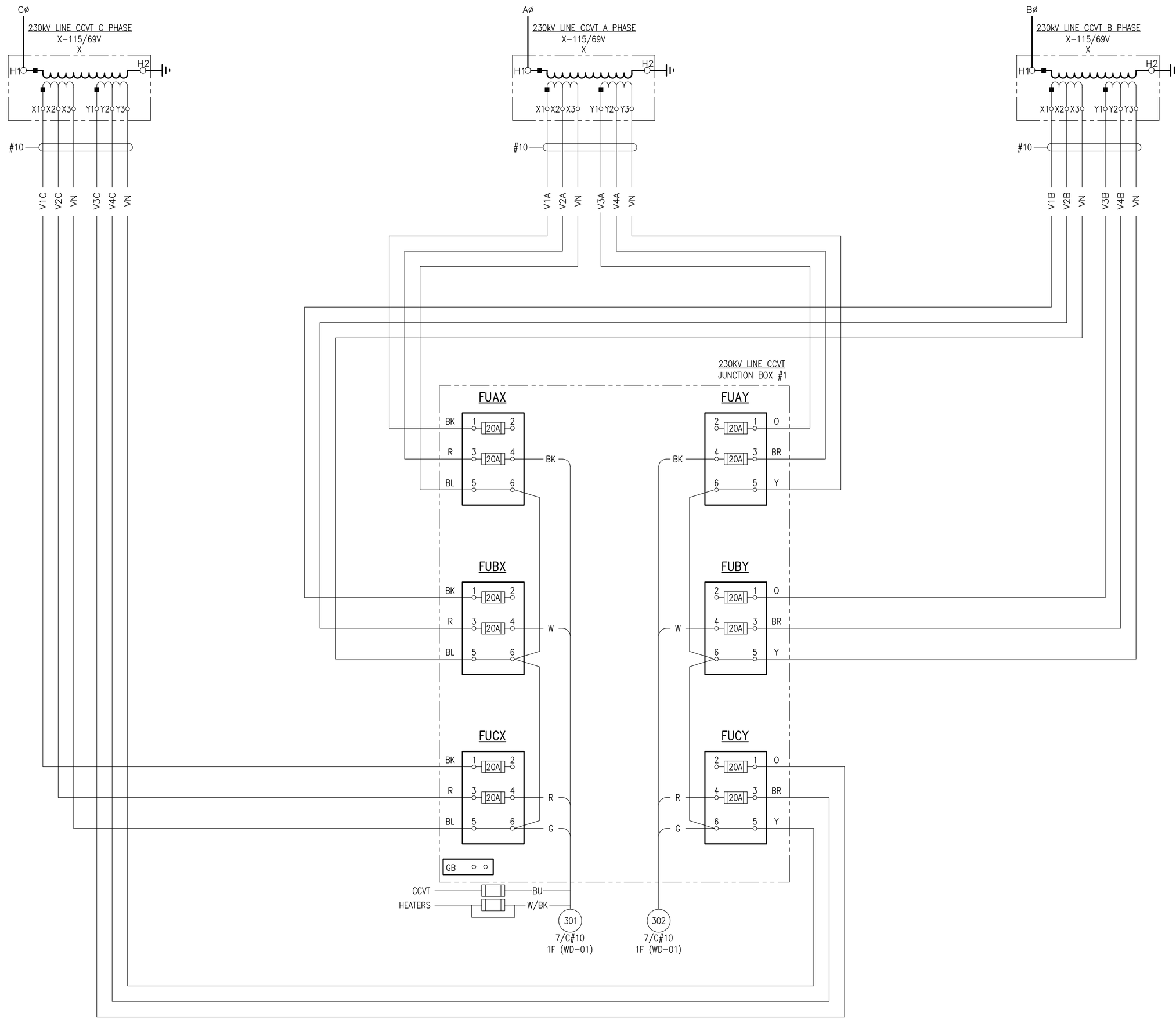
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION CB 5185 CONNECTION DIAGRAM

0 1" 2"

FILENAME	TWEND-CD-03.DWG
SCALE	NONE

SHEET **CD-03**



MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

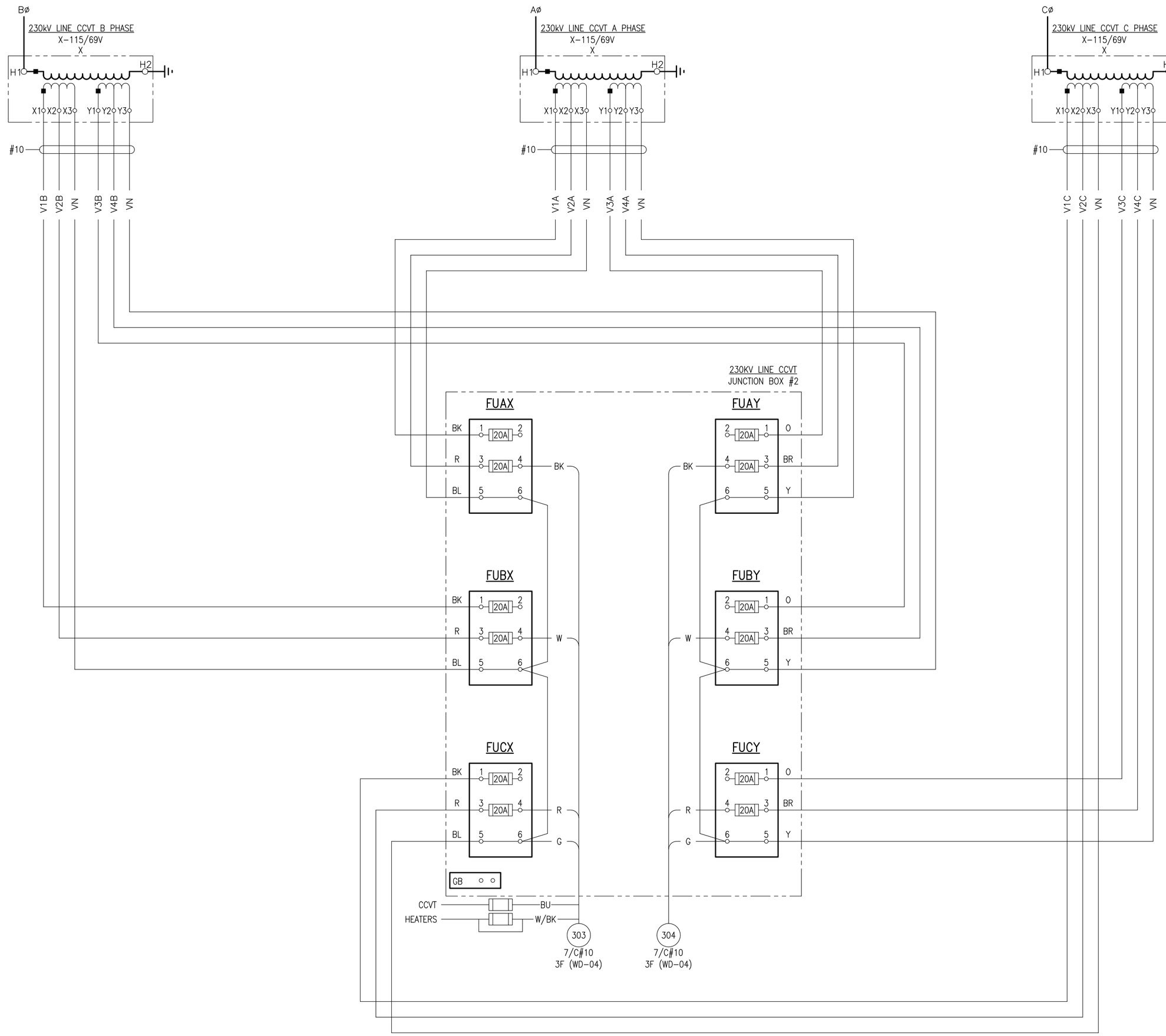
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
ELLENDALE LINE CCVT J-BOX #1
CONNECTION DIAGRAM

0 1" 2"

FILENAME	TWEND-CD-04.DWG
SCALE	NONE

SHEET
CD-04



MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

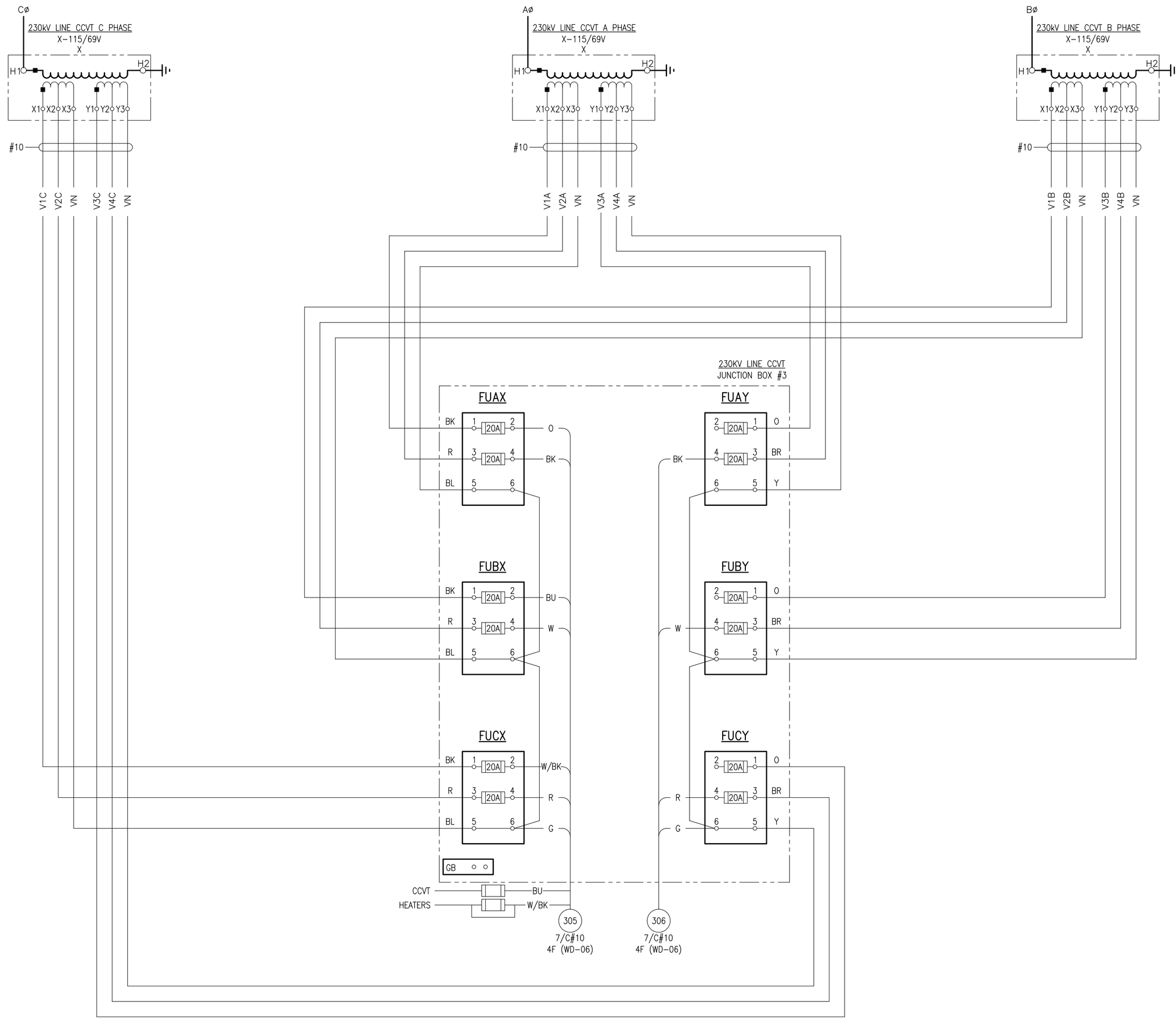
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
WISHEK LINE CCVT J-BOX #2
CONNECTION DIAGRAM

0 1" 2"

FILENAME	TWEND-CD-05.DWG
SCALE	NONE

SHEET
CD-05



MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

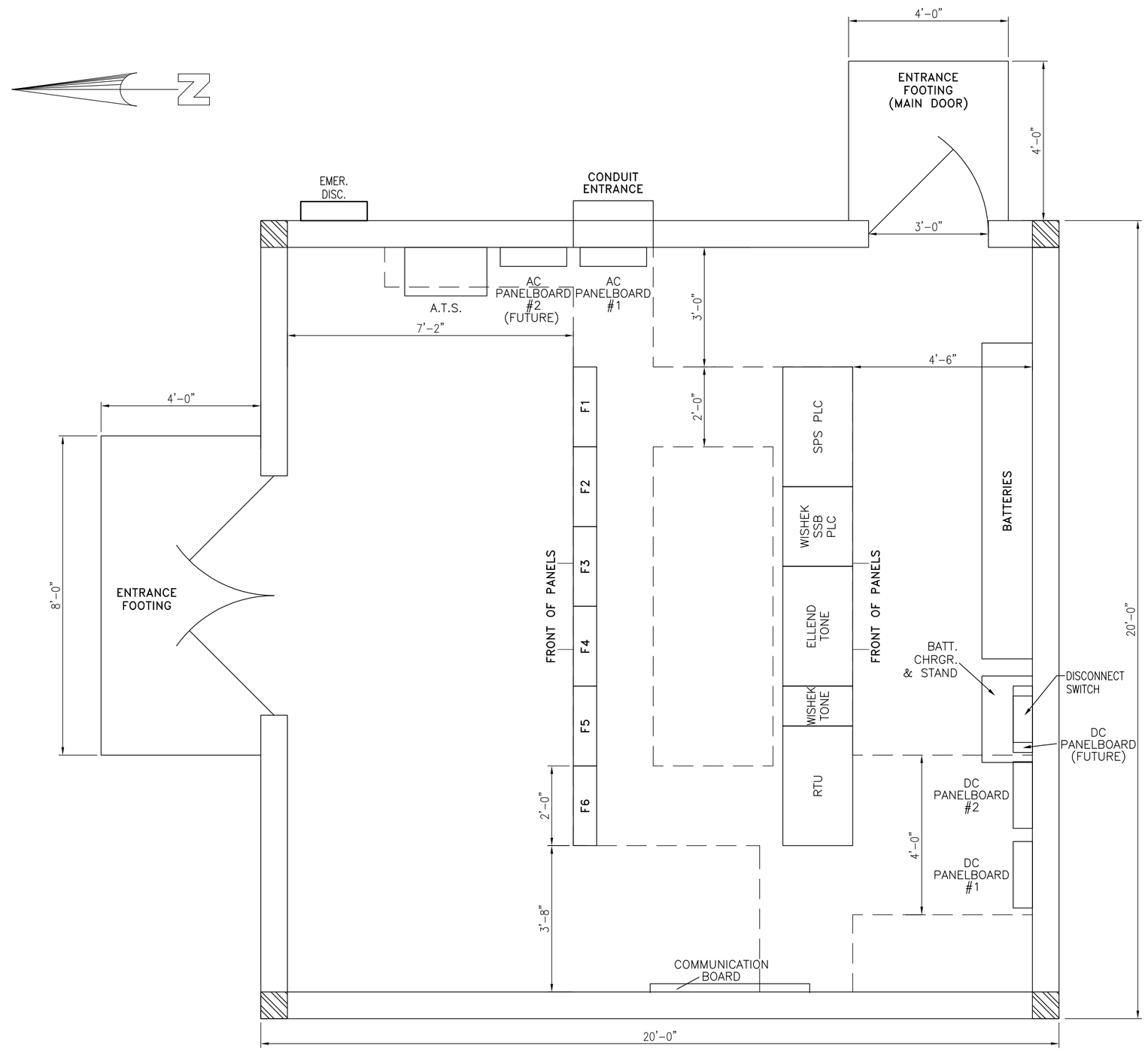
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
PROJECT LINE CCVT J-BOX #3
CONNECTION DIAGRAM

0 1" 2"

FILENAME	TWEND-CD-06.DWG
SCALE	NONE

SHEET
CD-06



MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

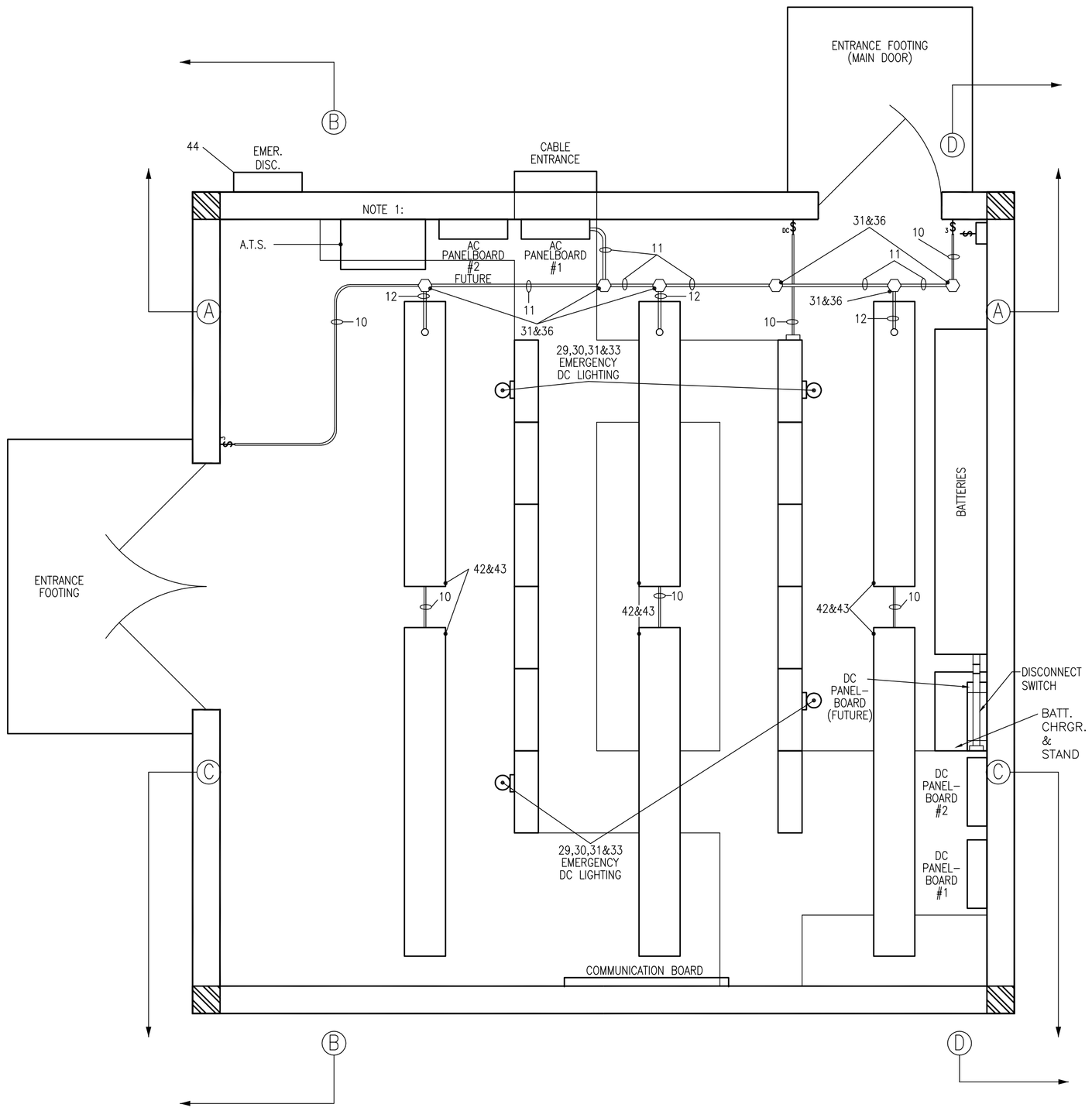
TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION CONTROL HOUSE

0 1" 2"

FILENAME	TWEND-CH-01
SCALE	NONE

SHEET **CH-01**



	ITEM	MATERIAL DESCRIPTION
	1	SPRING NUT; 3/8" SPRING, GALV, MFG-SUPER STRUT A100-3/8
	2	CABLE; POWER, 1/C#6 AWG CU., 600V XLP POLYETHELENE
	3	CABLE; POWER, 1/C#4 AWG CU., 600V
✳	4	WIRE; 1 CONDUCTOR, #12 AWG, 19 STRAND, BLACK
✳	5	WIRE; 1 CONDUCTOR, #12 AWG, 19 STRAND, WHITE
✳	6	WIRE; 1 CONDUCTOR, #12 AWG, 19 STRAND, RED
✳	7	WIRE; 1 CONDUCTOR, #12 AWG, 19 STRAND, BLUE
✳	8	WIRE; 1 CONDUCTOR, #12 AWG, 19 STRAND, GREEN
✳	9	LUG, BRONZE, SINGLE TAP, #10-#1, ANDERSON #TLS-22A
	10	CONDUIT; EMT THINWALL, 1/2"
●	11	CONDUIT; EMT THINWALL, 3/4"
	12	CONDUIT; FLEXIBLE LIQUID TIGHT, 1/2", TYPE "EF" GRAY
▲	13	CONDUIT; PVC RIGID ELECTRICAL, 2" SCH 40
▲	14	CONDUIT; PVC 4" RIGID ELECTRICAL SCH 40
▲	15	BUSHING CONDUIT 4' PLASTIC
✳	16	CONNECTOR; EMT, COMPRESSION TYPE, 1/2" CONDUIT
✳	17	COUPLING; EMT COMPRESSION, 1/2" CONDUIT ARLINGTON #830
✳	18	COUPLING; EMT COMPRESSION, 3/4" CONDUIT
▲	19	CONNECTOR; PVC 2" MALE ADAPTER, SCH 40 CARLON #E943J
▲	20	CONNECTOR; PVC 4" MALE ADAPTER
▲	21	FITTING; BELL END, 4" PVC
✳	22	LOCKNUT; STEEL CONDUIT, 3/4"
✳	23	LOCKNUT; STEEL CONDUIT, 2" APPLETON #BL200
▲	24	LOCKNUT; STEEL CONDUIT 4"
✳	25	STRAP; ONE HOLE STEEL, 1/2" EMT CONDUIT
✳	26	STRAP; ONE HOLE STEEL, 3/4" EMT CONDUIT
✳	27	STRAP; ONE HOLE 1" EMT CONDUIT
▲	28	ELBOW SERVICE ENTRANCE, 2" THREADED FOR RIGID CONDUIT BRIDGEPORT #1030
	29	LAMP INCANDESCENT,25W,130V,INSIDE FROST,MED.BASE
	30	RECEPTACLE KEYLESS, PORCELAIN LAMPHOLDER, 660W-250V LEVITON #9875
	31	BOX 4" OCTAGON OUTLET, 2-1/2" DEEP, 3/4"
	32	BOX HANDY, 4" X 2-1/8" DEEP, 1/2" KO'S APPLETON #4SSL-1/2, BOWERS #104
●	33	CONNECTOR ROMEX, 3/4", T&B #3303 TWO-SCREW CONNECTOR, 3/4" KNOCKOUT
▲	34	COVER; HANDY BOX, DUPLEX FLUSH RECEPTACLE APPLETON #2510
	35	COVER; HANDY BOX, ONE TOGGLE SWITCH APPLETON #2594
▲	36	COVER; OCTAGON BOX, FLAT 1/2" KO APPLETON #8413, BOWERS #500
▲	37	RECEPTACLE; DUPLEX, 15A-125V AC-DC, BROWN EAGLE #5262B
●	38	RECEPTACLE; GFCI DUPLEX, 15A-120V, LEVITON #6599-I W/WALLPLATE
▲	39	SWITCH; TOGGLE, SINGLE POLE, 10/5A/125/250V AC-DC SINGLE POLE
▲	40	SWITCH; TOGGLE, 3-WAY, 20A/120/277V AC, BROWN EAGLE #2223B
▲	41	CHAIN, SINGLE JACK, #12, 29LB. LOAD LIMIT, STL PLATED, CAMPBELL #080-1224
▲	42	LAMP FLUORESCENT, F96T12/CW/WM, SINGLE PIN BASE GE #F96T12/CW/WM
✳	43	FIXTURE; FLUORESCENT ES, 2-96" LAMPS, W/REFLECTOR ENERGY SAVING TYPE: F
	44	HEAVY DUTY SAFETY SWITCH, SQD, CLASS 3110 #H365NR

✳ ITEMS NOT SHOWN
▲ ITEMS SHOWN ON DWG. CH-03
● ITEMS SHOWN ON DWG. CH-02 AND CH-03

NOTE 1: CONTRACTOR TO VERIFY LOCATION FOR CONDUIT ENTRANCE FOR AC FROM DISTRIBUTION CIRCUIT.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

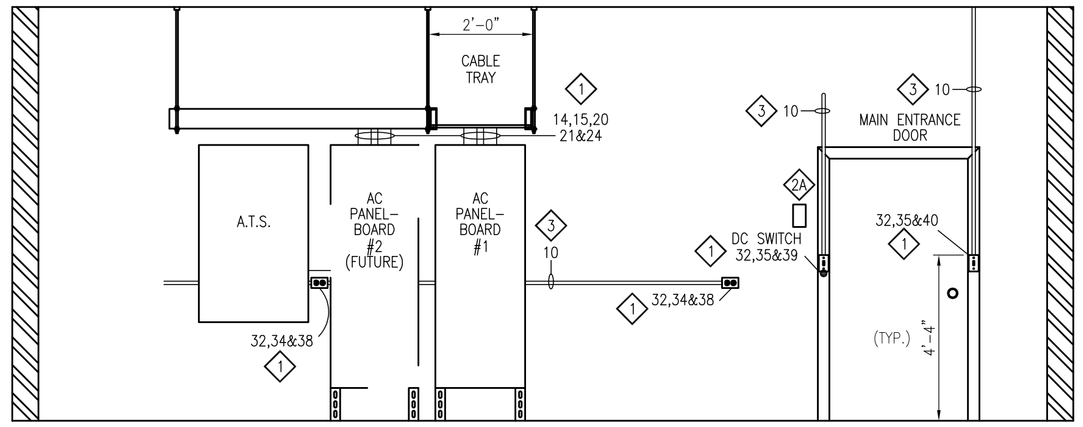
TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION CONTROL HOUSE

0 1" 2"

FILENAME	TWEND-CH-02
SCALE	1/2"=1'

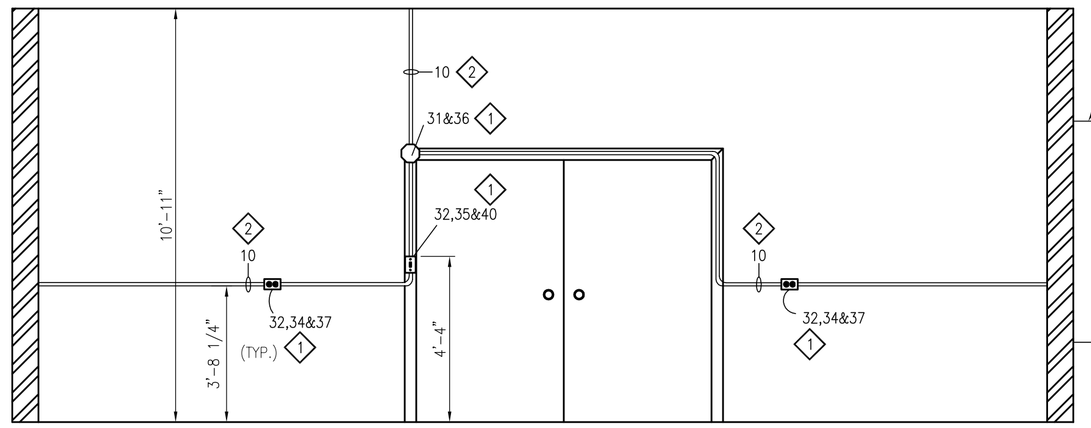
SHEET **CH-02**



20'x20' CONTROL HOUSE
SECTION "A" (TYPICAL)
SCALE: N.T.S.

CONTROL HOUSE "A"
CONSTRUCTION NOTE(S):

1. –REFER TO DWG. CH–02 FOR MATERIAL DESCRIPTION.
2A. –TELEPHONE(S) SHALL BE INSTALLED NEXT TO MAIN ENTRANCE DOOR AT NO MORE THAN 2'–0" OF FRAME EDGE.
3. –CONDUIT SIZE FOR RECEPTACLES, LIGHT FIXTURES AND SINGLE TOGGLE SWITCHES SHALL BE ½" EMT UNLESS OTHERWISE NOTED ON DRAWINGS.

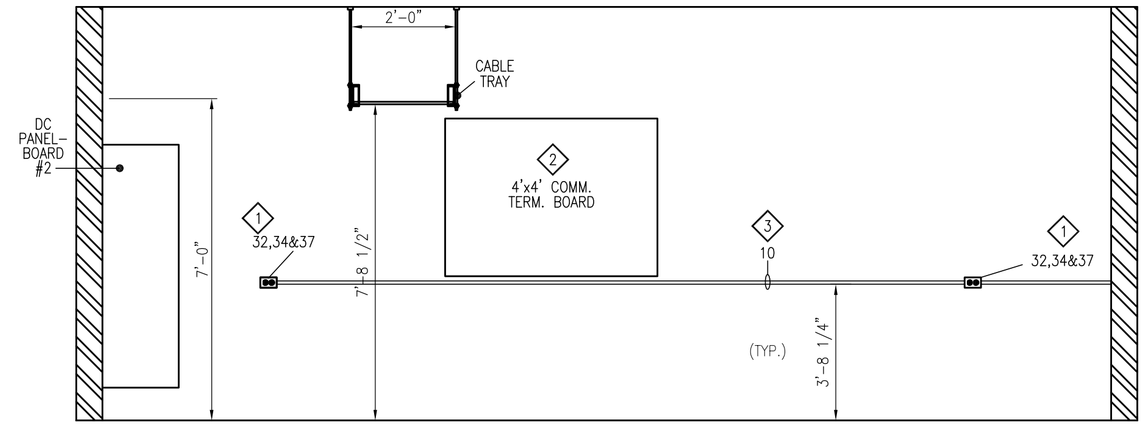


EMERGENCY DISCONNECT

20'x20' CONTROL HOUSE
SECTION "B" (TYPICAL)

CONTROL HOUSE "B"
CONSTRUCTION NOTE(S):

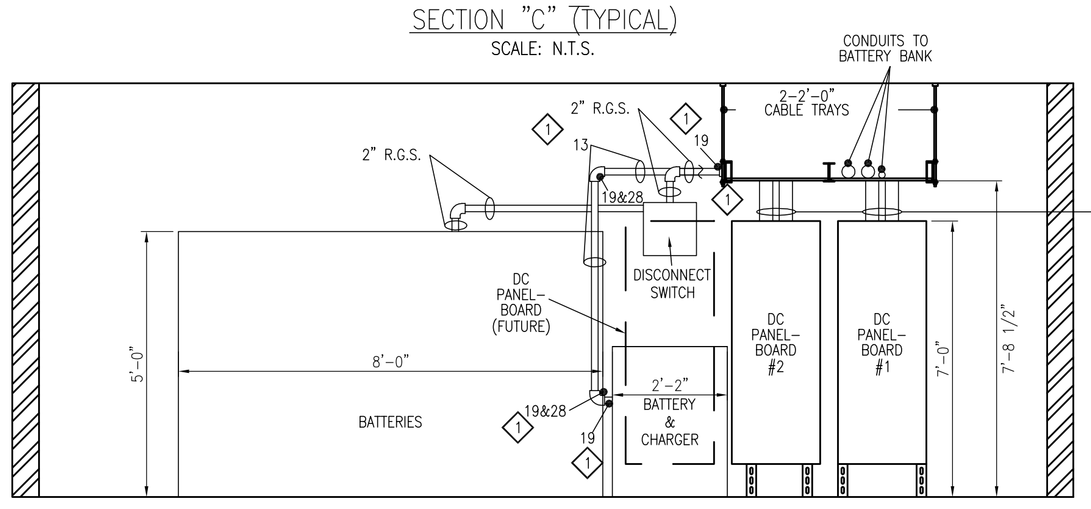
1. –REFER TO DWG. CH–02 FOR MATERIAL DESCRIPTION.
2. –CONDUIT SIZE FOR RECEPTACLES, LIGHT FIXTURES AND SINGLE TOGGLE SWITCHES SHALL BE ½" EMT UNLESS OTHERWISE NOTED ON DRAWINGS.



20'x20' CONTROL HOUSE
SECTION "C" (TYPICAL)
SCALE: N.T.S.

CONTROL HOUSE "C"
CONSTRUCTION NOTE(S):

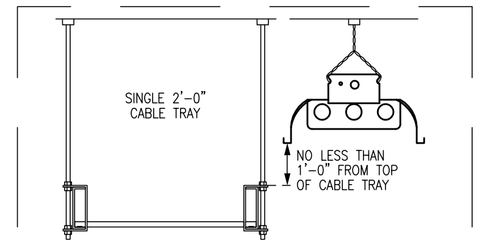
1. –REFER TO DWG. CH–02 FOR MATERIAL DESCRIPTION.
2. –COMMUNICATION BOARD LOCATION WILL BE DETERMINED BY ON SITE CONSTRUCTION PERSONNEL.
3. –CONDUIT SIZE FOR RECEPTACLES, LIGHT FIXTURES AND SINGLE TOGGLE SWITCHES SHALL BE ½" EMT UNLESS OTHERWISE NOTED ON DRAWINGS.



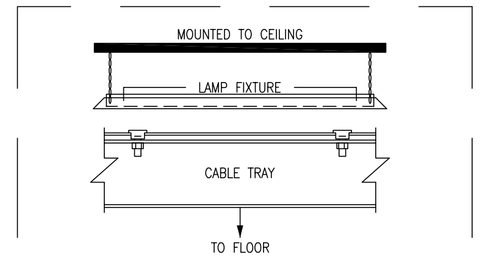
20'x20' CONTROL HOUSE
SECTION "D" (TYPICAL)
SCALE: N.T.S.

CONTROL HOUSE "D"
CONSTRUCTION NOTE(S):

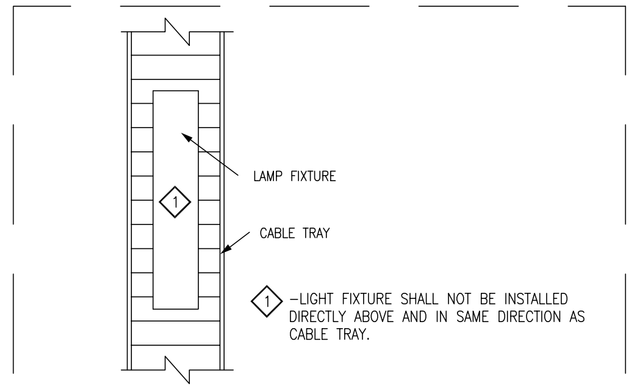
1. –REFER TO DWG. CH–02 FOR MATERIAL DESCRIPTION.
2. –CONDUIT SIZE FOR RECEPTACLES, LIGHT FIXTURES AND SINGLE TOGGLE SWITCHES SHALL BE ½" EMT UNLESS OTHERWISE NOTED ON DRAWINGS.



FLUORESCENT LAMP FIXTURE
INSTALLATION DETAIL (TYPICAL)
(FRONT VIEW)



FLUORESCENT LAMP FIXTURE
INSTALLATION DETAIL (TYPICAL)
(SIDE VIEW)



UNACCEPTACLE FLUORESCENT LAMP FIXTURE
INSTALLATION DETAIL (TYPICAL)
(TOP VIEW)

MORTENSON®

HDR
HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

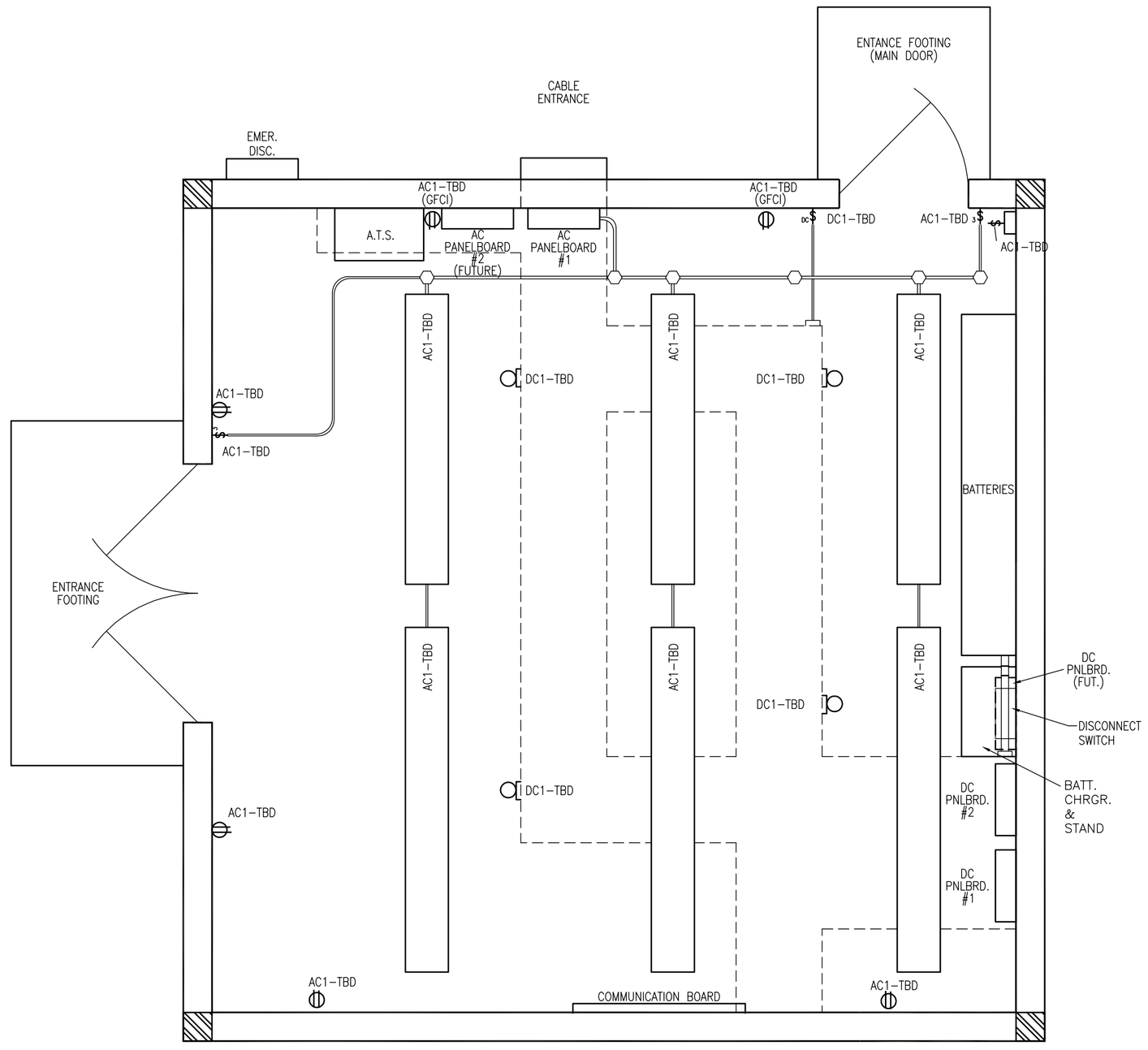
TATANKA WIND ENERGY

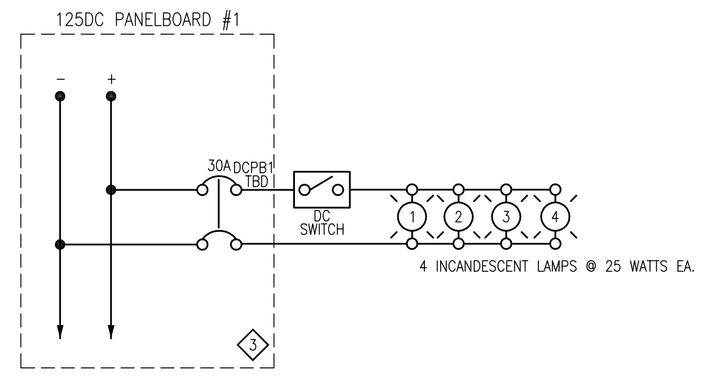
TATANKA 230KV INTERCONNECT SUBSTATION CONTROL HOUSE

0 1" 2"

FILENAME	TWEND–CH–03
SCALE	NONE

SHEET
CH-03





DC LIGHTING SCHEMATIC

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

TATANKA 230KV
INTERCONNECT SUBSTATION
CONTROL HOUSE

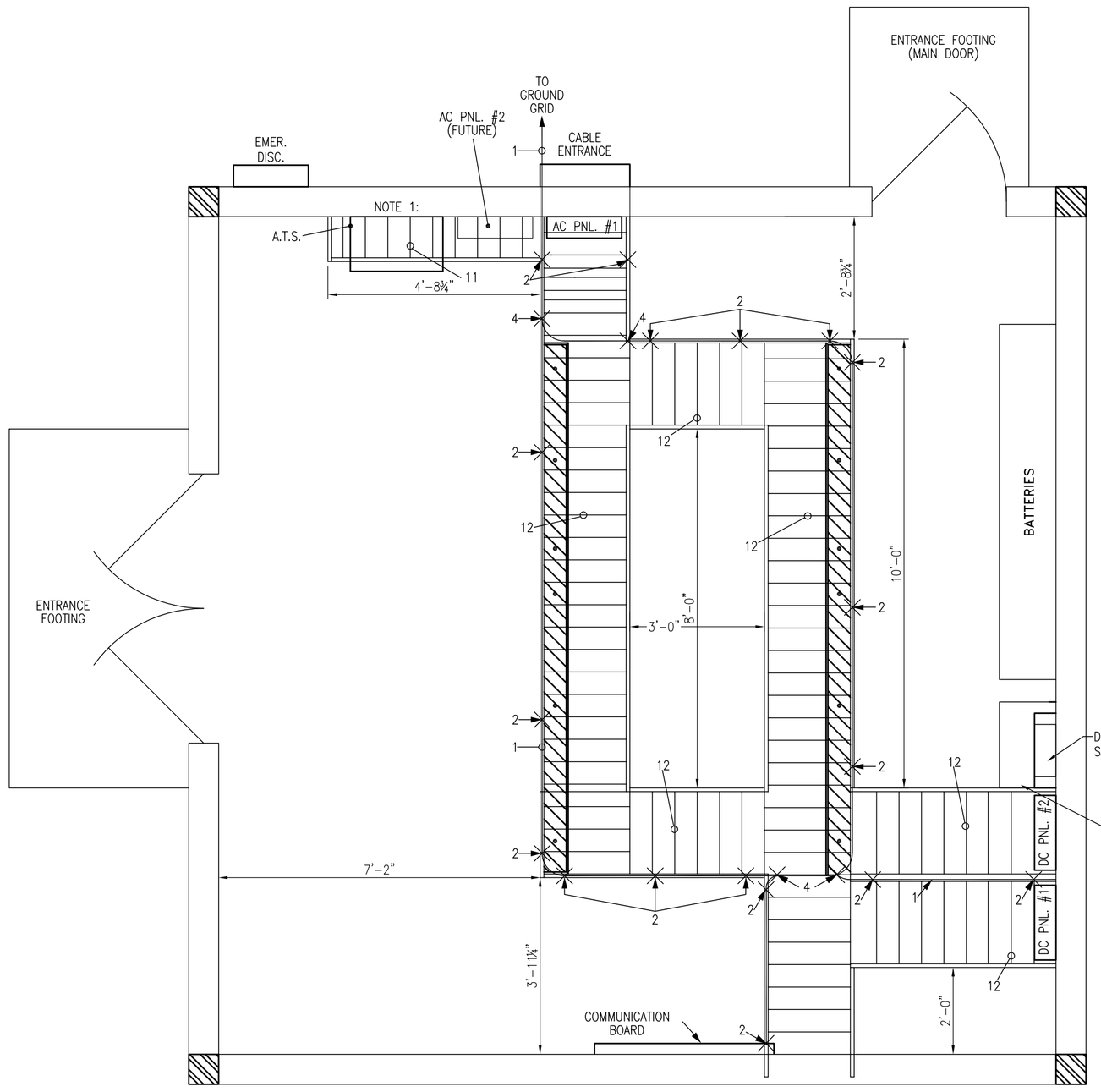
0 1" 2"

FILENAME	TWEND-CH-04
SCALE	NONE

SHEET
CH-04

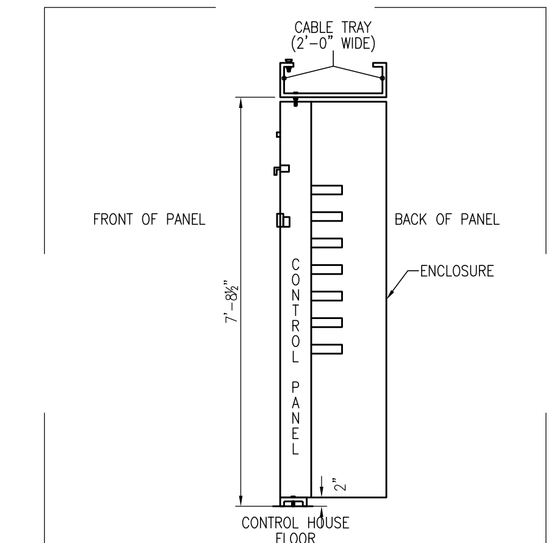
ITEM		MATERIAL DESCRIPTION	UNITS
1		COPPER; 4/0 AWG 19STR BARE MEDIUM HARD DRAWN	LB
2		LUG; BRONZE SINGLE TAP TP, #6-250 ANDERSON #TLS-42-LTP	EA
3	*	CONNECTOR; BRONZE SPLIT-BOLT TP, 4/0 STR #4 SOL BLACKBURN	EA
4		CONNECTOR; GRND TAP, 3/0-250 & 3/0-250, BRANDY #YGHC29C29	EA
5	*	CHANNEL; KINDORF #B-905, 1-1/2" X 10' STEEL	FT
6		CLAMP, CABLE TRAY SINGLE OVERHEAD HANGER, ALUMINUM P-W #836-01	EA
7	*	CONNECTOR, CABLE TRAY ANGLE 6" ALUMINUM P-W #09-4609-1320	EA
8		COVER, CABLE TRAY FLAT 12' X 24" ALUM	EA
9		NUT; CABLE TRAY HANGER ROD 1/2" -13 TPI	EA
10		ROD, CABLE TRAY HANGER, 1/2"-13 TPI X 10' ZINC	EA
11		TRAY CABLE, LADDER TYPE, 24' X 12" X 6" ALUM. P-W #09-4609-0024-12	EA
12		TRAY CABLE, LADDER TYPE, 24' X 24" X 6" ALUM. P-W #09-4609-0024-24	EA

*ITEMS NOT SHOWN



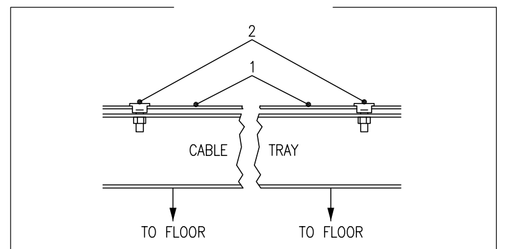
CABLE TRAY INSTALLATION DETAILS (TYPICAL)

SCALE: N.T.S.



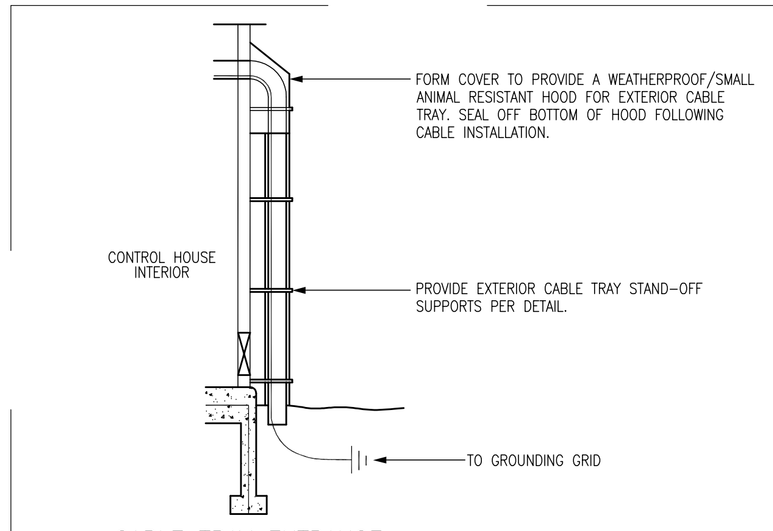
CABLE TRAY & CHANNEL IRON INSTALLATION DETAIL (TYPICAL)

SCALE: N.T.S.



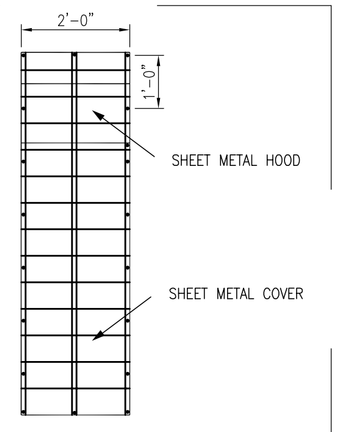
CABLE TRAY GROUNDING INSTALLATION DETAIL (TYPICAL)

SCALE: N.T.S.



CABLE TRAY ENTRANCE WITHOUT CABLE VAULT SIDE VIEW DETAIL (TYPICAL)

SCALE: N.T.S.



CABLE TRAY ENTRANCE FRONT VIEW DETAIL (TYPICAL)

SCALE: N.T.S.

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION CONTROL HOUSE

0 1" 2"

FILENAME	TWEND-CH-05
SCALE	NONE

SHEET **CH-05**

D.C. CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
100	X	X	X	X'	X
101	BATTERY	DC PANEL #1	2-1/C#2/0	30'	DC POWER
102	DC PANEL #2	DC PANEL #1	2-1/C#2/0	20'	DC POWER
103	DC PANEL #1	CB 5181	4/C#10	200'	MOTOR
104	DC PANEL #1	CB 5181	2/C#10	220'	TRIP 1
105	DC PANEL #1	PANEL 1F	2/C#10	50'	21AE
106	DC PANEL #1	CB 5181	2/C#10	220'	TRIP 2
107	DC PANEL #1	PANEL 1F	2/C#10	50'	21BE
108	DC PANEL #1	CB 5181	2/C#10	220'	CLOSE
109	DC PANEL #1	CB 5177	4/C#10	120'	MOTOR
110	DC PANEL #1	CB 5177	2/C#10	120'	TRIP 1
111	DC PANEL #1	PANEL 4F	2/C#10	50'	21AP
112	DC PANEL #1	CB 5177	2/C#10	120'	TRIP 2
113	DC PANEL #1	PANEL 4F	2/C#10	50'	21BP
114	DC PANEL #1	CB 5177	2/C#10	120'	CLOSE
115	DC PANEL #1	CB 5185	4/C#10	130'	MOTOR
116	DC PANEL #1	CB 5185	2/C#10	130'	TRIP 1
117	DC PANEL #1	PANEL 3F	2/C#10	50'	21AW
118	DC PANEL #1	CB 5185	2/C#10	130'	TRIP 2
119	DC PANEL #1	PANEL 3F	2/C#10	50'	21BW
120	DC PANEL #1	CB 5185	2/C#10	130'	CLOSE
121	DC PANEL #1	DC LIGHTS	2/C#10	100'	LIGHTS
122	DC PANEL #1	BATT. CHGR.	4/C#8	20'	CHARGER
123	DC PANEL #2	PANEL 1F	2/C#10	50'	50/62BF1
124	DC PANEL #2	SCADA RTU	2/C#10	50'	RTU
125	DC PANEL #2	PANEL 2F	2/C#10	50'	50/62BF2
126	DC PANEL #2	E-PLC	2/C#10	50'	PLC
127	DC PANEL #2	PANEL 3F	2/C#10	50'	50/63BF3
128	DC PANEL #2	W-PLC	2/C#10	50'	PLC
129	DC PANEL #2	PANEL 2F	2/C#10	50'	2030
130	DC PANEL #2	PANEL 4F	2/C#10	50'	METER
131	BATTERY	BATTERY DISCONNECT	2/C#4/0	20'	DC
132	BATTERY DISCONNECT	DC PANEL #1	2/C#4/0	50'	DC
133	DC PANEL #2	MDU TONE EQUIP.	2/C#10	100'	DC POWER

A.C. CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
200	AC PANEL #1	X	X	X'	X
201	AC PANEL #1	ATS	(2)3-1/C#4/0	20'	POWER
202	AC PANEL #1	CB 5181	2-3/C#6	220'	MOTOR, HTR
203	AC PANEL #1	CB 5177	2-3/C#6	120'	MOTOR, HTR
204	AC PANEL #1	CB 5185	2-3/C#6	130'	MOTOR, HTR
205	AC PANEL #1	A/C UNIT	2-3/C#6	60'	POWER
206	AC PANEL #1	BATT. CHGR.	2-3/C#8	50'	CHARGER
207	AC PANEL #1	YARD LT1	2/C#10		LIGHTS
208	AC PANEL #1	YARD LT2	2/C#10		LIGHTS
209	AC PANEL #1	YARD RCPT1	2/C#10		RCPT
210	AC PANEL #1	SWBD PANEL #1	2/C#10		CCVT HEATERS
211	AC PANEL #1	BLDG LT	2/C#10		LIGHTS
212	AC PANEL #1	BLDG RCPT1	2/C#10		RCPT
213	AC PANEL #1	BLDG RCPT2	2/C#10		RCPT
214	AC PANEL #1	SCADA RTU	2/C#10	30'	RTU
215	DISTRUBUTION CIRCUIT	ATS	(2)3-1/C 4/0	20'	AC
216	EMERGENCY DISC.	ATS	(2)3-1/C 4/0	20'	AC

P.T. CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
300	X	X	X	X'	X
301	CCVT JBOX1	PANEL 1F	7/C#10	200'	21AE
302	CCVT JBOX1	PANEL 1F	7/C#10	200'	21BE
303	CCVT JBOX2	PANEL 3F	7/C#10	100'	21AW
304	CCVT JBOX2	PANEL 3F	7/C#10	100'	21BW
305	CCVT JBOX3	PANEL 4F	7/C#10	260'	21AP, M1
306	CCVT JBOX3	PANEL 4F	7/C#10	260'	21BP
307	PANEL 4F	PANEL 1F	4/C#10	30'	SYNC
308	PANEL 4F	PANEL 3F	4/C#10	20'	SYNC
309	PANEL 1F	PANEL 3F	4/C#10	25'	SYNC
310	PANEL 3F	PANEL 1F	4/C#10	25'	SYNC

C.T. CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
400	X	X	X	X'	X
401	CB 5181	PANEL 1F	4C#10	220'	21AE
402	CB 5181	PANEL 1F	4C#10	220'	21BE
403	CB 5181	PANEL 1F	4C#10	220'	SPARE
404	CB 5181	PANEL 4F	4C#10	220'	21AP
405	CB 5181	PANEL 4F	4C#10	220'	21BP
406	CB 5181	PANEL 1F	4C#10	220'	50/62BF1
407	CB 5177	PANEL 3F	4C#10	120'	21AW
408	CB 5177	PANEL 3F	4C#10	120'	21BW
409	CB 5177	PANEL 2F	4C#10	120'	SPARE
410	CB 5177	PANEL 1F	4C#10	120'	21AE
411	CB 5177	PANEL 1F	4C#10	120'	21BE
412	CB 5177	PANEL 2F	4C#10	120'	50/62BF2
413	CB 5185	PANEL 3F	4C#10	130'	21AW
414	CB 5185	PANEL 3F	4C#10	130'	21BW
415	CB 5185	PANEL 3F	4C#10	130'	SPARE
416	CB 5185	PANEL 4F	4C#10	130'	21AP
417	CB 5185	PANEL 4F	4C#10	130'	21BP
418	CB 5185	PANEL 3F	4C#10	130'	50/62BF3
419	PANEL 4F	OCT BOX	4C#10	50'	METER

CONTROL CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
500	X	X	X	X'	X
501	CB 5181	PANEL 1F	12/C#10	200'	T1 & C
502	CB 5181	PANEL 1F	4/C#10	200'	T2
503	CB 5181	PANEL 1F	7/C#10	200'	STATUS
504	CB 5181	PANEL 1F	7/C#10	200'	ALARMS
505	CB 5181	PANEL 4F	4/C#10	200'	STATUS
506	CB 5181	PANEL 1F	4/C#10	200'	SPARE
507	CB 5177	PANEL 2F	12/C#10	120'	T1 & C
508	CB 5177	PANEL 2F	4/C#10	120'	T2
509	CB 5177	PANEL 2F	7/C#10	120'	ALARMS
510	CB 5177	PANEL 2F	7/C#10	120'	ALARMS
511	CB 5177	PANEL 1F	4/C#10	120'	STATUS
512	CB 5177	PANEL 3F	4/C#10	120'	STATUS
513	CB 5185	PANEL 3F	12/C#10	130'	T1 & C
514	CB 5185	PANEL 3F	4/C#10	130'	T2
515	CB 5185	PANEL 3F	7/C#10	130'	STATUS
516	CB 5185	PANEL 3F	7/C#10	130'	ALARMS
517	CB 5185	PANEL 4F	4/C#10	130'	STATUS
518	CB 5185	PANEL 3F	4/C#10	130'	SPARE
519	PANEL 1F	PANEL 2F	7/C#10	20'	TRIP 1
520	PANEL 1F	PANEL 2F	12/C#10	20'	TRIP 2/ BFI/RI
521	PANEL 1F	PANEL 2F	12/C#10	20'	CB 5177
522	PANEL 1F	PANEL 3F	7/C#10	25'	21AP & BP
523	PANEL 1F	PANEL 4F	4/C#10	30'	BC & BF
524	PANEL 2F	PANEL 3F	7/C#10	20'	TRIP 1
525	PANEL 2F	PANEL 3F	12/C#10	20'	TRIP 2 BFI/RI
526	PANEL 2F	PANEL 3F	12/C#10	20'	CB 5177
527	PANEL 3F	PANEL 4F	4/C#10	20'	TRIP 1
528	PANEL 3F	PANEL 4F	4/C#10	20'	TRIP 2
529	PANEL 3F	PANEL 4F	4/C#10	20'	21AP & BP
530	PANEL 3F	PANEL 4F	4/C#10	20'	BC & BF
531	MDU TONE	PANEL 4F	2C#10	X	SPS

COMMUNICATION CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
6700	X	X	X	X'	X
6701	2030 PORT 1	SEL-421 (1F)	C273A	20'	21AE
6702	2030 PORT 2	SEL-311C (1F)	C273A	20'	21BE
6703	2030 PORT 3	SEL-421 (3F)	C273A	20'	21AW
6704	2030 PORT 4	SEL-311C (3F)	C273A	20'	21BW
6705	2030 PORT 5	SEL-311C (4F)	C273A	25'	21AP
6706	2030 PORT 6	SEL-311C (4F)	C273A	25'	21BP
6707					
6708	2030 PORT 12	MODEM	C220	2'	
6709	2030 PORT 9	SEL-501 (1F)	C273A	20'	50/62BF1
6710	2030 PORT 10	SEL-501 (2F)	C273A	6'	50/62BF2
6711	2030 PORT 11	SEL-501 (3F)	C273A	20'	50/62BF3
6712					
6713					
6714					
6715					
6716	2030 PORT 16	SCADA RTU	C280	40'	
6717	GPS CLOCK	2030 IRIG-B	C953	2'	IRIG-B
6718	GPS CLOCK	METER IRIG-B	C962	25'	IRIG-B

FIBER OPTIC CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
6500	X	X	X	X'	X
6501	SEL-311C (4F)	FIBER TERM. BOX	2	40'	21AP
6502	SEL-311C (4F)	FIBER TERM. BOX	2	40'	21BP

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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW - SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	PWC
DRAWN	GDS
PROJECT NUMBER	48069

acciona

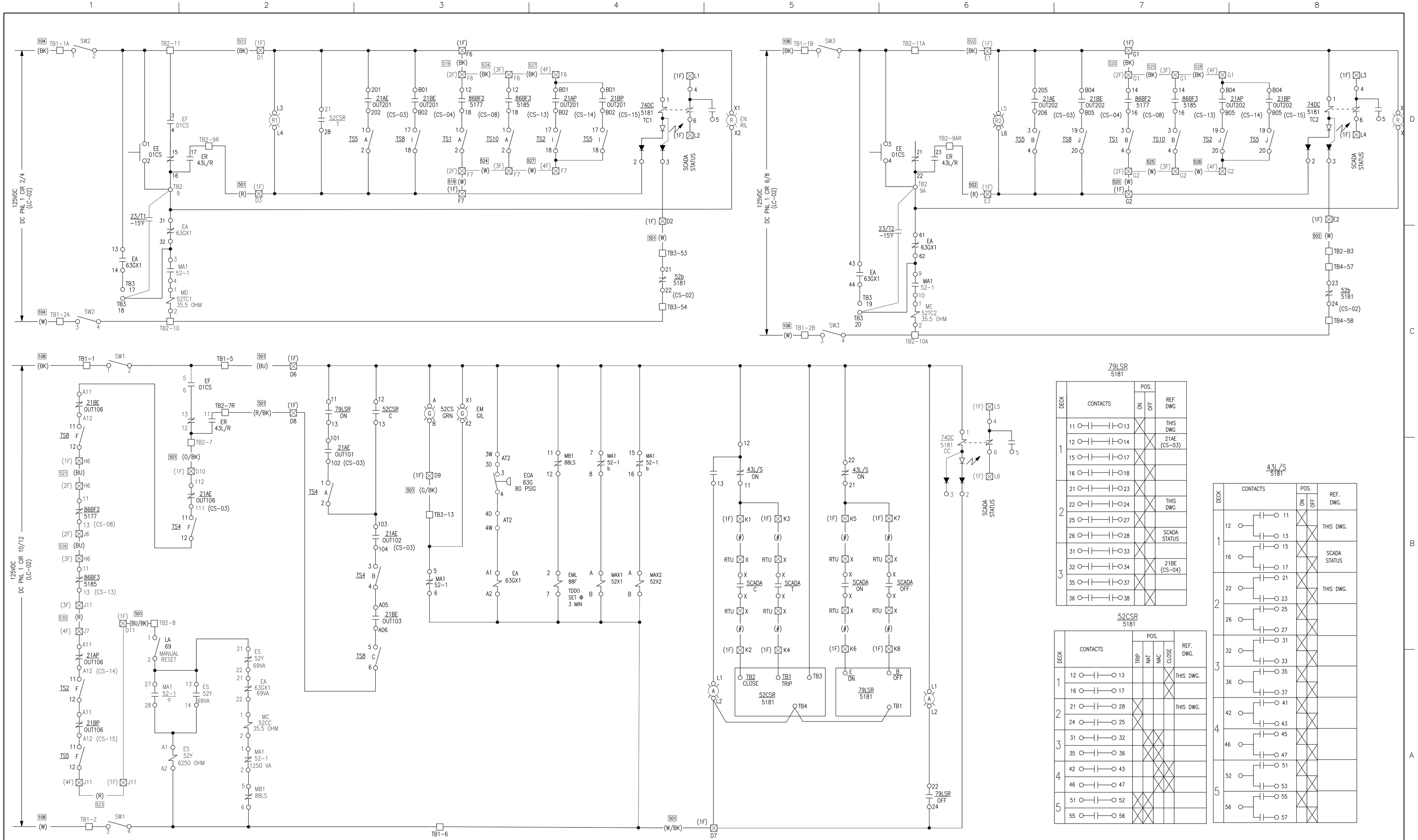
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION CABLE LIST

0 1" 2"

FILENAME	TWEND-CL-01.DWG
SCALE	NONE

SHEET **CL-01**



ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	REVISED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

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HDR Engineering, Inc.

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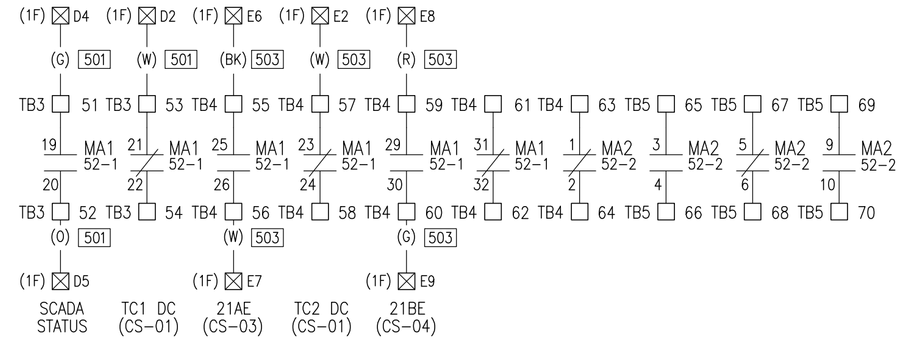
TATANKA WIND ENERGY

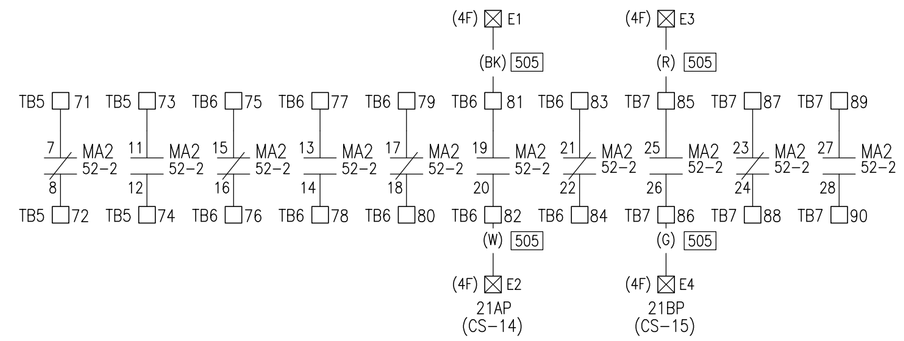
230kV INTERCONNECT SUBSTATION PCB 5181 TRIP AND CLOSE DC SCHEMATIC DIAGRAM

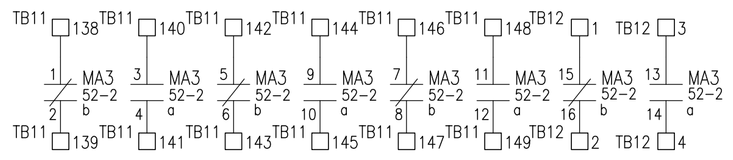
FILENAME	TWEND-CS-01.DWG
SCALE	NONE

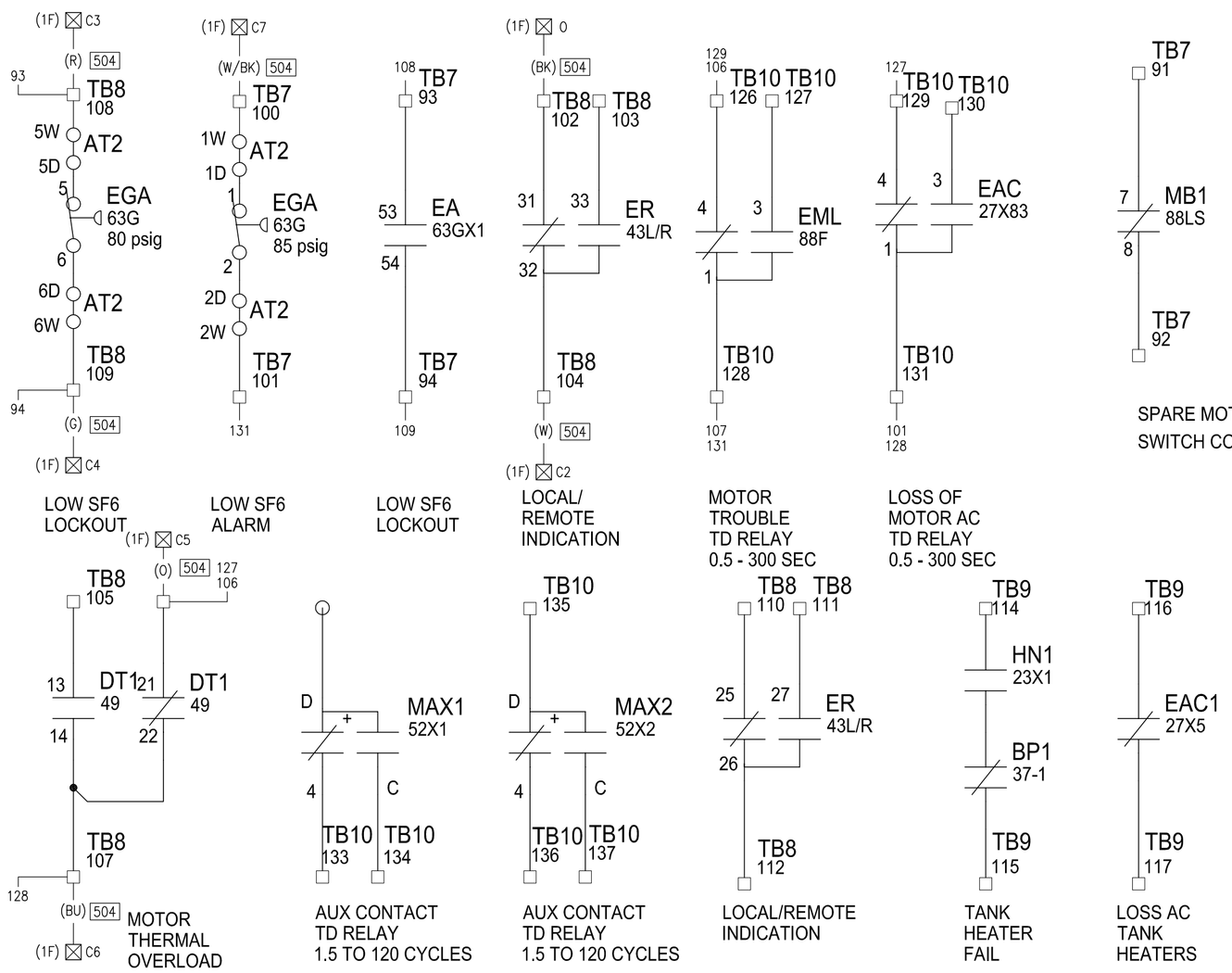
SHEET CS-01

AUXILIARY SWITCHES

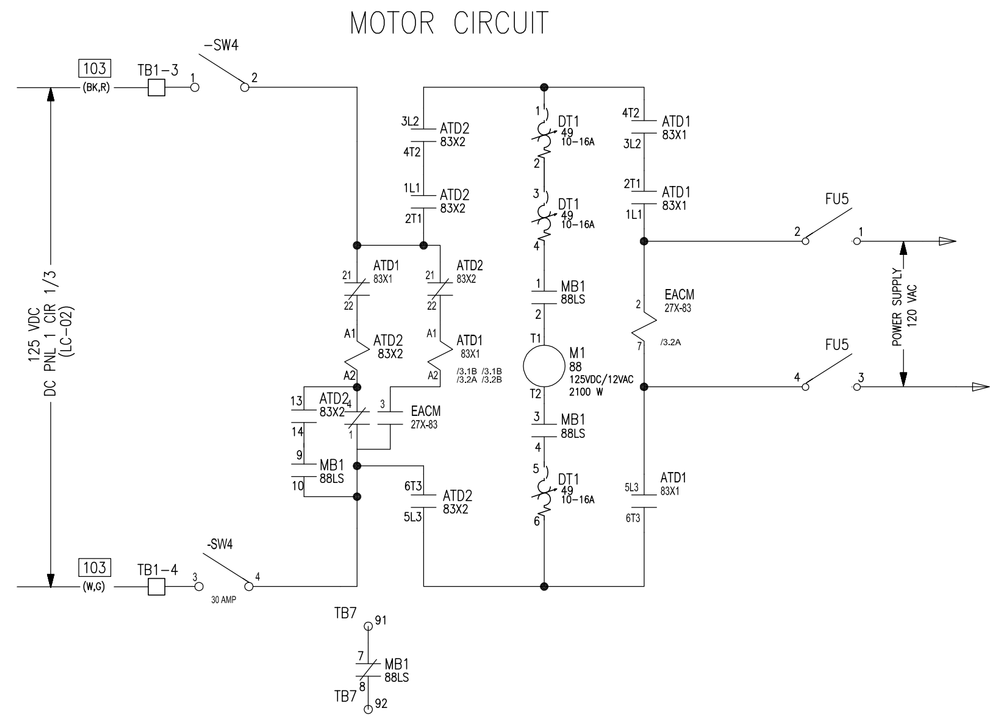






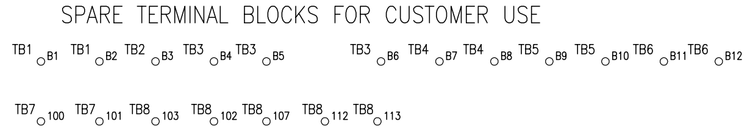


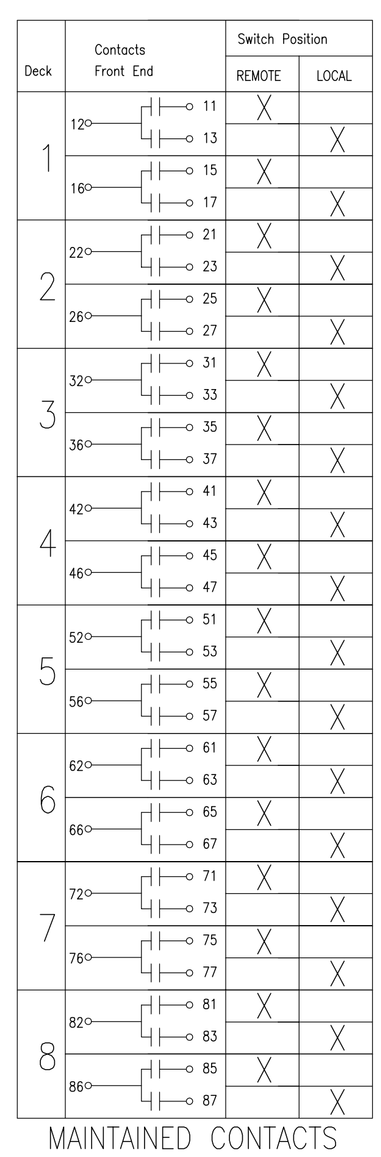
MOTOR CIRCUIT



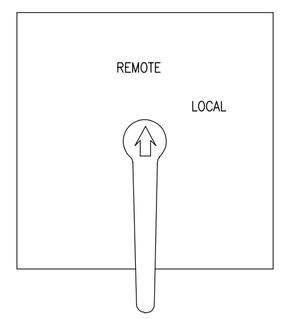
SPARE MOTOR LIMIT SWITCH CONTACT

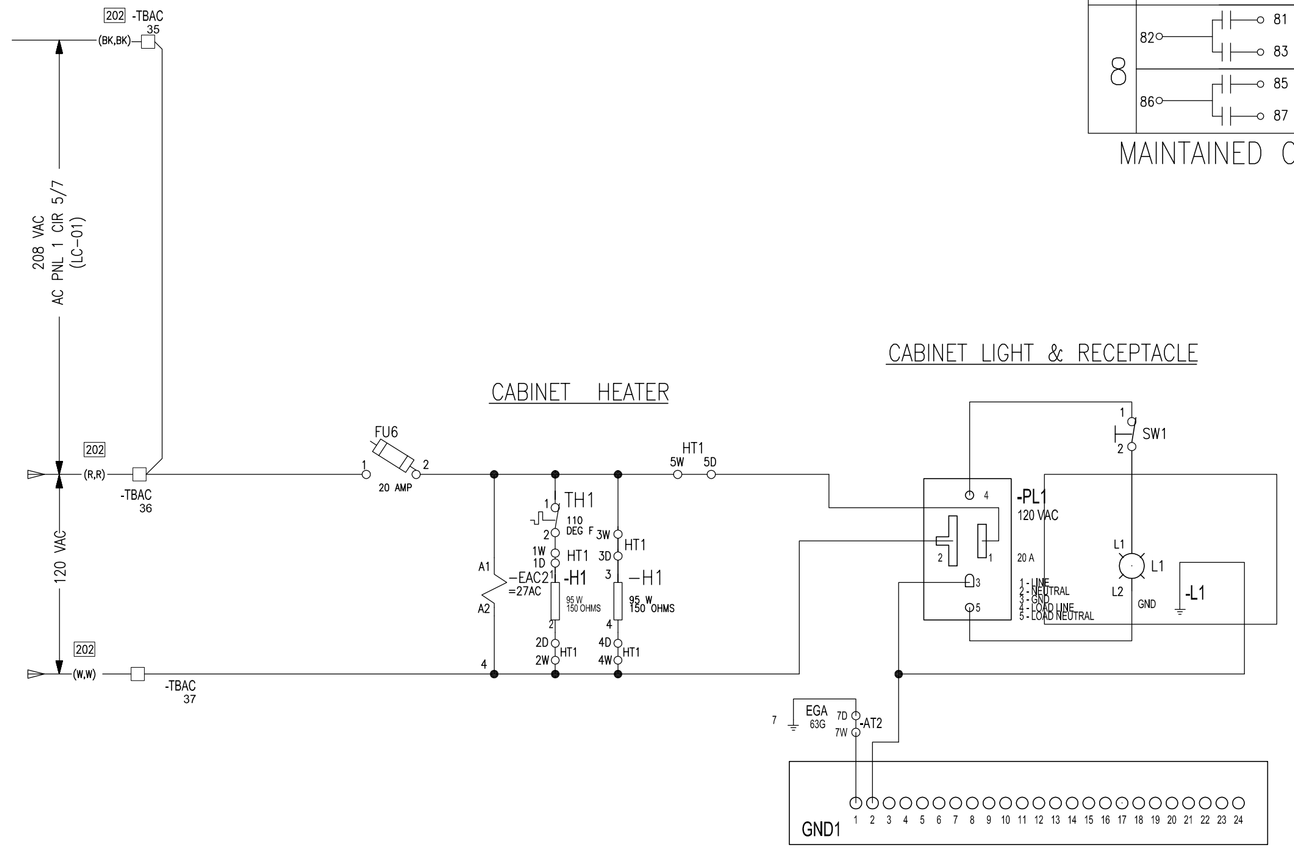
SPARE TERMINAL BLOCKS FOR CUSTOMER USE

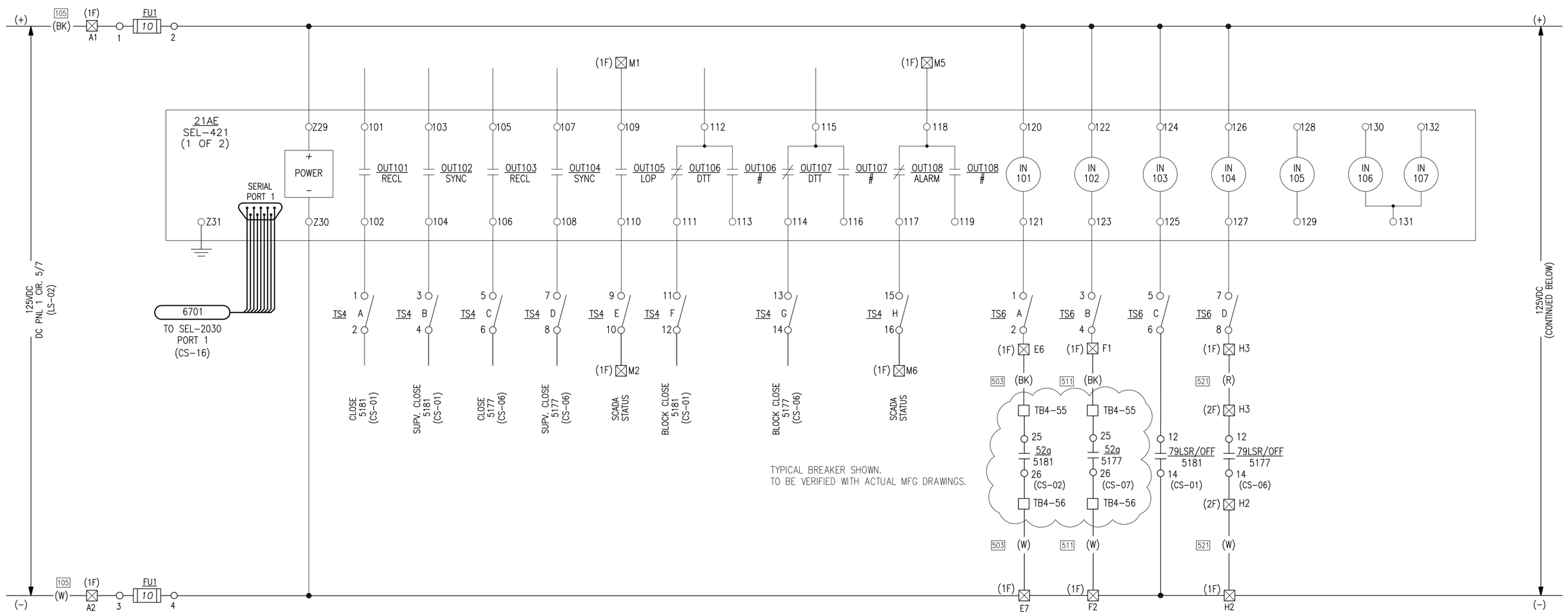




MAINTAINED CONTACTS







PROJECT MANAGER	WEB	
PROJECT NUMBER	48069	

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
	03-30-07	ISSUED FOR CONSTRUCTION

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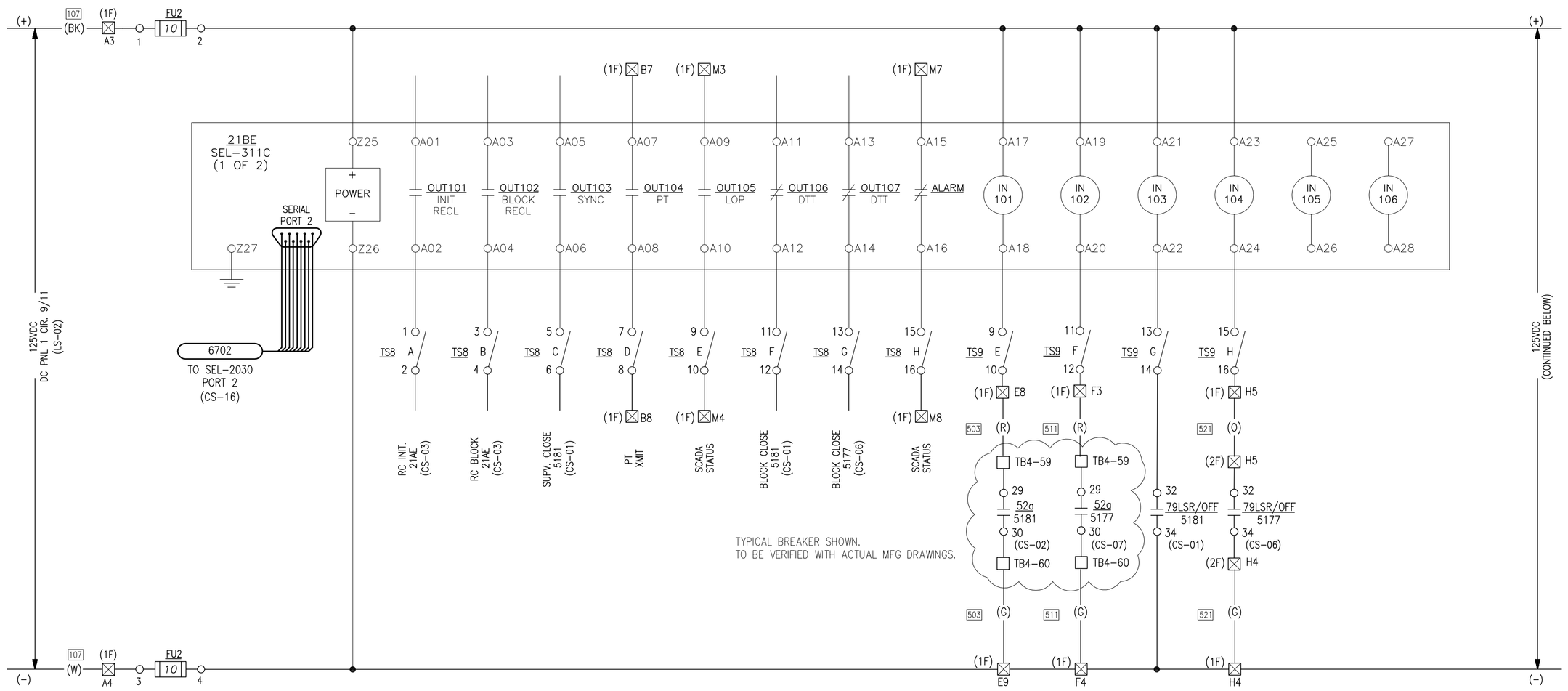
TATANKA WIND ENERGY

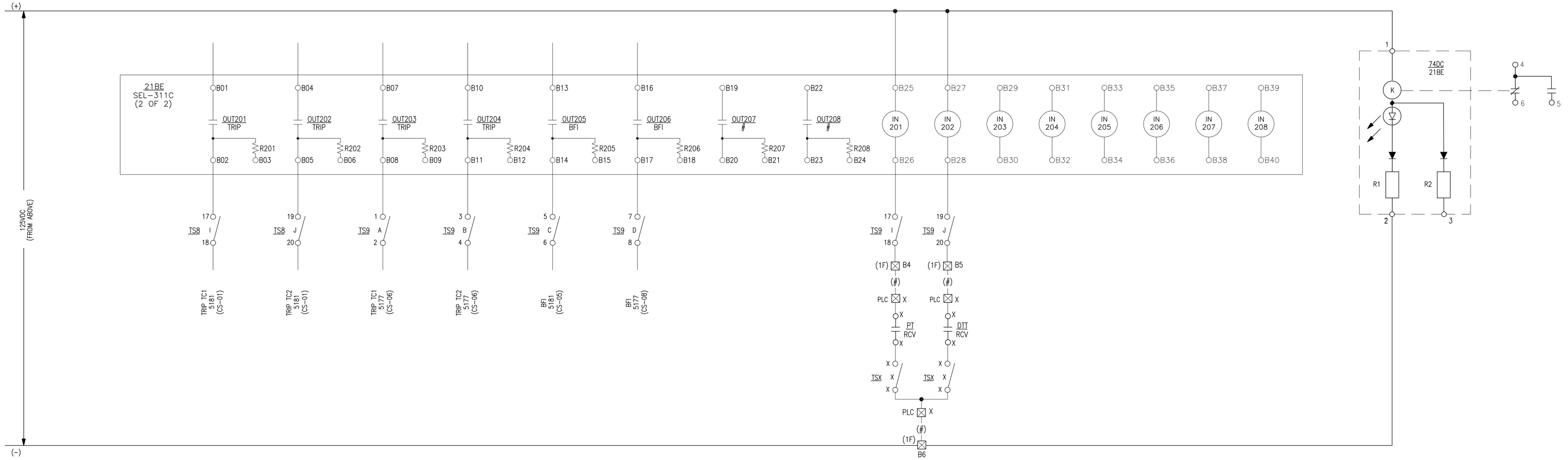
230kV INTERCONNECT SUBSTATION
ELLENDALE PRIMARY LINE RELAY
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-03.DWG
SCALE	NONE

SHEET **CS-03**





	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

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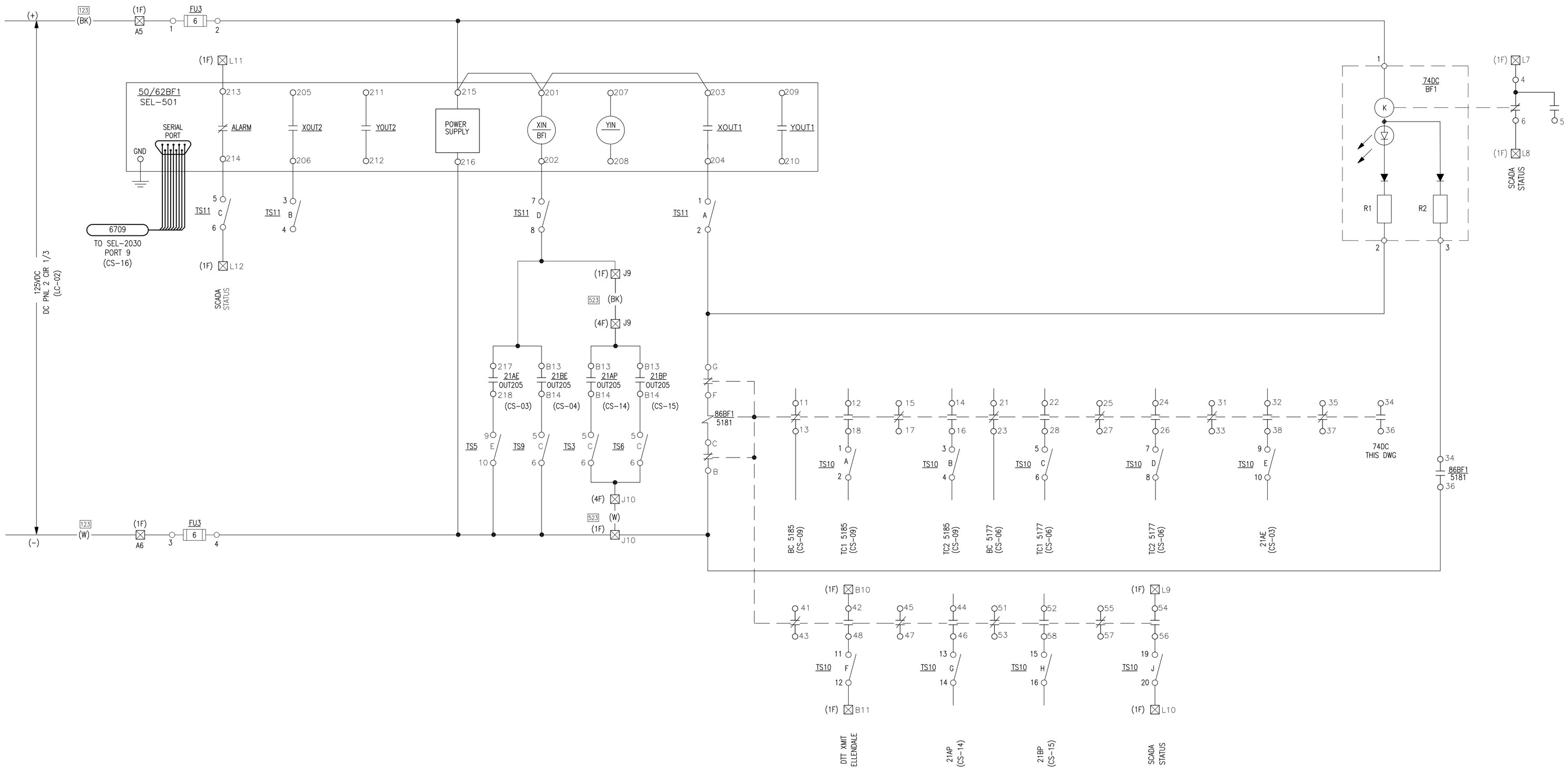
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
ELLENDALE SECONDARY LINE RELAY
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-04.DWG
SCALE	NONE

SHEET
CS-04



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HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

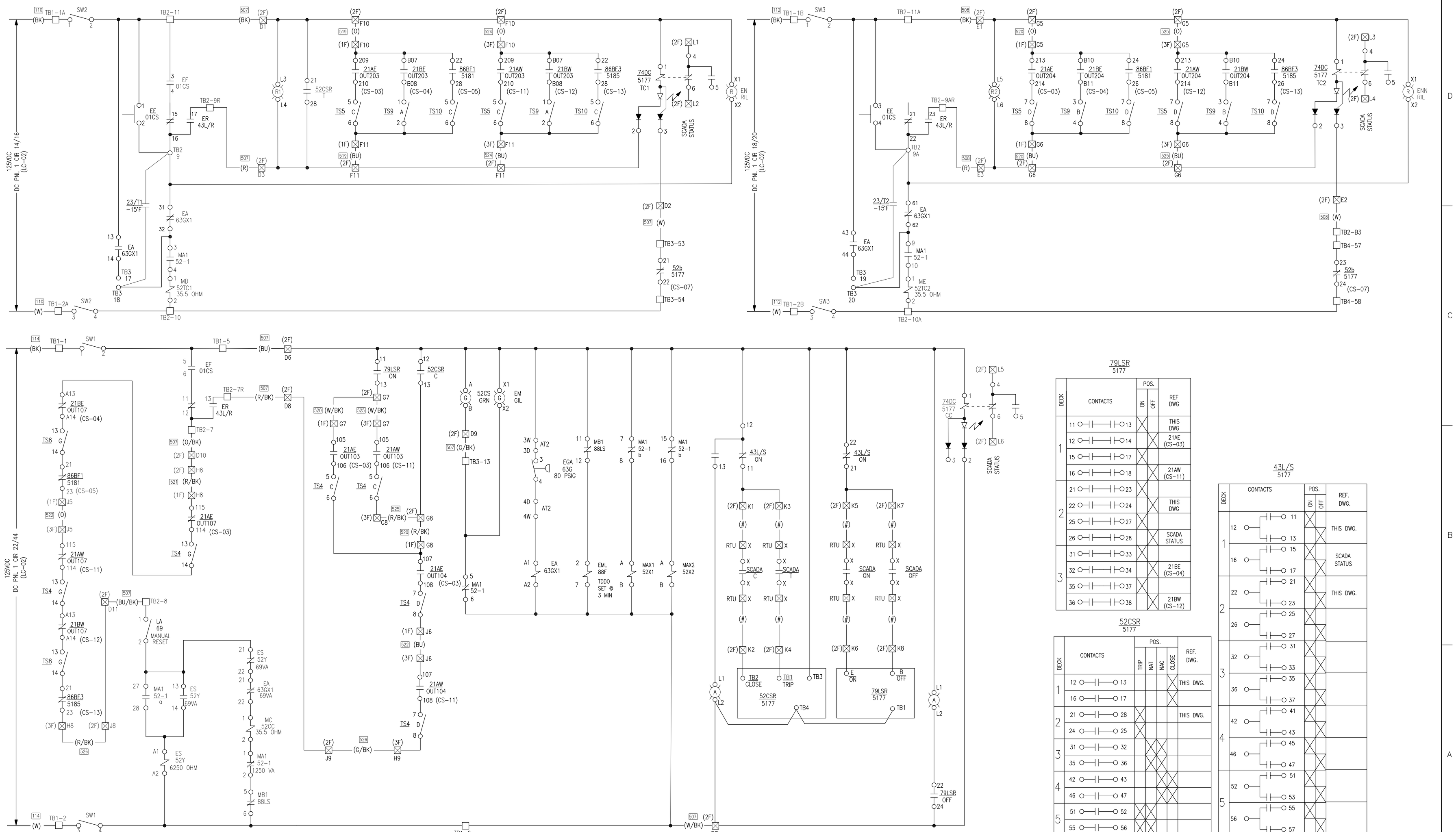
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
PCB 5181 BREAKER FAILURE
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-05.DWG
SCALE	NONE

SHEET CS-05



79LSR 5177

DECK	CONTACTS	POS. ON	POS. OFF	REF DWG
1	11 — 13		X	THIS DWG
	12 — 14		X	21AE (CS-03)
	15 — 17	X		
	16 — 18		X	21AW (CS-11)
2	21 — 23	X		
	22 — 24		X	THIS DWG
	25 — 27	X		
	26 — 28		X	SCADA STATUS
3	31 — 33	X		
	32 — 34		X	21BE (CS-04)
	35 — 37	X		
	36 — 38		X	21BW (CS-12)

43L/S 5177

DECK	CONTACTS	POS. ON	POS. OFF	REF. DWG.
1	11 — 12	X		
	13 — 14		X	THIS DWG.
	15 — 16	X		
	17 — 18		X	SCADA STATUS
2	21 — 22	X		
	23 — 24		X	THIS DWG.
	25 — 26	X		
	27 — 28		X	
3	31 — 32	X		
	33 — 34		X	THIS DWG.
	35 — 36	X		
	37 — 38		X	
4	41 — 42	X		
	43 — 44		X	
	45 — 46	X		
	47 — 48		X	
5	51 — 52	X		
	53 — 54		X	
	55 — 56	X		
	57 — 58		X	

52CSR 5177

DECK	CONTACTS	POS. TRIP	POS. NAT	POS. NAC	POS. CLOSE	REF. DWG.
1	12 — 13				X	THIS DWG.
	16 — 17				X	
2	21 — 28				X	THIS DWG.
	24 — 25				X	
3	31 — 32		X	X		
	35 — 36		X	X		
4	42 — 43				X	
	46 — 47				X	
5	51 — 52	X				
	55 — 56	X				

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	REVISED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

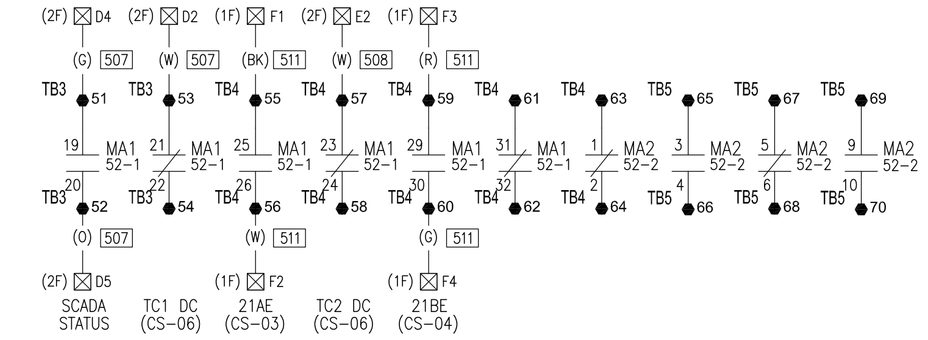
230kV INTERCONNECT SUBSTATION PCB 5177 TRIP AND CLOSE DC SCHEMATIC DIAGRAM

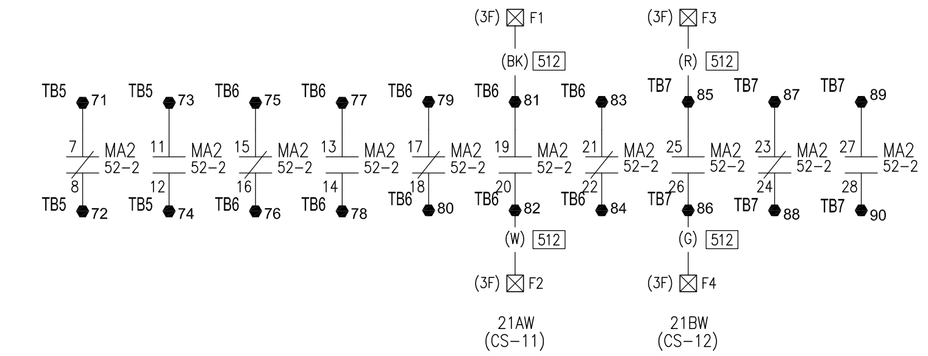
0 1" 2"

FILENAME	TWEND-CS-06.DWG
SCALE	NONE

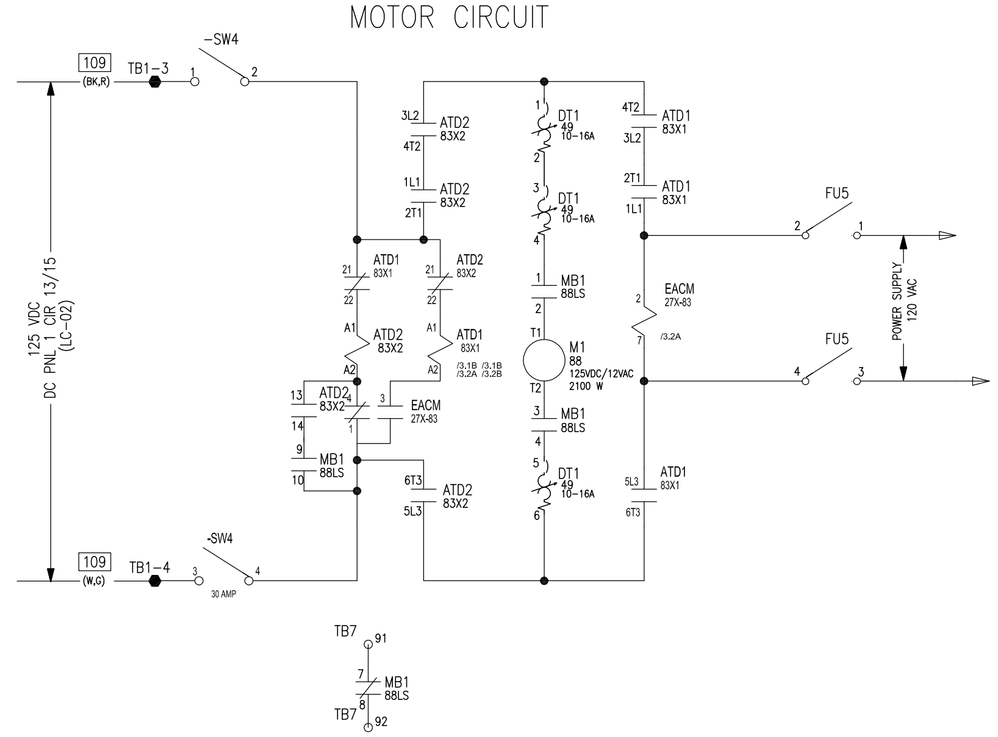
SHEET CS-06

AUXILIARY SWITCHES



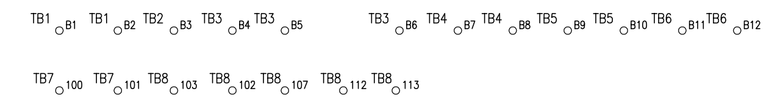


MOTOR CIRCUIT



SPARE MOTOR LIMIT SWITCH CONTACT

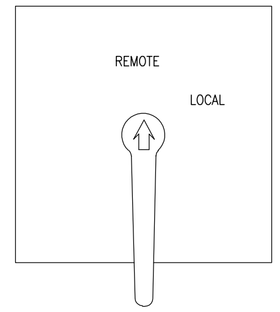
SPARE TERMINAL BLOCKS FOR CUSTOMER USE

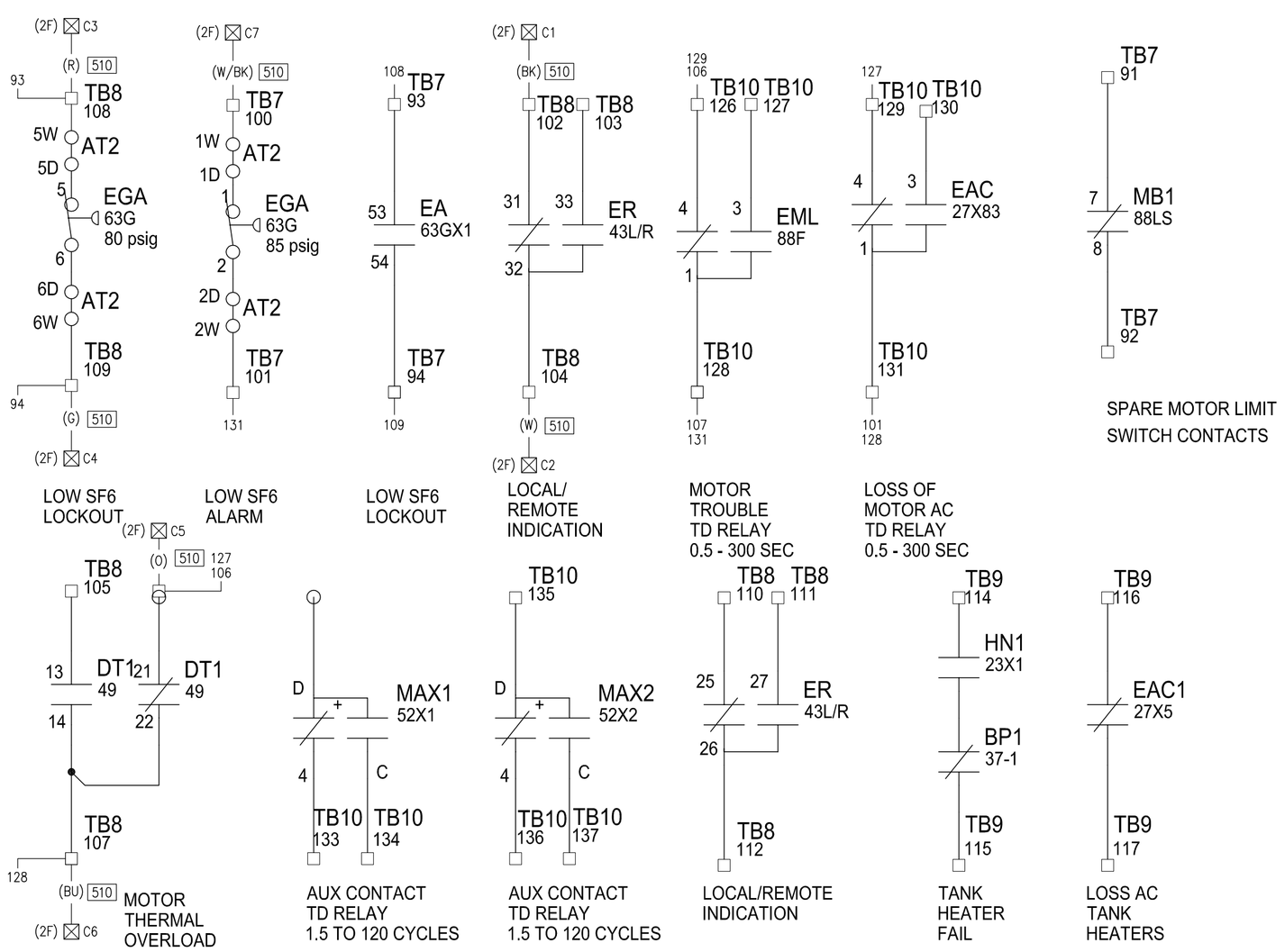


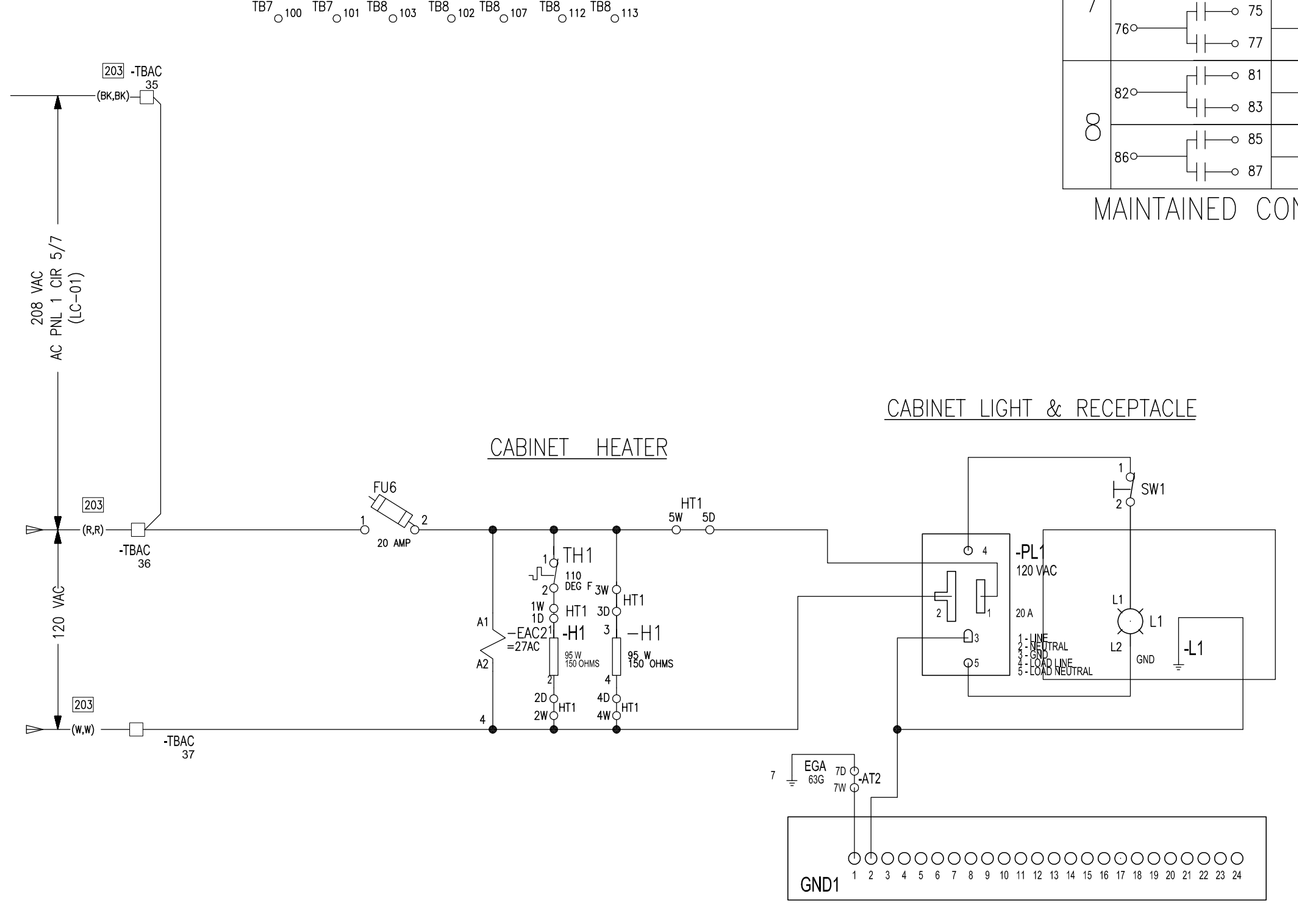
Deck	Contacts Front End	Switch Position REMOTE	Switch Position LOCAL
1	11	X	
	12 — 13		X
	15	X	
	16 — 17		X
2	21	X	
	22 — 23		X
	25	X	
	26 — 27		X
3	31	X	
	32 — 33		X
	35	X	
	36 — 37		X
4	41	X	
	42 — 43		X
	45	X	
	46 — 47		X
5	51	X	
	52 — 53		X
	55	X	
	56 — 57		X
6	61	X	
	62 — 63		X
	65	X	
	66 — 67		X
7	71	X	
	72 — 73		X
	75	X	
	76 — 77		X
8	81	X	
	82 — 83		X
	85	X	
	86 — 87		X

MAINTAINED CONTACTS

ER
43L/R







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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	REVISED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

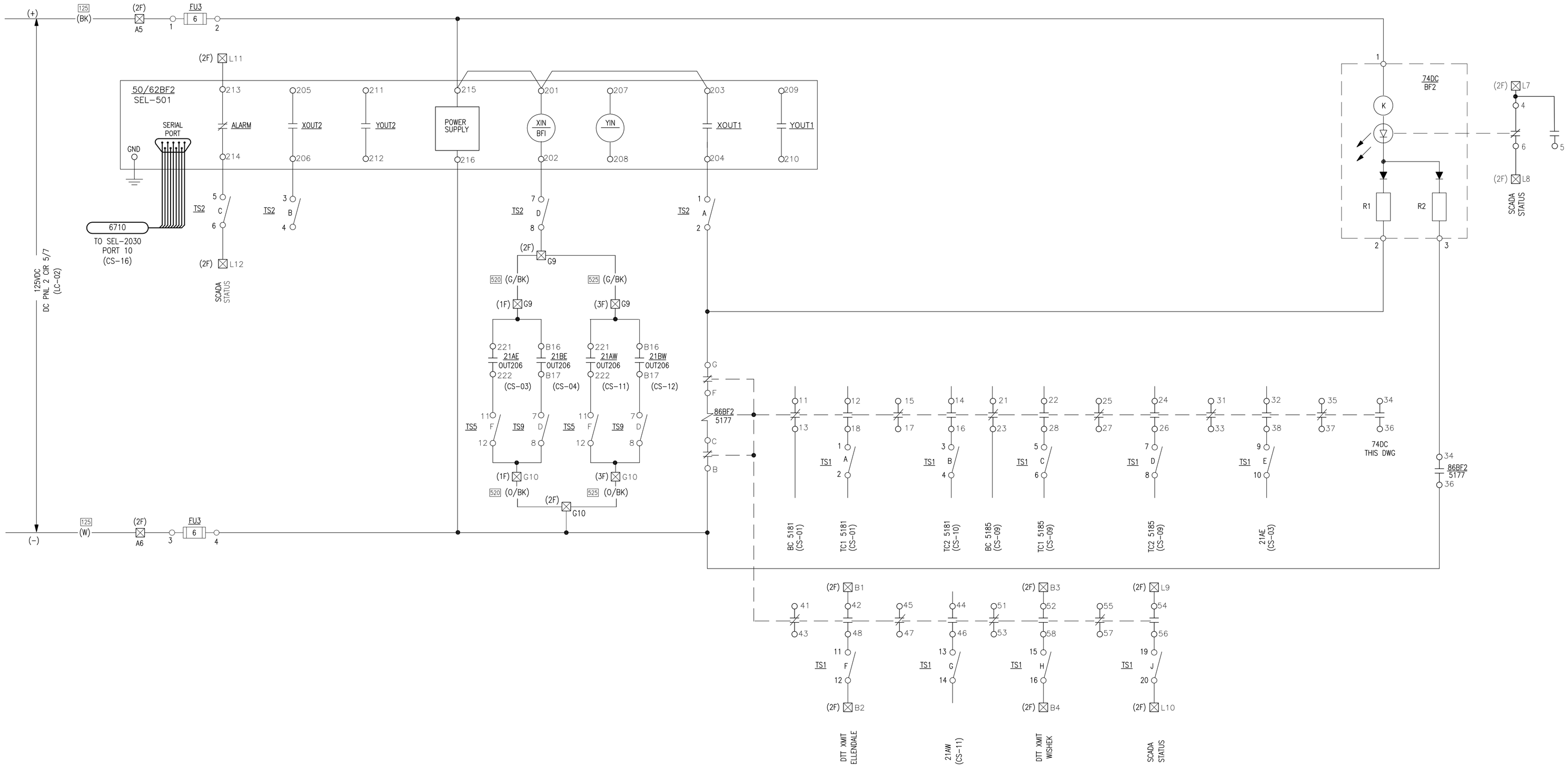
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-07.DWG
SCALE	NONE

SHEET CS-07



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	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

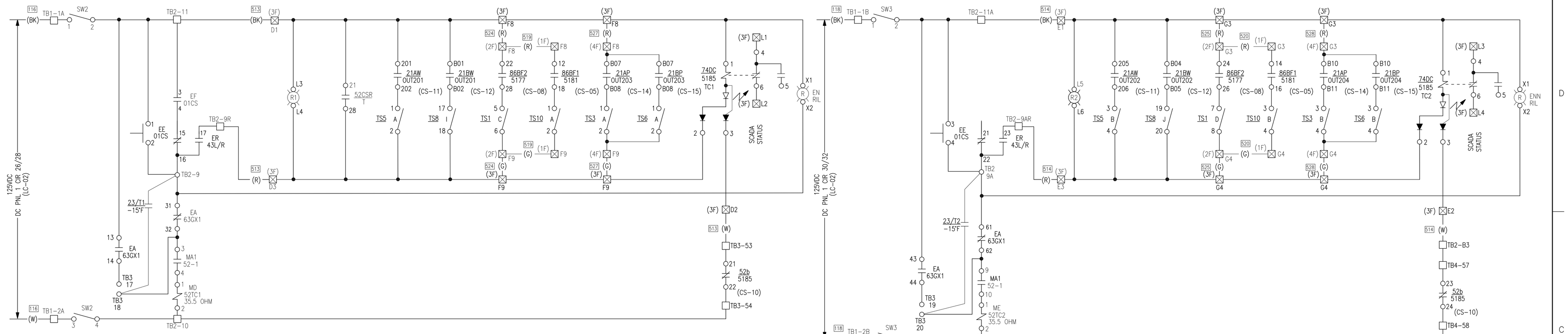
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
PCB 5177 BREAKER FAILURE
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-08.DWG
SCALE	NONE

SHEET
CS-08



79LSR 5185

DECK	CONTACTS	POS. ON	POS. OFF	REF DWG
1	11 — 13			THIS DWG
	12 — 14			21AW (CS-11)
	15 — 17			
	16 — 18			
2	21 — 23			
	22 — 24			THIS DWG
	25 — 27			
	26 — 28			SCADA STATUS
3	31 — 33			
	32 — 34			21BW (CS-12)
	35 — 37			
	36 — 38			

43L/S 5185

DECK	CONTACTS	POS. ON	POS. OFF	REF. DWG.
1	12 — 11			THIS DWG.
	16 — 15			SCADA STATUS
	17			
2	22 — 21			THIS DWG.
	26 — 25			
	27			
3	32 — 31			
	36 — 35			
	37			
4	42 — 41			
	46 — 45			
	47			
5	52 — 51			
	56 — 55			
	57			

52CSR 5185

DECK	CONTACTS	POS. TRIP	POS. NAT	POS. NAC	POS. CLOSE	REF. DWG.
1	12 — 13					THIS DWG.
	16 — 17					
2	21 — 28					THIS DWG.
	24 — 25					
3	31 — 32					
	35 — 36					
4	42 — 43					
	46 — 47					
5	51 — 52					
	55 — 56					

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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	REVISED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

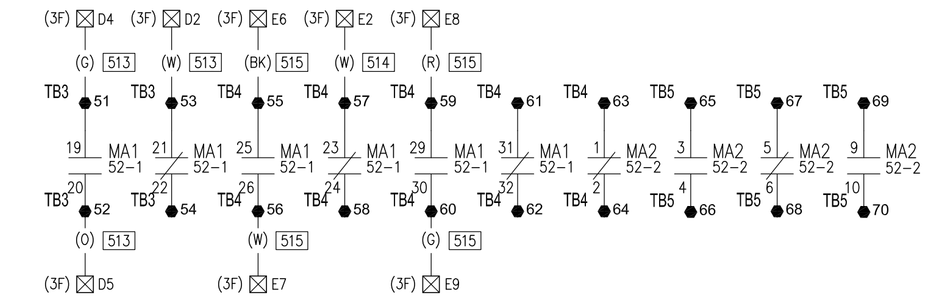
230kV INTERCONNECT SUBSTATION PCB 5185 TRIP AND CLOSE DC SCHEMATIC DIAGRAM

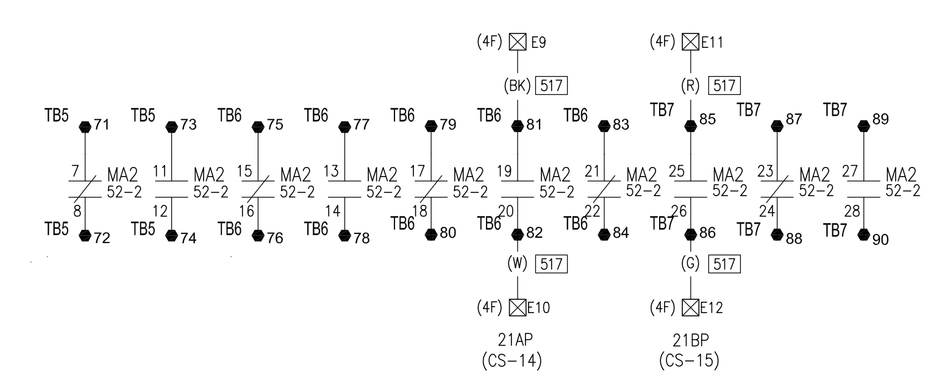
0 1" 2"

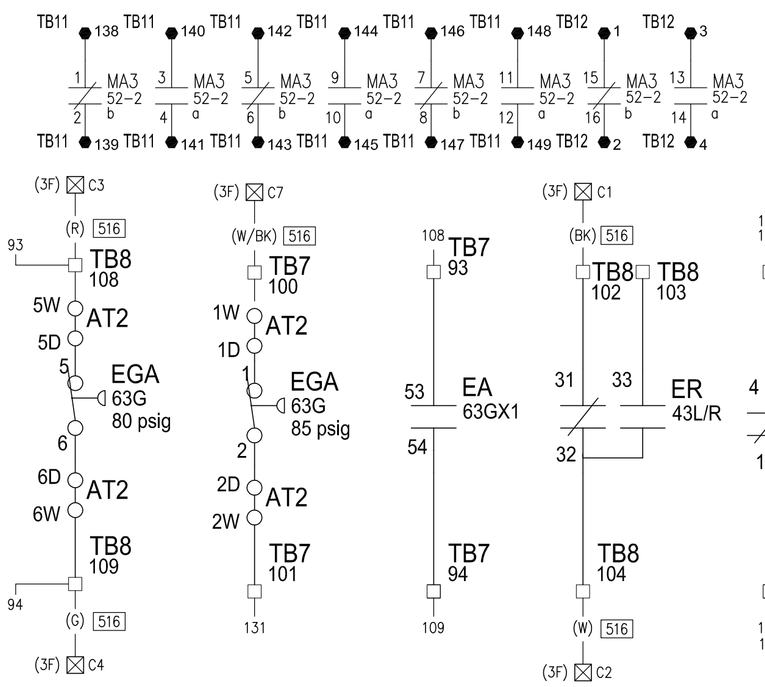
FILENAME	TWEND-CS-09.DWG
SCALE	NONE

SHEET CS-09

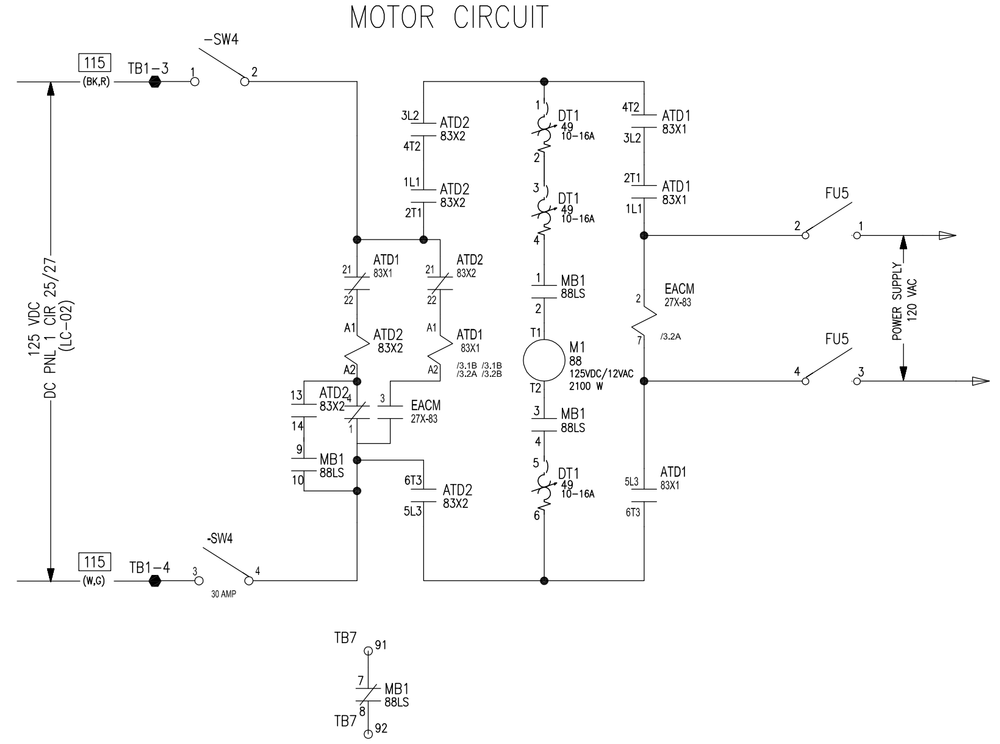
AUXILIARY SWITCHES

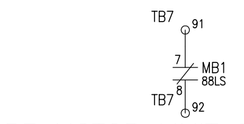






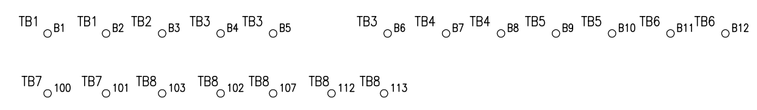
MOTOR CIRCUIT





SPARE MOTOR LIMIT SWITCH CONTACT

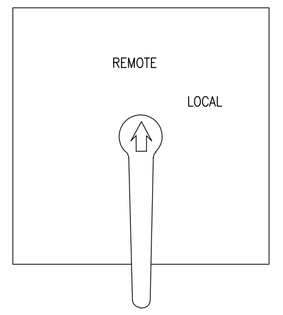
SPARE TERMINAL BLOCKS FOR CUSTOMER USE

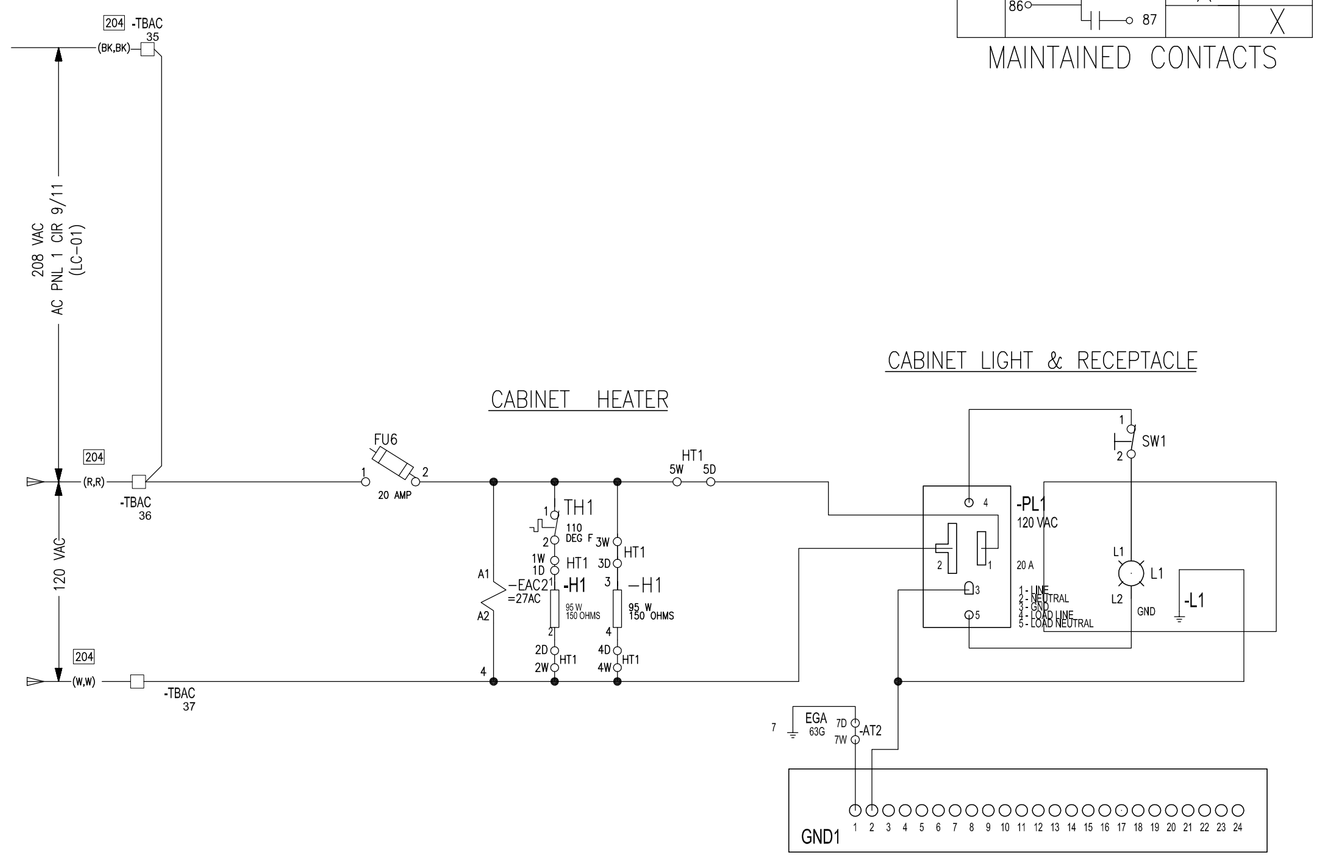


Deck	Contacts Front End		Switch Position REMOTE	Switch Position LOCAL
1	12	11	X	
		13		X
	16	15	X	
		17		X
2	22	21	X	
		23		X
	26	25	X	
		27		X
3	32	31	X	
		33		X
	36	35	X	
		37		X
4	42	41	X	
		43		X
	46	45	X	
		47		X
5	52	51	X	
		53		X
	56	55	X	
		57		X
6	62	61	X	
		63		X
	66	65	X	
		67		X
7	72	71	X	
		73		X
	76	75	X	
		77		X
8	82	81	X	
		83		X
	86	85	X	
		87		X

MAINTAINED CONTACTS

ER
43L/R





ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	REVISED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

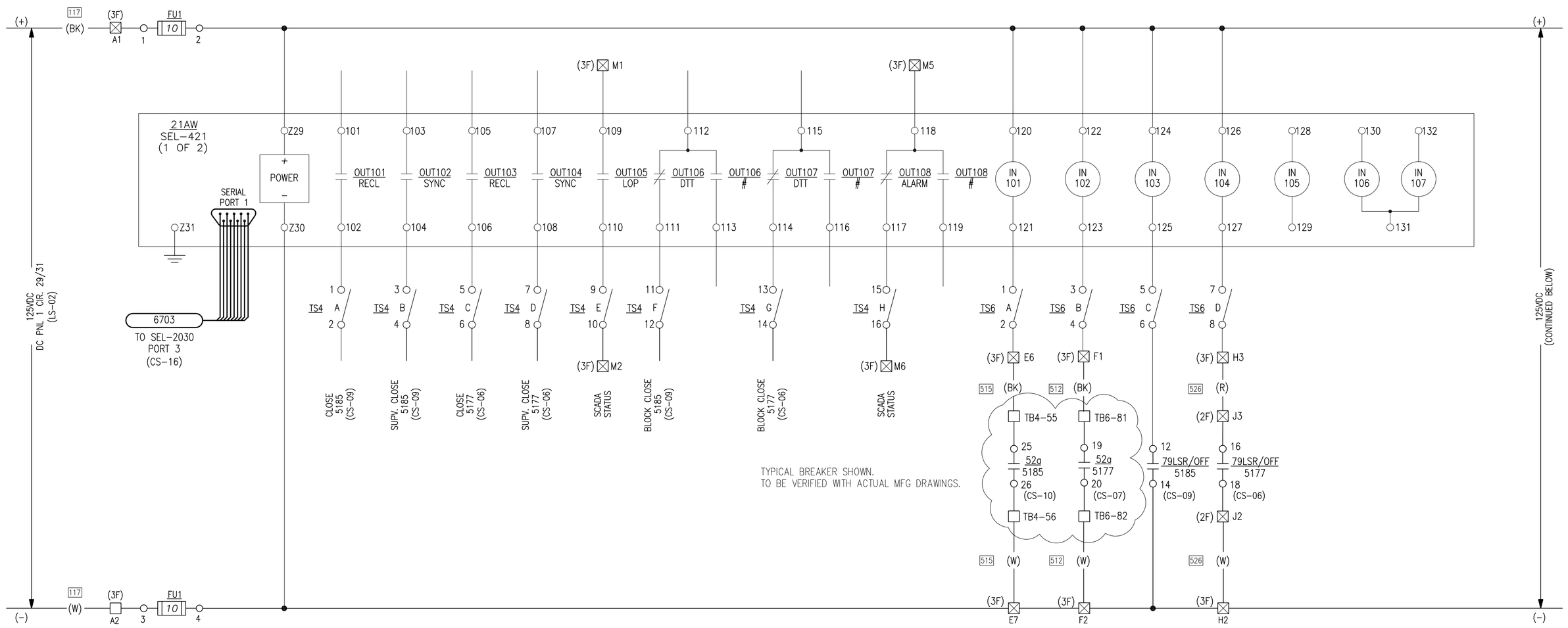
HDR Engineering, Inc.

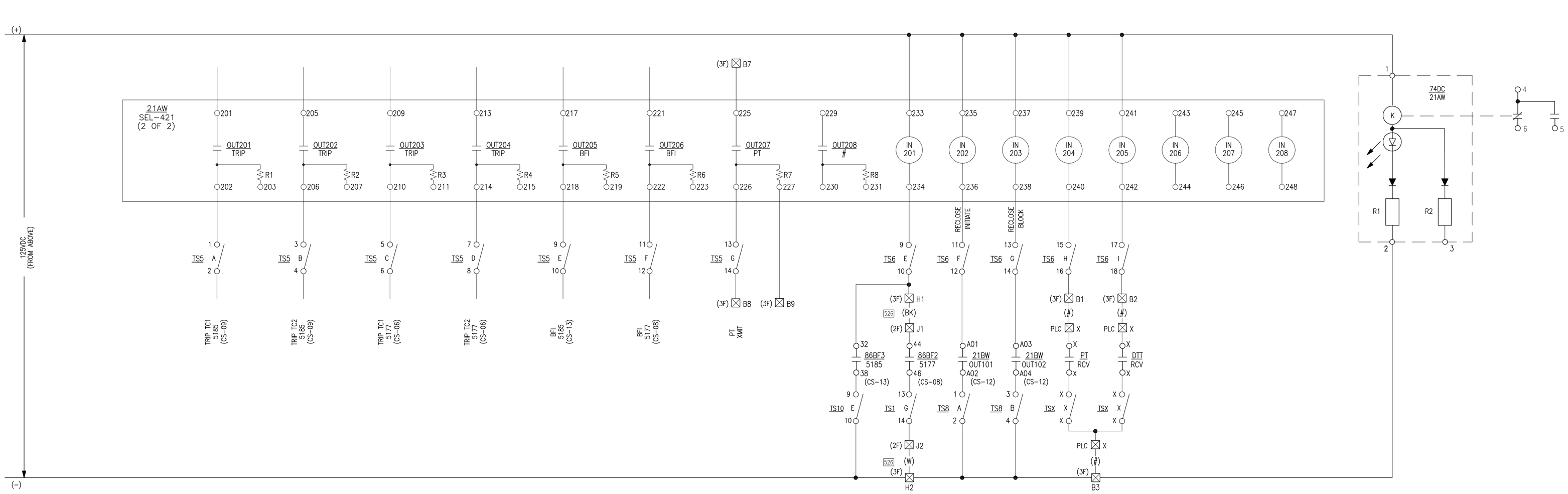
acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5185
DC SCHEMATIC DIAGRAM

FILENAME	TWEND-CS-10.DWG
SCALE	NONE
SHEET	CS-10





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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

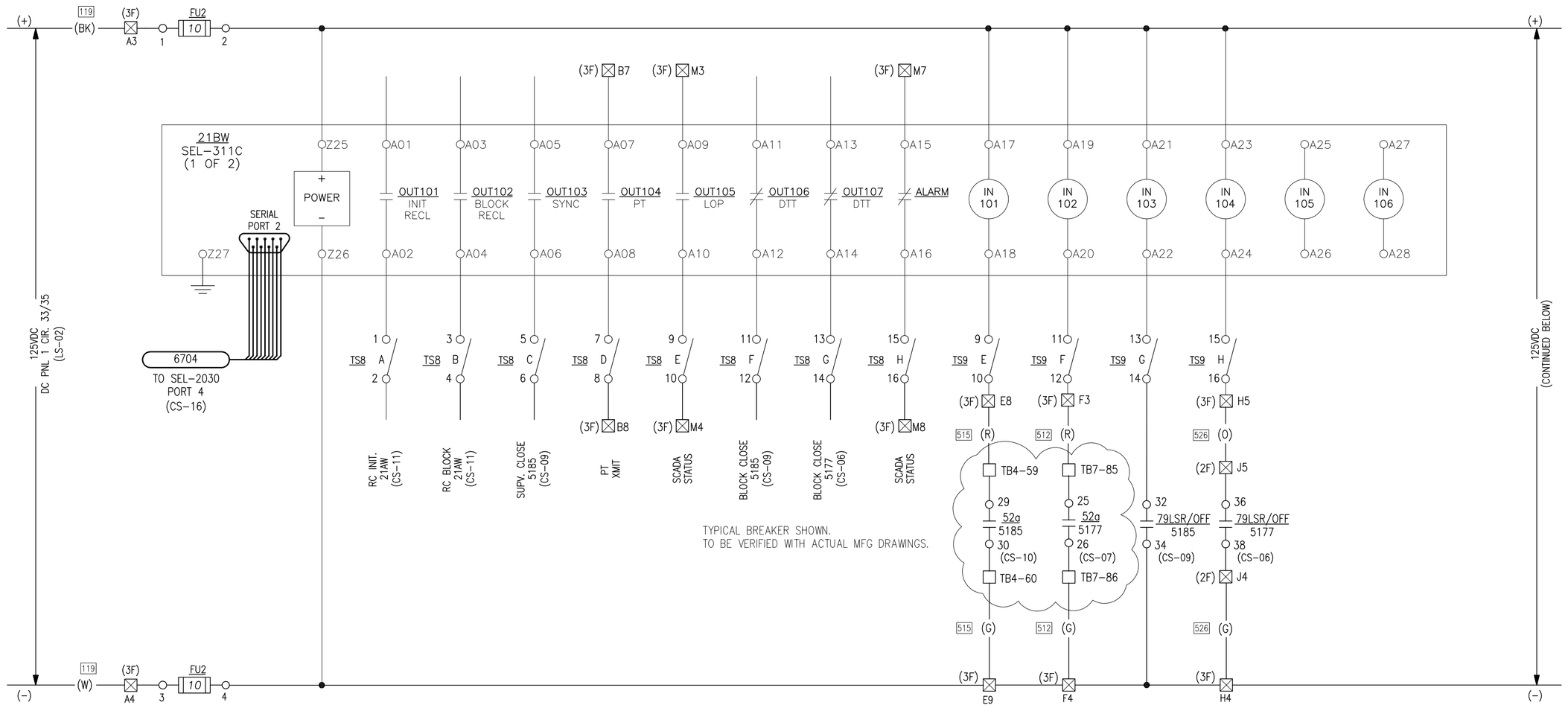
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
WISHEK PRIMARY LINE RELAY
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-11.DWG
SCALE	NONE

SHEET **CS-11**



	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

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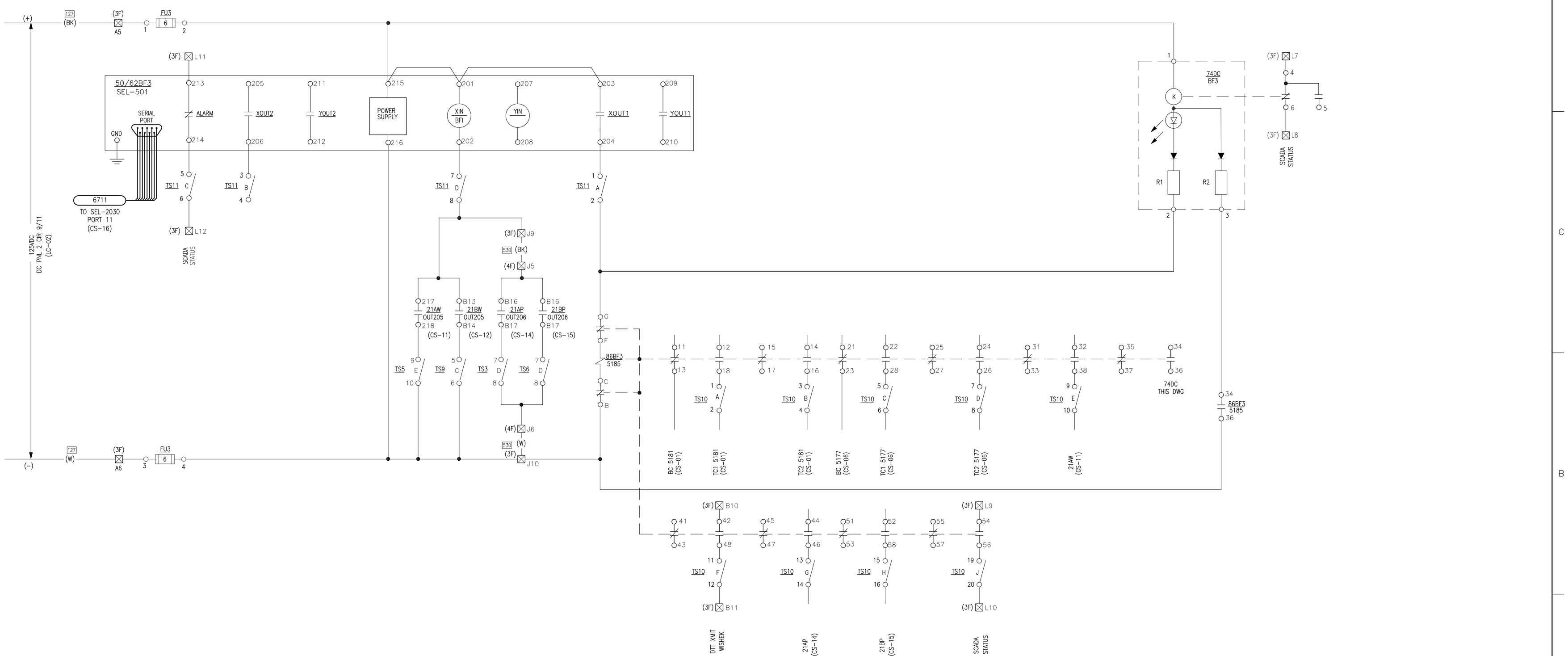
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION WISHEK SECONDARY LINE RELAY DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-12.DWG
SCALE	NONE

SHEET CS-12



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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

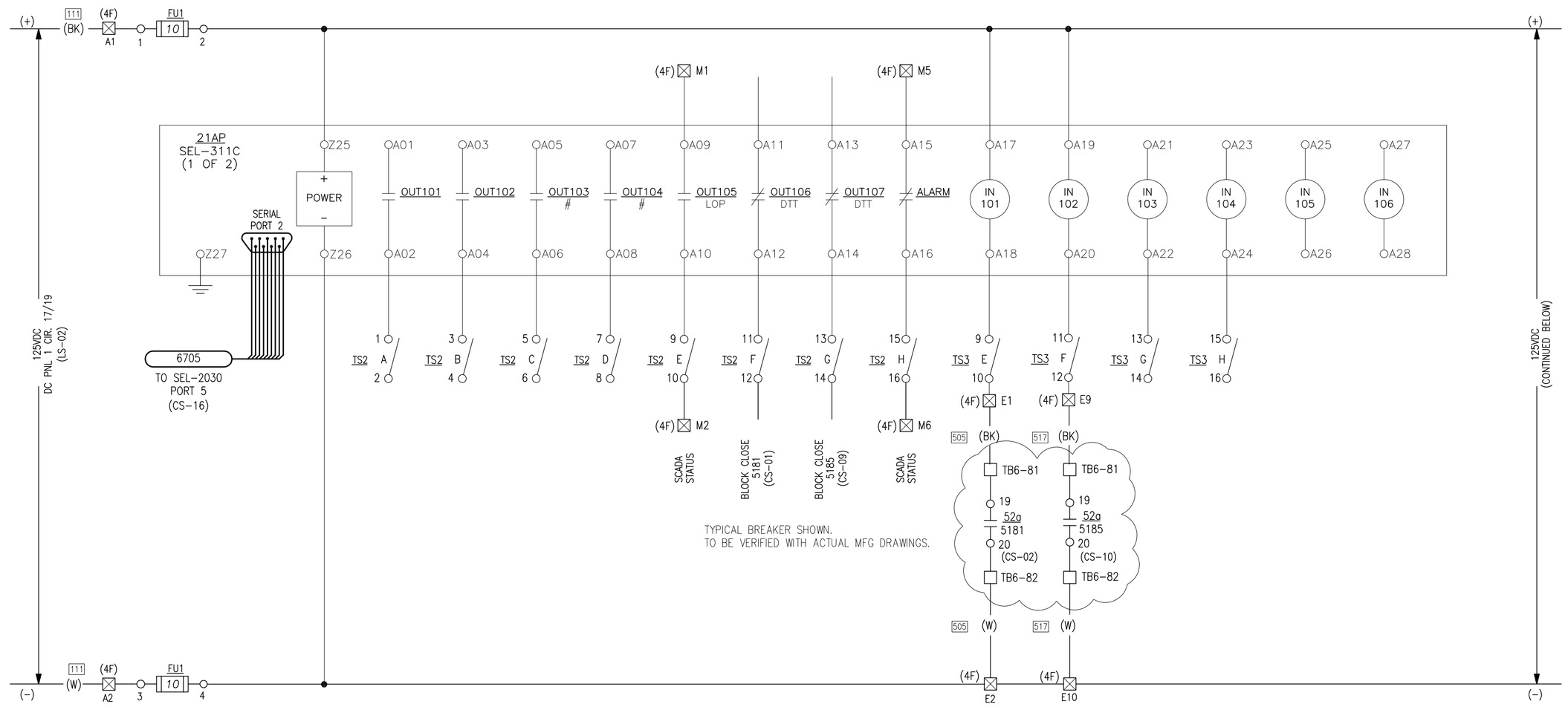
TATANKA WIND ENERGY

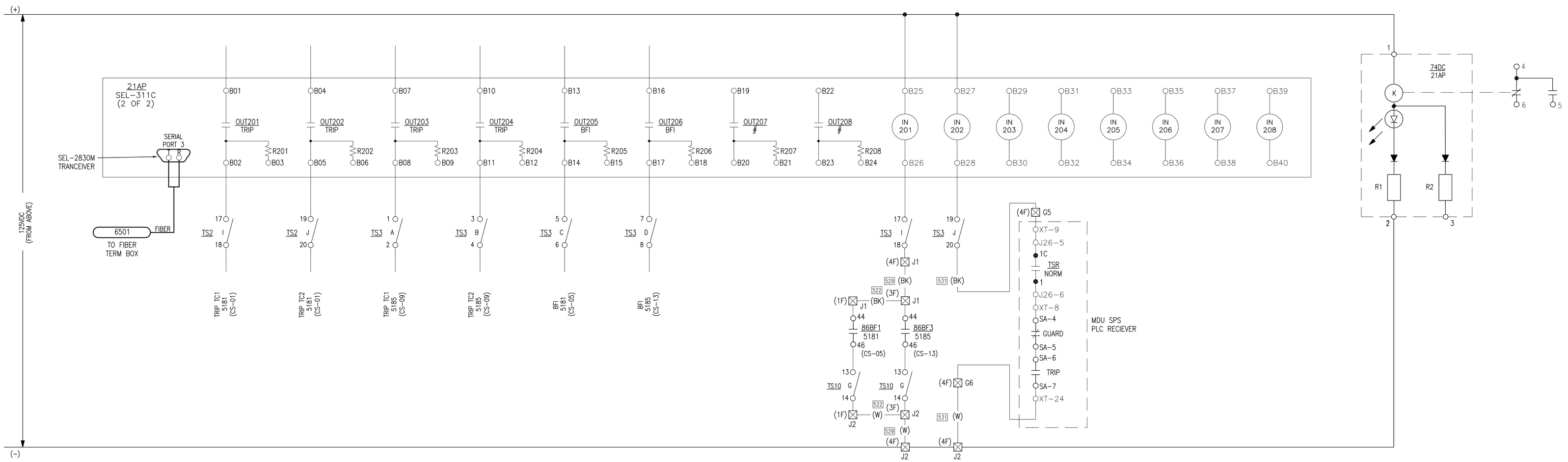
230kV INTERCONNECT SUBSTATION
PCB 5185 BREAKER FAILURE
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-13.DWG
SCALE	NONE

SHEET **CS-13**





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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48069

acciona

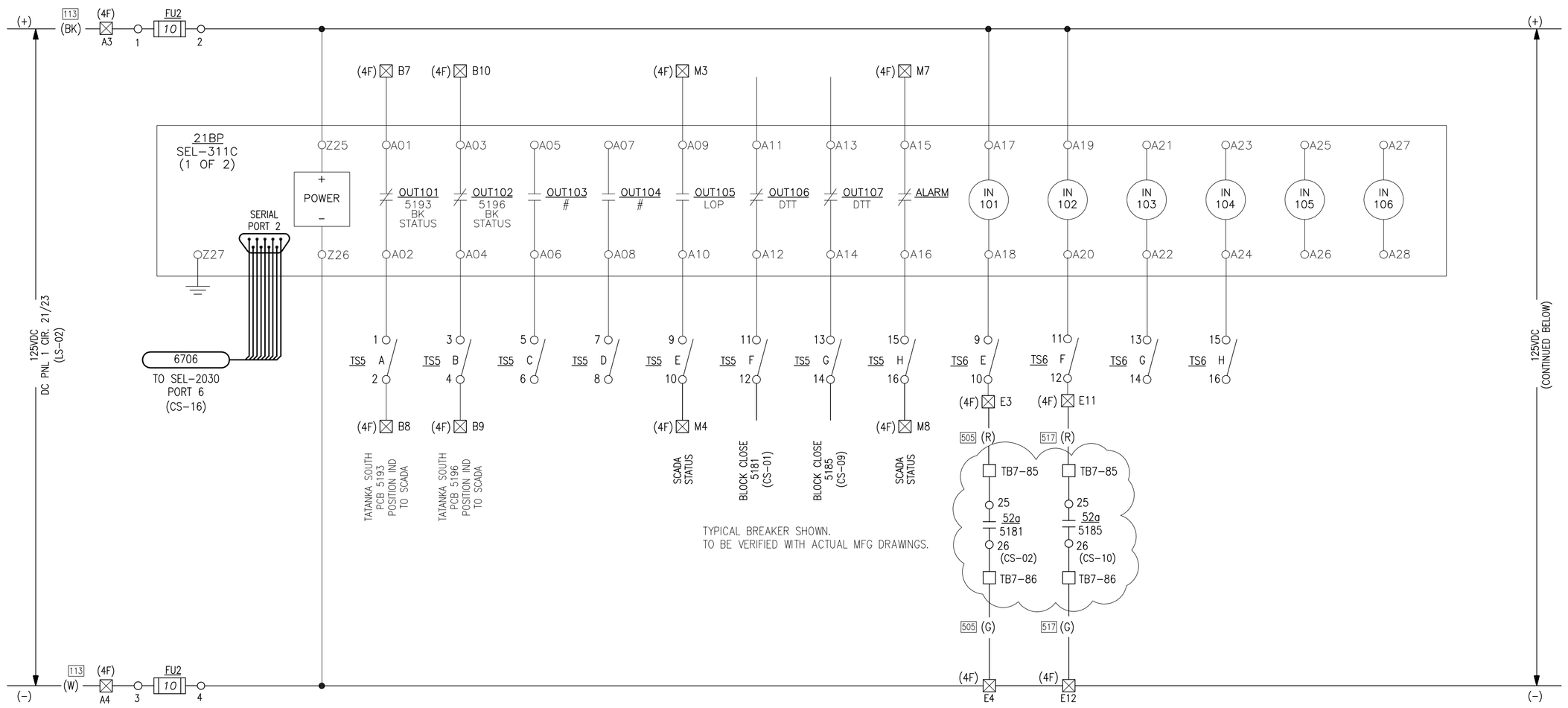
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION PROJECT PRIMARY LINE RELAY DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-14.DWG
SCALE	NONE

SHEET **CS-14**



ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	2-28	ADDED BKR STATUS FOR 5193 & 5196
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

acciona

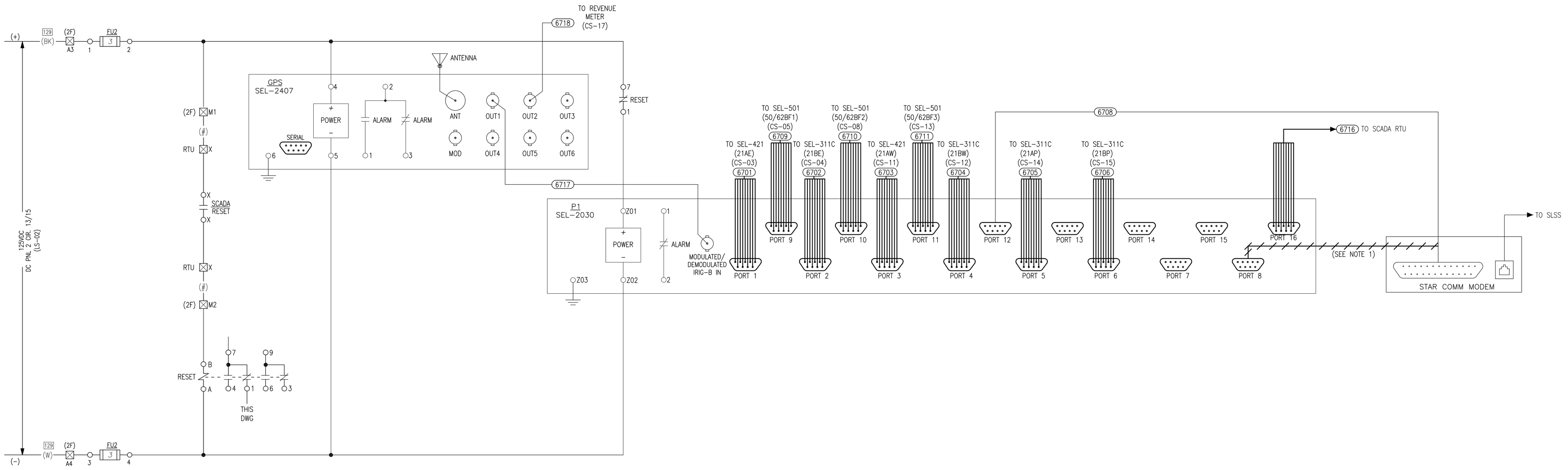
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION PROJECT SECONDARY LINE RELAY DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-15.DWG
SCALE	NONE

SHEET **CS-15**



NOTES:
1. REROUTE CABLE 6708 CONNECTING STAR COMM MODEM AND SEL-2030 PORT 8 TO SEL-2030 PORT 12. REPLACE CABLE IF NECESSARY.

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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48069

acciona

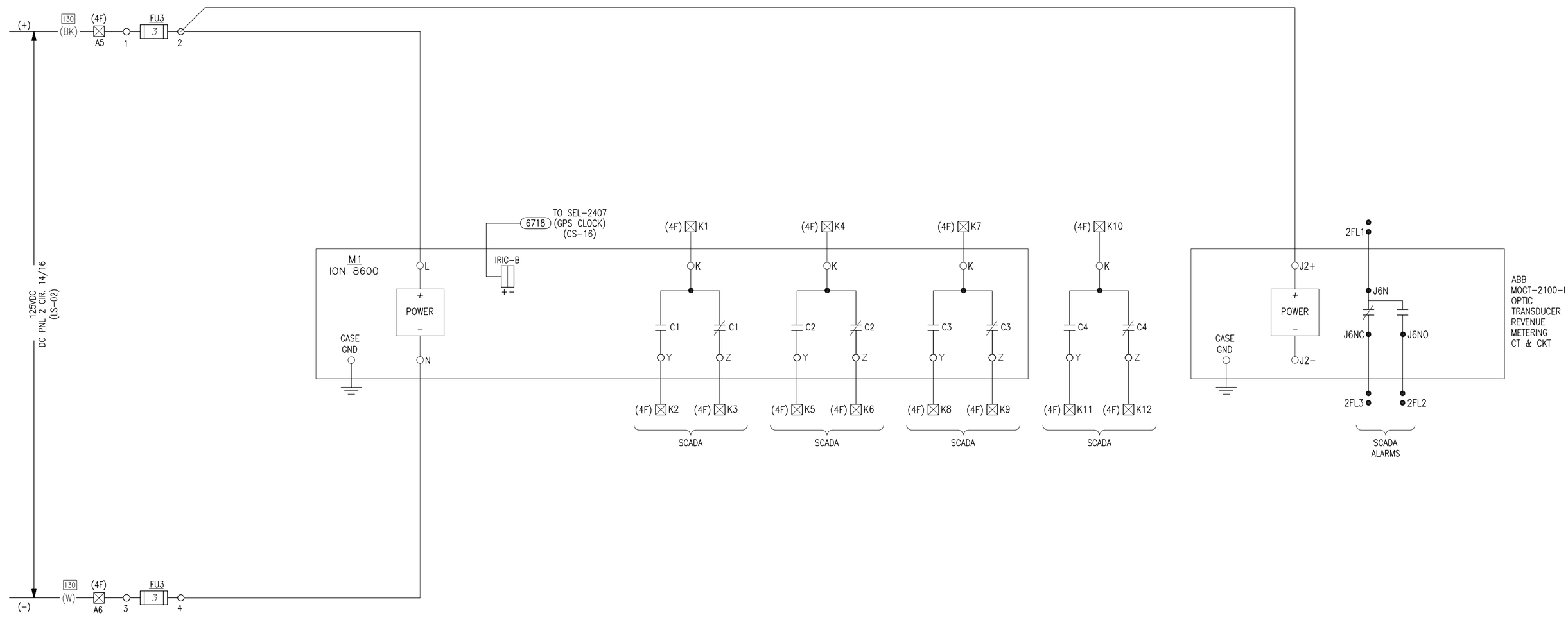
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION RELAY COMMUNICATIONS EQUIPMENT DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-16.DWG
SCALE	NONE

SHEET CS-16



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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

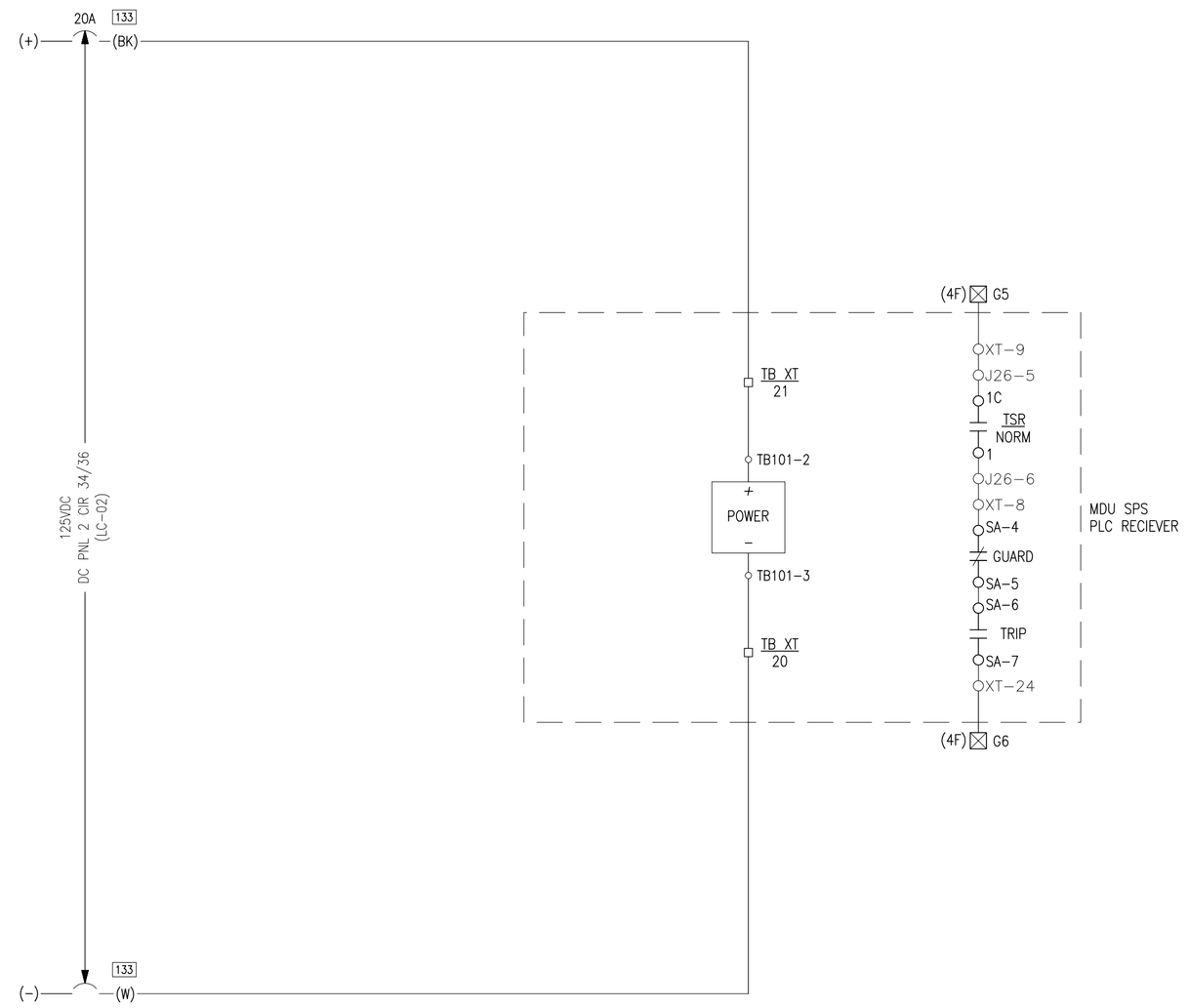
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
REVENUE METER
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-17.DWG
SCALE	NONE

SHEET
CS-17



LEGEND

□	EQUIPMENT TERMINAL
○	DEVICE TERMINAL
⊠	RELAY PANEL TERMINATION BLOCK
XXX	CABLE NUMBER

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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48069

acciona

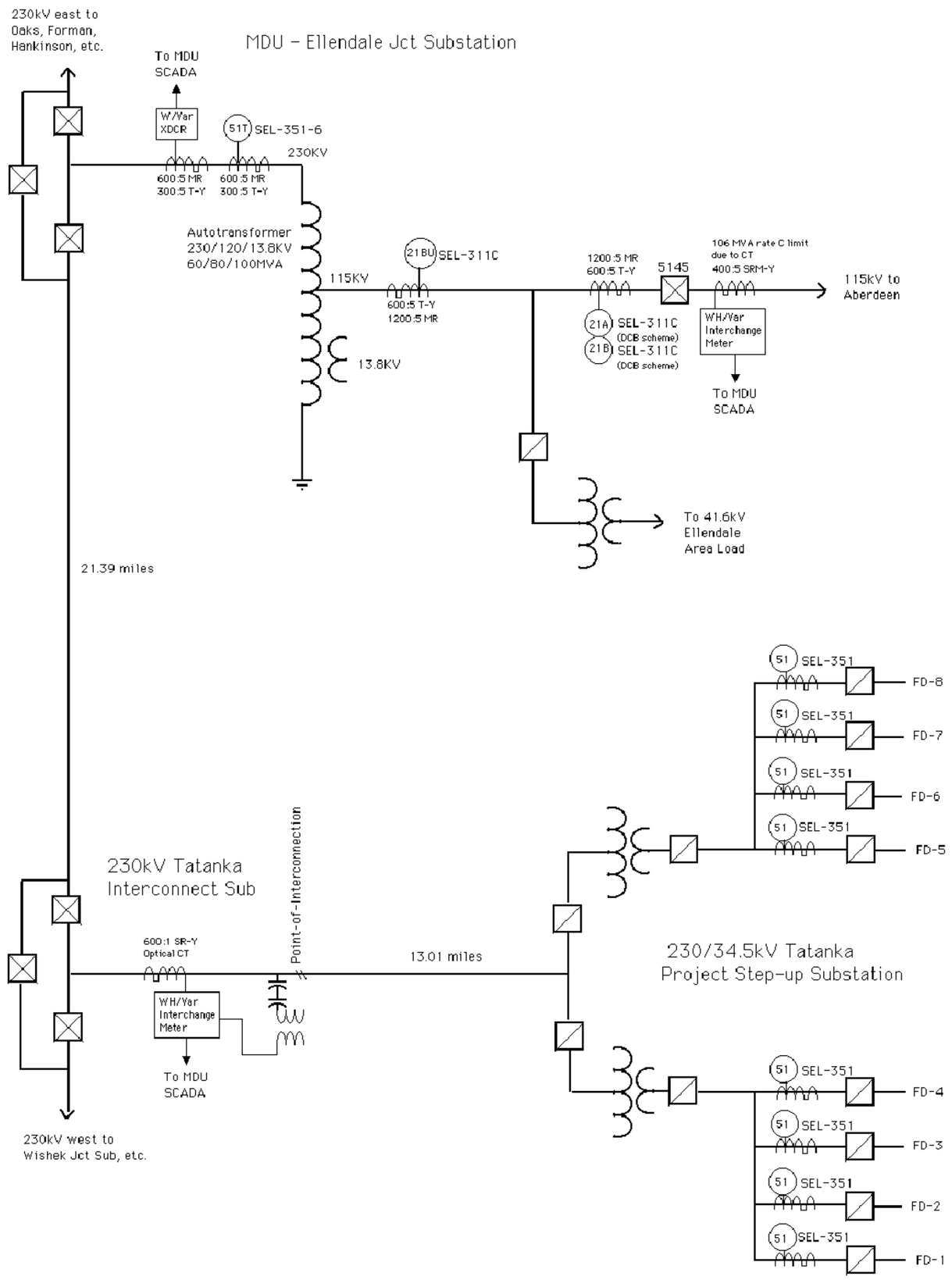
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
MDU TONE EQUIPMENT
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-18.DWG
SCALE	NONE

SHEET
CS-18



SPS Purpose - To avoid or to delay various transmission system upgrades, Acciona Energy and MDU have agreed to install a Special Protection System (SPS) for the Tatanka Wind Farm. The upgrades that are obviated by this SPS scheme include replacement of the Ellendale 230/115kV autotransformer, re-building of the Ellendale-to-Aberdeen 115kV line, and/or construction of additional 230kV transmission lines and facilities that would originate from the Interconnection Substation.

SPS Scheme Initiation - The SPS scheme will be initiated by protective relays that are located at MDU's Ellendale Jct Substation. The relays will monitor current flow in the 230/115kV autotransformer and current over the 115kV Ellendale-to-Aberdeen transmission line. Time-overcurrent or a definite time delay will be used by each relay to avoid nuisance tripping. When an overcurrent at either location exceeds the magnitude and time parameters, the relay involved will set a latch that triggers a REDUCE signal. The REDUCE signal will remain latched until the current level that triggered it has dropped to some fraction (probably 90%) of the triggering value.

SPS Scheme Action - Once an overcurrent level is detected by the SPS, a REDUCE signal will be transmitted from the Ellendale substation via two independent communication paths to the Tatanka Project Step-up Substation.

Receipt of the REDUCE signal shall initiate actions in the Tatanka Supervisory Control and Data Acquisition (SCADA) system to cause the Tatanka wind farm to reduce power output at a pre-defined rate. Power will be reduced to a point at which the REDUCE signals will de-assert when the sensed current at the Ellendale substation reduces below the RESET level. To serve as a redundant protection control, timers in the Tatanka Step-Up substation will sequentially trip 34.5kV collection system breakers to force a power reduction, in case the SCADA system fails to reduce wind farm output, or fails to reduce the power level quickly enough. If the SPS is functioning normally, it will not be necessary to trip any circuit breakers because the REDUCE signal will de-assert before the timers time-out.

SPS Scheme Reset - The REDUCE signal will de-assert when the sensed current that triggered that event falls to some fraction of the triggering current level (probably 90%). The hysteresis that results will ensure that the system operating point is driven far enough away from the triggering threshold to avoid oscillations.

Following SPS Scheme Reset - Once the REDUCE signal de-asserts, the Tatanka SCADA system enters a HOLD mode, where it operates at a reduced power output limit. This limit will be maintained by the SCADA system until the MDU electric system operator informs the Tatanka operator that the limit can be raised. At that time, the operating power limit can be adjusted to some higher value, or removed altogether. During the "HOLD" mode, collection system circuit breaker configuration may be changed by the Tatanka operators, as long as the power limit in effect is not exceeded.

SPS Scheme Arming - The SPS scheme shall be "armed" and ready to operate at all times. When one of the two redundant communication channels is removed from normal service for maintenance, the remaining channel shall be considered adequate for SPS operation, and the Tatanka facility power output shall not be limited, as long as Tatanka operators remain in contact with MDU operators. If a failure of equipment or one or more communication channels is detected by supervisory circuits, the SCADA system shall adjust the power output limit as required by the reliability coordinator and the SPS Operating Guide.

SPS Scheme Redundancy - The SPS shall use redundant relays at the Ellendale substation, and two independent communication paths from the Ellendale substation to the Tatanka interconnection and Step-Up substations. Within the Tatanka facility, the redundancy is achieved by having two independent methods of reducing power: (1) Using the SCADA system to reduce power and (2) tripping 34.5kV circuits breakers to open up parts of the collection system.

See Also
Drawing 57-2269-1
Ellendale to Tatanka SPS
Logic Description

Ellendale to Tatanka SPS
Logic Description
For
Ellendale to Tatanka Wind Farm
Generation Reduction

MDU	ELLENDALE JCT SUBSTATION	
DRAWN BY: DHR	MONTANA-DAKOTA UTILITIES CO.	SCALE:
DATE:	DRAWING NO: 100207-1 / FILE NO: 57-2269-1	APPROVED:

57-2269-1

MORTENSON®

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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48069

acciona

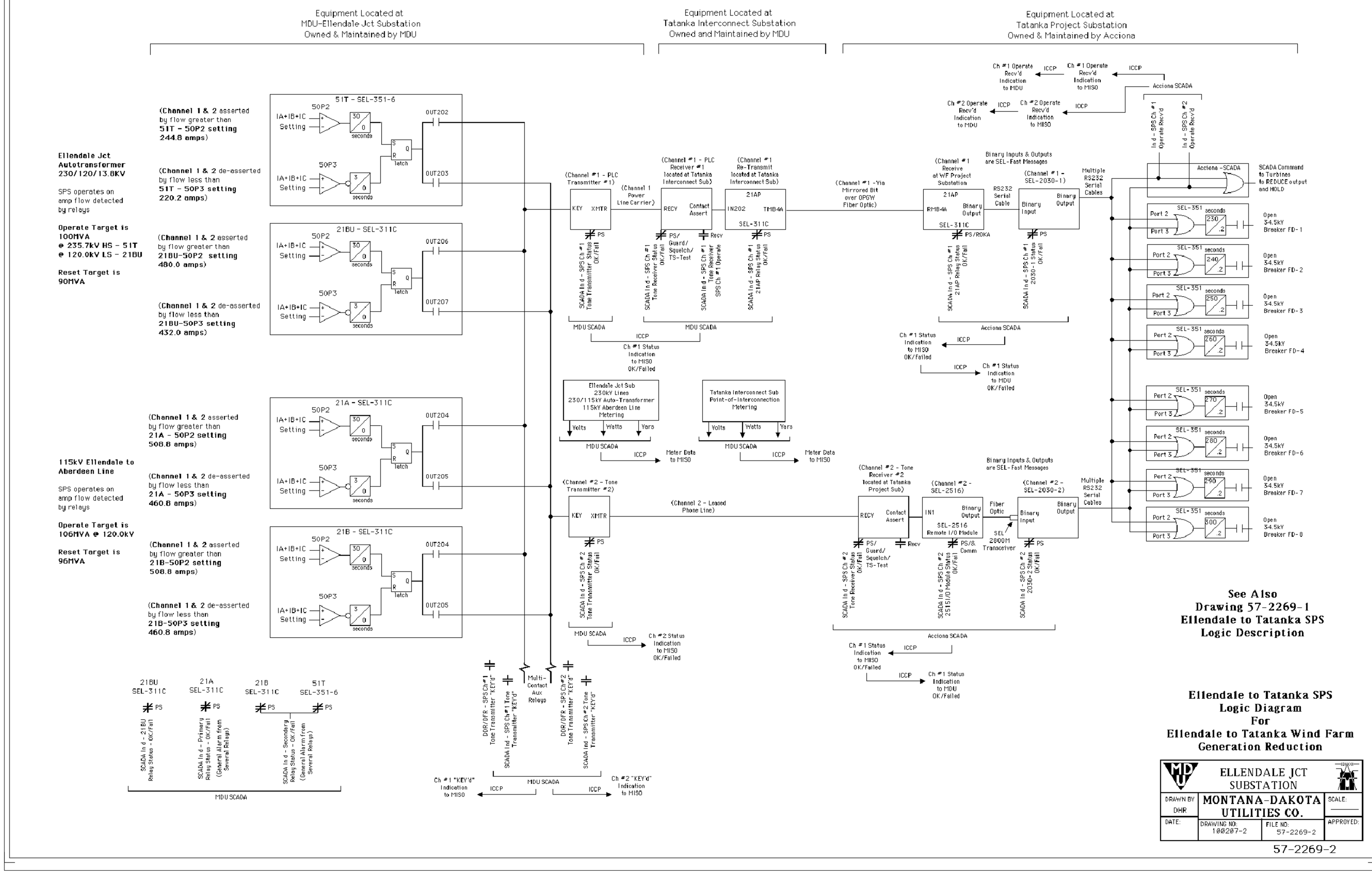
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
SPS LOGIC DESCRIPTION

0 1" 2"

FILENAME	TWEND-CS-19.DWG
SCALE	NONE

SHEET
CS-19



MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW - SPS UPGRADE

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48069

acciona

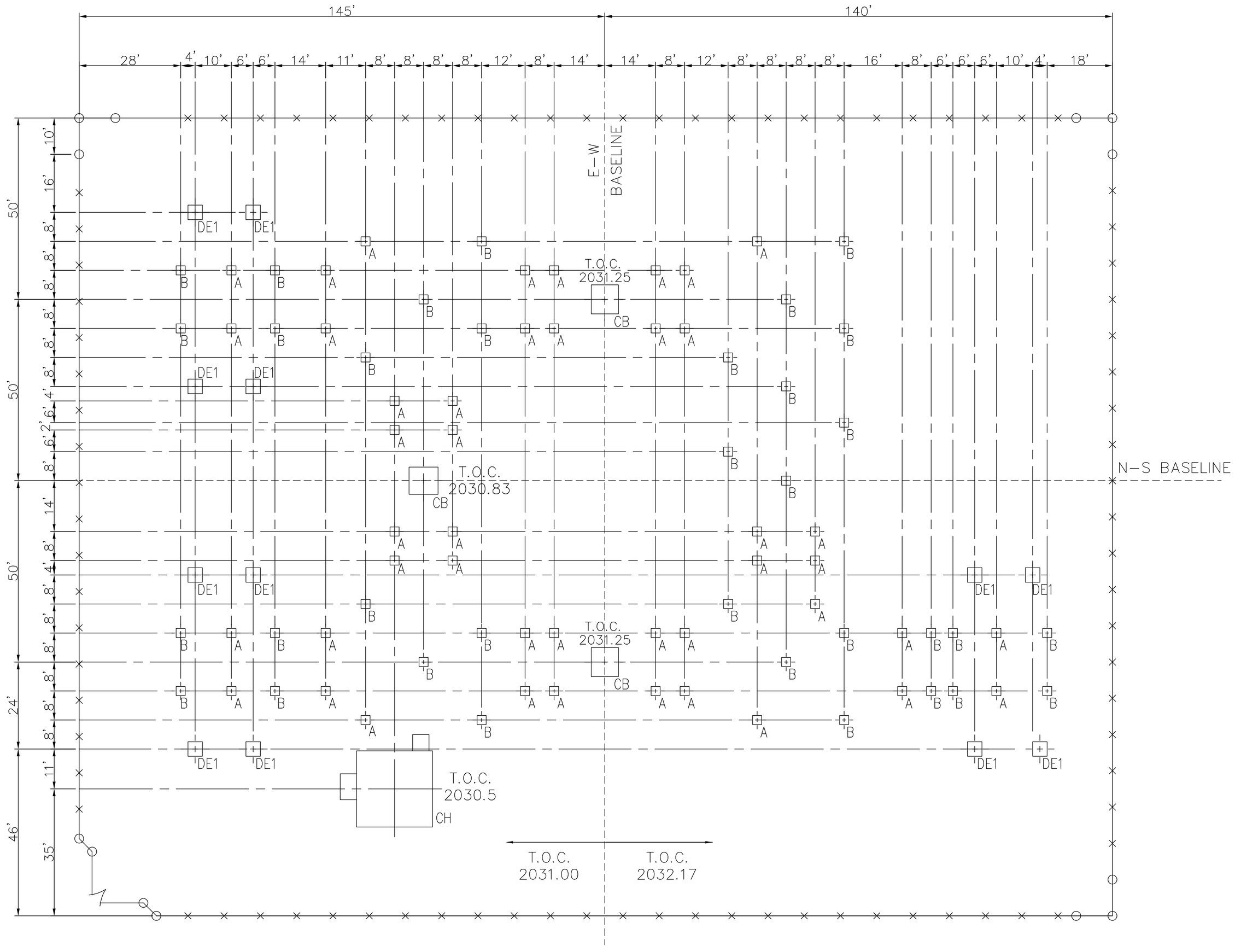
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION SPS LOGIC DIAGRAM

0 1" 2"

FILENAME	TWEND-CS-20.DWG
SCALE	NONE

SHEET
CS-20



FOUNDATION SCHEDULE				
FOUNDATION DESIGNATION	DRAWING REFERENCE	QTY	CONCRETE REQUIREMENTS PER UNIT	CONCRETE REQUIREMENTS TOTAL
A	TWEND-FD-02	45	2.3	103.5
B	TWEND-FD-02	34	2.3	78.2
CB	TWEND-FD-02	3	4.7	14.1
DE1	TWEND-FD-02	12	8.6	103.2
CH	TWEND-FD-03	1	34	34

NOTES:

1. CONSTRUCTION JOINTS WILL NOT BE ALLOWED WITHOUT PRIOR WRITTEN CONSENT FROM THE OWNER, UNLESS OTHERWISE NOTED ON THE DRAWINGS.

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HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
3	07-31-07	MODIFIED CONTROL BUILDING FOUNDATION
2	07-16-07	REVISED NOTES & QUANTITIES
1	06-13-07	REVISED T.O.C. ELEVATIONS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

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TATANKA WIND ENERGY

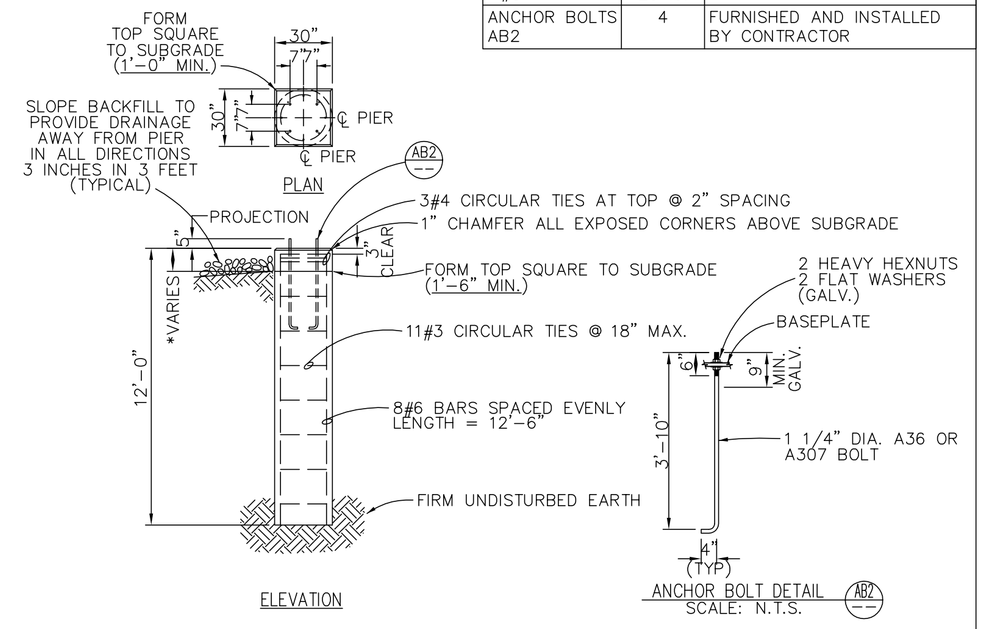
TATANKA 230KV INTERCONNECT SUBSTATION FOUNDATION PLAN

0 1" 2"

FILENAME	TWEND-FD-01
SCALE	1/16"=1'

SHEET FD-01

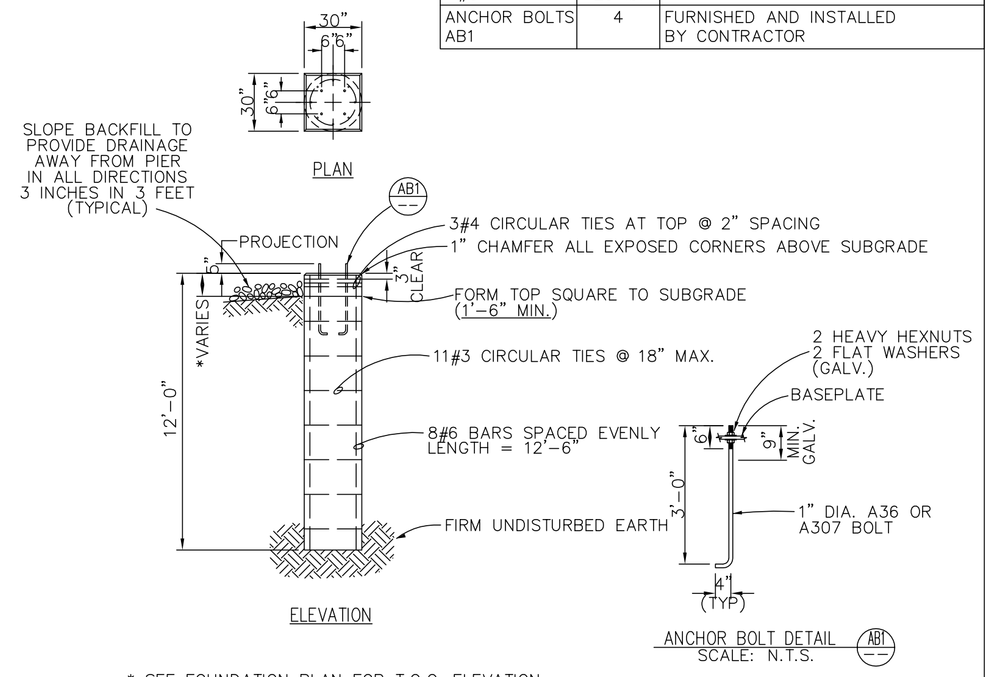
MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	2.3 c.y.	PER SPEC.
REBAR #6 #3	 150 lb. 29 lb.	PER SPEC.
ANCHOR BOLTS AB2	4	FURNISHED AND INSTALLED BY CONTRACTOR



* SEE FOUNDATION PLAN FOR T.O.C. ELEVATION

FOUNDATION A FD01

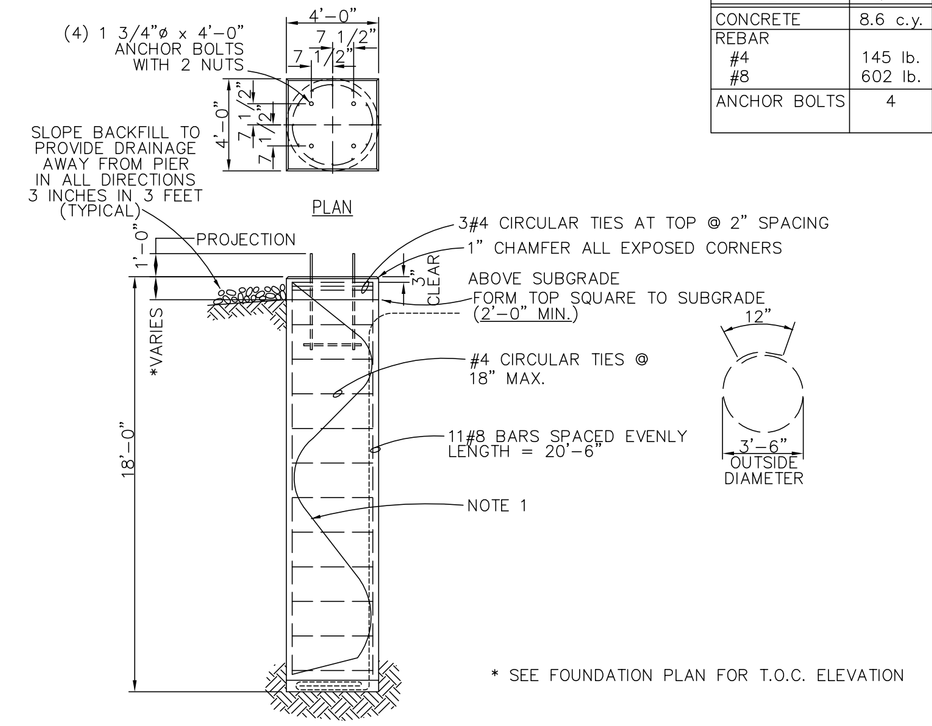
MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	2.3 c.y.	PER SPEC.
REBAR #6 #3	 150 lb. 29 lb.	PER SPEC.
ANCHOR BOLTS AB1	4	FURNISHED AND INSTALLED BY CONTRACTOR



* SEE FOUNDATION PLAN FOR T.O.C. ELEVATION

FOUNDATION B FD01

MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	8.6 c.y.	PER SPEC.
REBAR #4 #8	 145 lb. 602 lb.	PER SPEC.
ANCHOR BOLTS	4	FURNISHED BY DE FABRICATOR INSTALLED BY CONTRACTOR

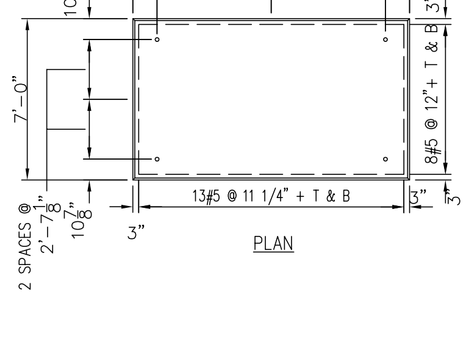


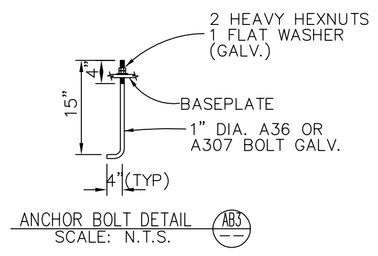
* SEE FOUNDATION PLAN FOR T.O.C. ELEVATION

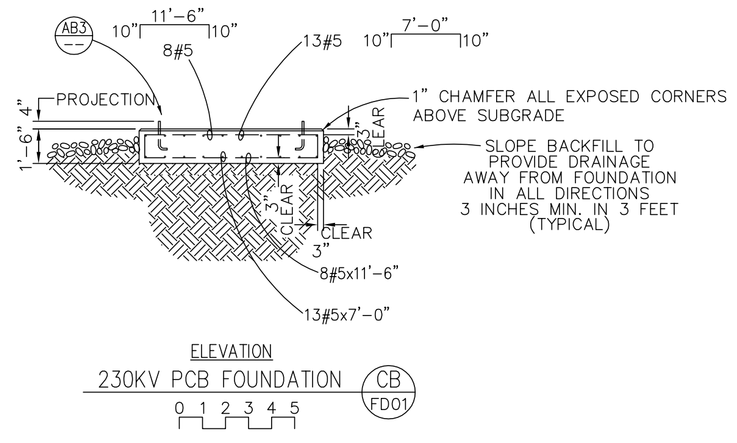
FOUNDATION DE1 FD01

NOTE:
1. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING MATERIALS AND LABOR TO ADEQUATELY BRACE THE REBAR CAGE TO WITHSTAND CONSTRUCTION LOADS.

MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	4.7 c.y.	PER SPEC.
REBAR #5	 418.2 lb.	PER SPEC.
ANCHOR BOLTS	4	1" DIA. A36 FURNISHED BY CONTRACTOR







ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
1	07-16-07	REVISED DETAILS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

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TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION FOUNDATION DETAILS - A, B, CB & DE1

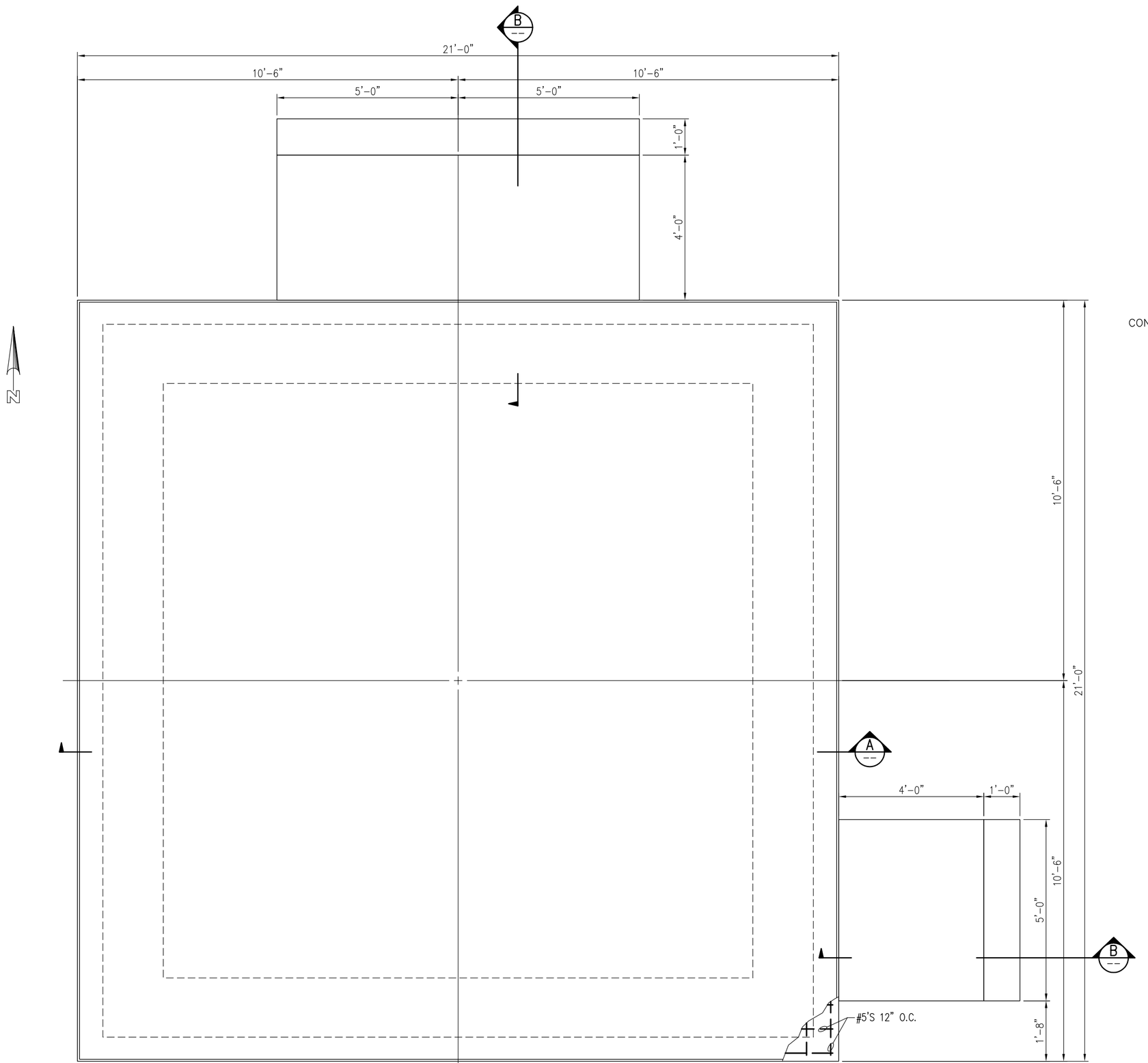
0 1" 2"

FILENAME	TWEND-FD-02
SCALE	NONE

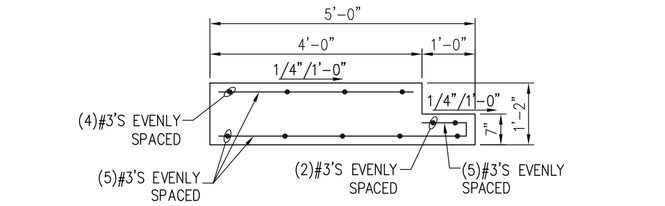
SHEET FD-02

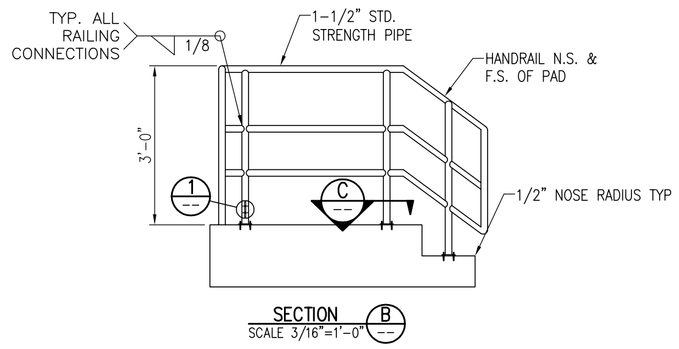
MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	34 c.y.	PER SPEC.
REBAR	2205 lb.	#5 GRADE 60
	34 lb.	#3 GRADE 60

CONTROL HOUSE FOUNDATION



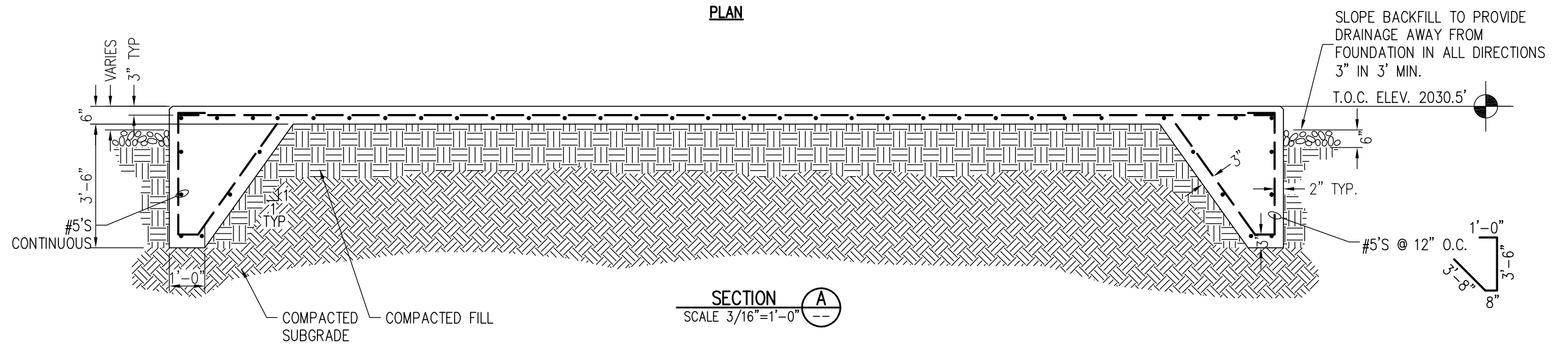
PLAN





SECTION B
SCALE 3/16"=1'-0"

NOTE: POUR ENTRANCE PAD AFTER CONTROL HOUSE IS SET ON FOUNDATION



SECTION A
SCALE 3/16"=1'-0"

FOUNDATION CH
SCALE 3/16"=1'-0"

GENERAL NOTES:
1) CHAMFER FOR ALL EXPOSED EDGES 1/2"

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
2	11-12-07	MODIFIED ENTRANCE PAD HEIGHT
1	07-31-07	MODIFIED CONTROL BUILDING FOUNDATION
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

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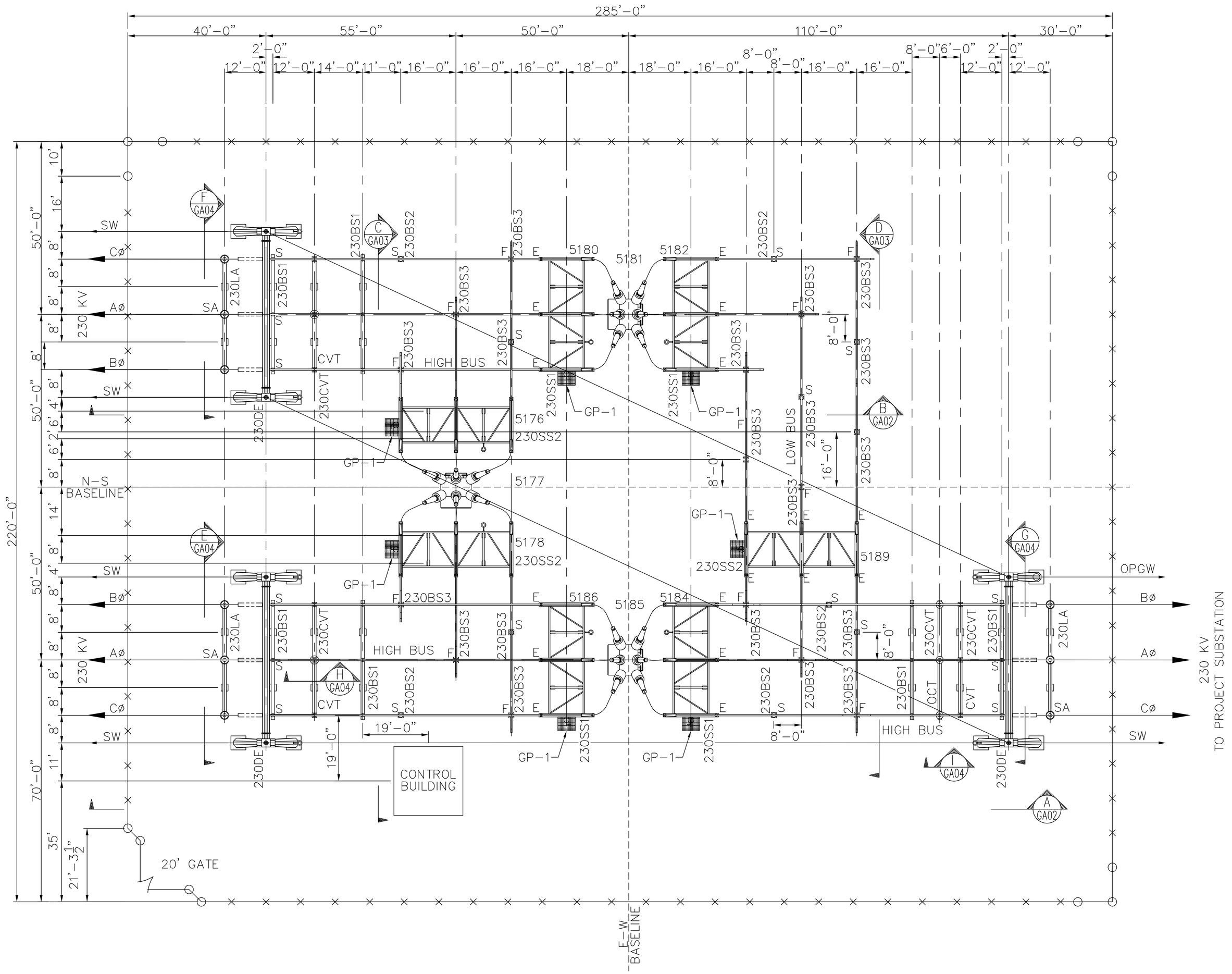
TATANKA WIND ENERGY

TATANKA 230kV INTERCONNECT SUBSTATION FOUNDATION DETAILS - CH

0 1" 2"

FILENAME	TWEND-FD-03
SCALE	NONE

SHEET FD-03





STRUCTURAL STEEL SCHEDULE			
STRUCTURE DESIGNATION	DESCRIPTION	QTY	REF. DWG.
230SS1	230kV 3Ø SWITCH STAND (22'-6" STRUCTURE HEIGHT)	4	TWEND-SS-01
230SS2	230kV 3Ø SWITCH STAND (10'-6" STRUCTURE HEIGHT)	3	TWEND-SS-01
230BS1	230kV 3Ø BUS SUPPORT (23'-0" STRUCTURE HEIGHT)	6	TWEND-SS-02
230BS2	230kV 1Ø BUS SUPPORT (23'-0" STRUCTURE HEIGHT)	4	TWEND-SS-02
230BS3	230kV 1Ø BUS SUPPORT (11'-0" STRUCTURE HEIGHT)	20	TWEND-SS-02
230CVT	230kV 3Ø CVT/CT STAND	4	TWEND-SS-03
230LA	230kV 3Ø LIGHTNING ARRESTER STAND	3	TWEND-SS-03
GP-1	GROUND PLATFORM	7	TWEND-SS-04
230DE	DEADEND TOWER	3	TWEND-SS-05

NOTES:

1. ACTUAL 230KV BREAKER TO BE CONFIRMED.

LEGEND

A / GA02 — SECTION DETAIL NUMBER / REFER TO DRAWING FOR SECTION DETAIL

F – FIXED SUPPORT
S – SLIP SUPPORT
E – EXPANSION SUPPORT
C – APPROXIMATE COUPLER LOCATION

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

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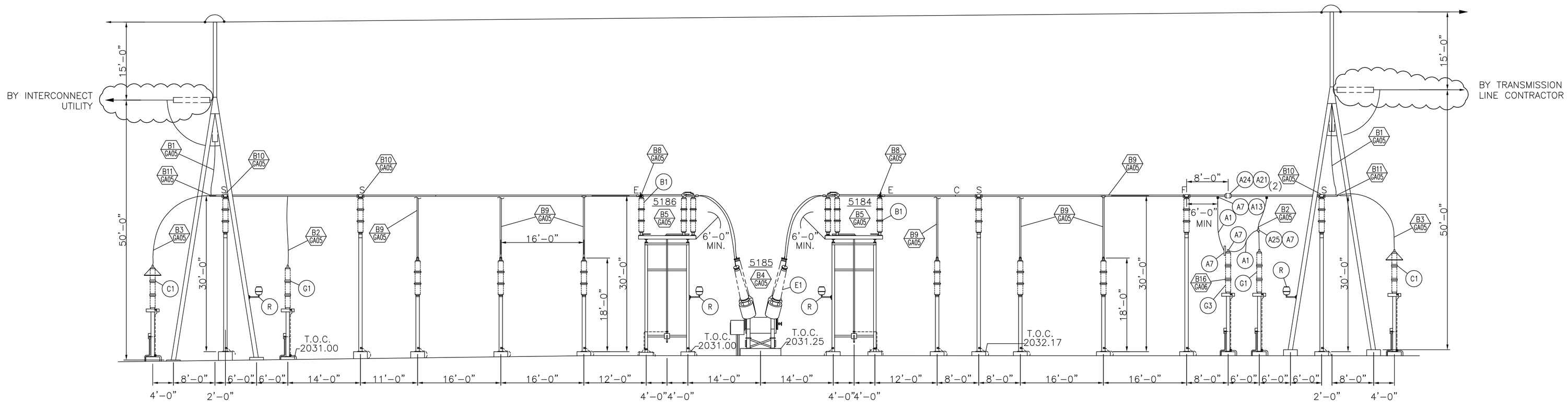
TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION GENERAL ARRANGEMENT

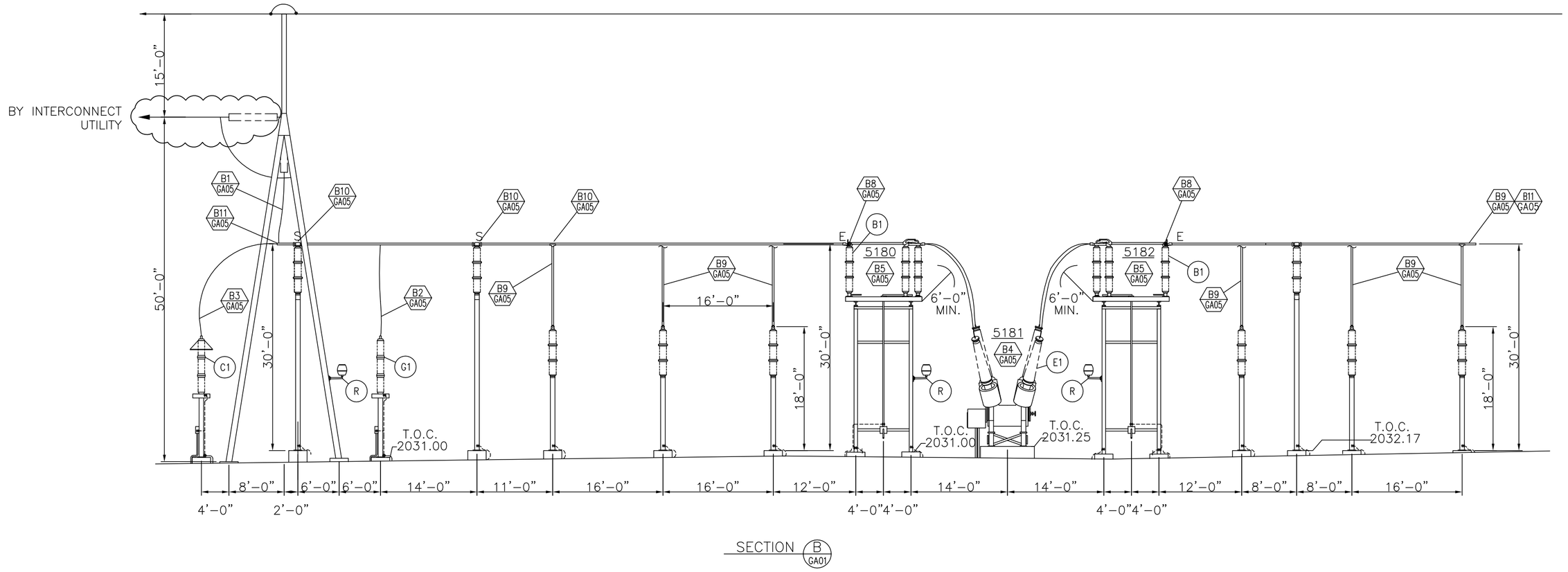
0 1" 2"

FILENAME	TWEND-GA-01
SCALE	1/16"=1'

SHEET GA-01



SECTION A GA01



SECTION B GA01

NOTES:

1. BUS HEIGHT IS FROM BOTTOM OF STEEL BASEPLATE TO CENTER-LINE OF BUS.
2. T.O.C. IS 'TOP OF CONCRETE'
3. ACTUAL 230KV BREAKER TO BE CONFIRMED.

LEGEND:

S – SLIP
F – FIXED
E – EXPANSION
C – APPROXIMATE LOCATION OF COUPLER

B1 GA05 ——— BUS CONNECTION DETAIL NUMBER
REFER TO DRAWING TWEND-GA-05

G1 ——— BILL OF MATERIAL ITEM NUMBER
REFER TO DRAWING TWEND-GA-08

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
1	06-14-07	REVISED T.O.C. ELEVATIONS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

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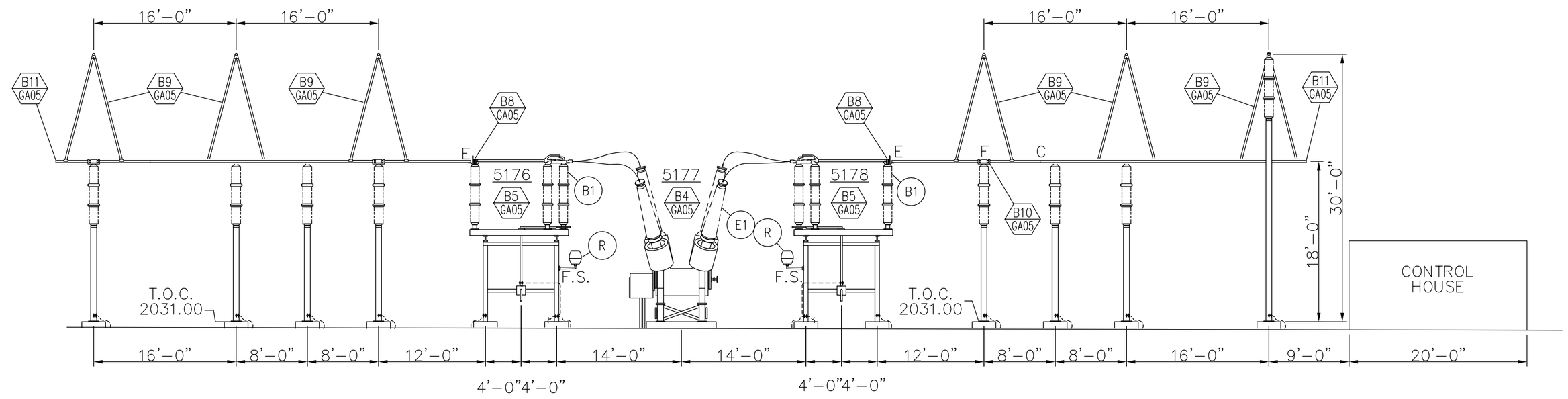
TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION SECTIONS A & B

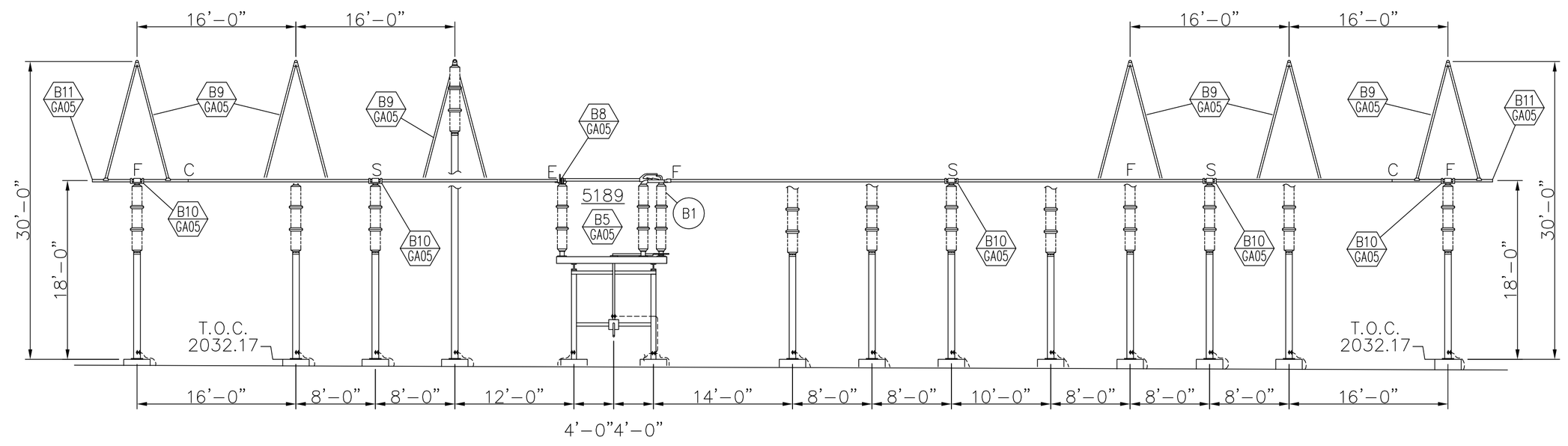
0 1" 2"

FILENAME	TWEND-GA-02
SCALE	3/32"=1'

SHEET GA-02



SECTION C GA01



SECTION D GA01

NOTES

1. BUS HEIGHT IS FROM BOTTOM OF STEEL BASEPLATE TO CENTER-LINE OF BUS.
2. T.O.C. IS 'TOP OF CONCRETE'
3. ACTUAL 230KV BREAKER TO BE CONFIRMED.

LEGEND

S – SLIP
F – FIXED
E – EXPANSION
C – APPROXIMATE COUPLER LOCATION
F.S. – FARSIDE
N.S. – NEARSIDE

B1 GA05 ——— BUS CONNECTION DETAIL NUMBER
REFER TO DRAWING TWEND-GA-05

B1 ——— BILL OF MATERIAL ITEM NUMBER
REFER TO DRAWING TWEND-GA-08

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
1	06-14-07	REVISED T.O.C. ELEVATIONS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

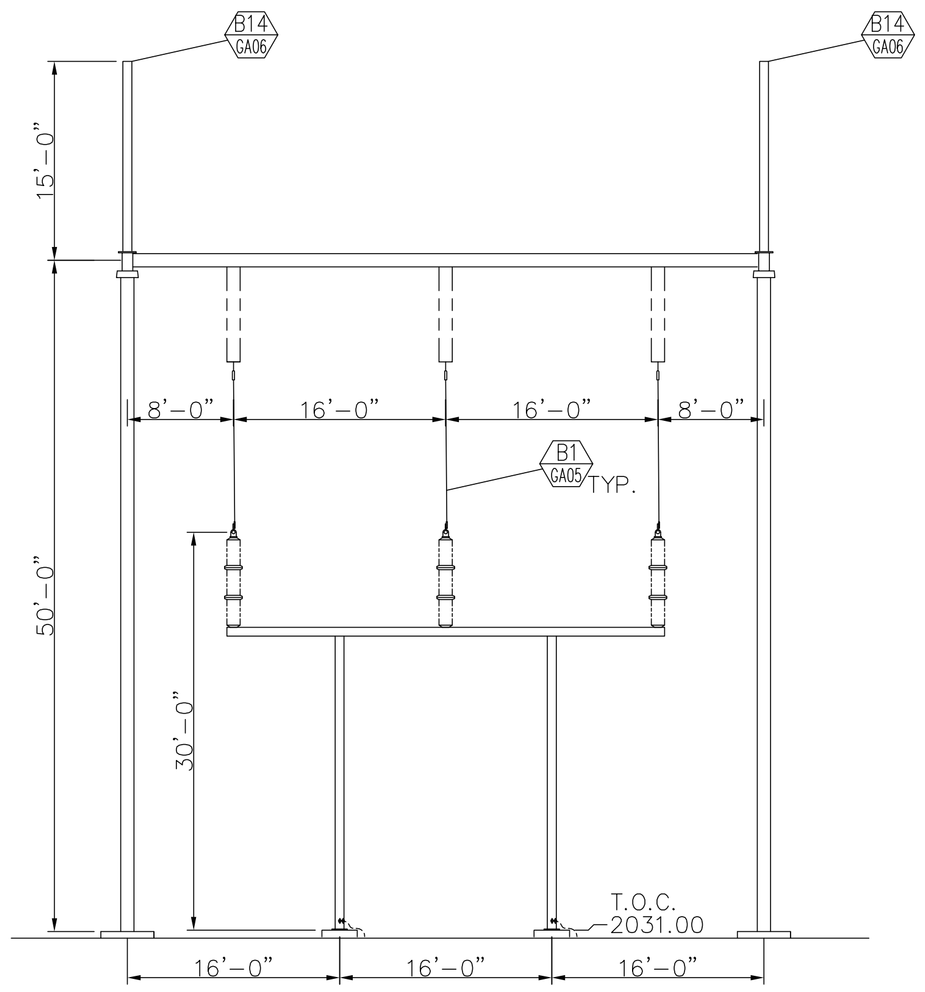
TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION SECTIONS C & D

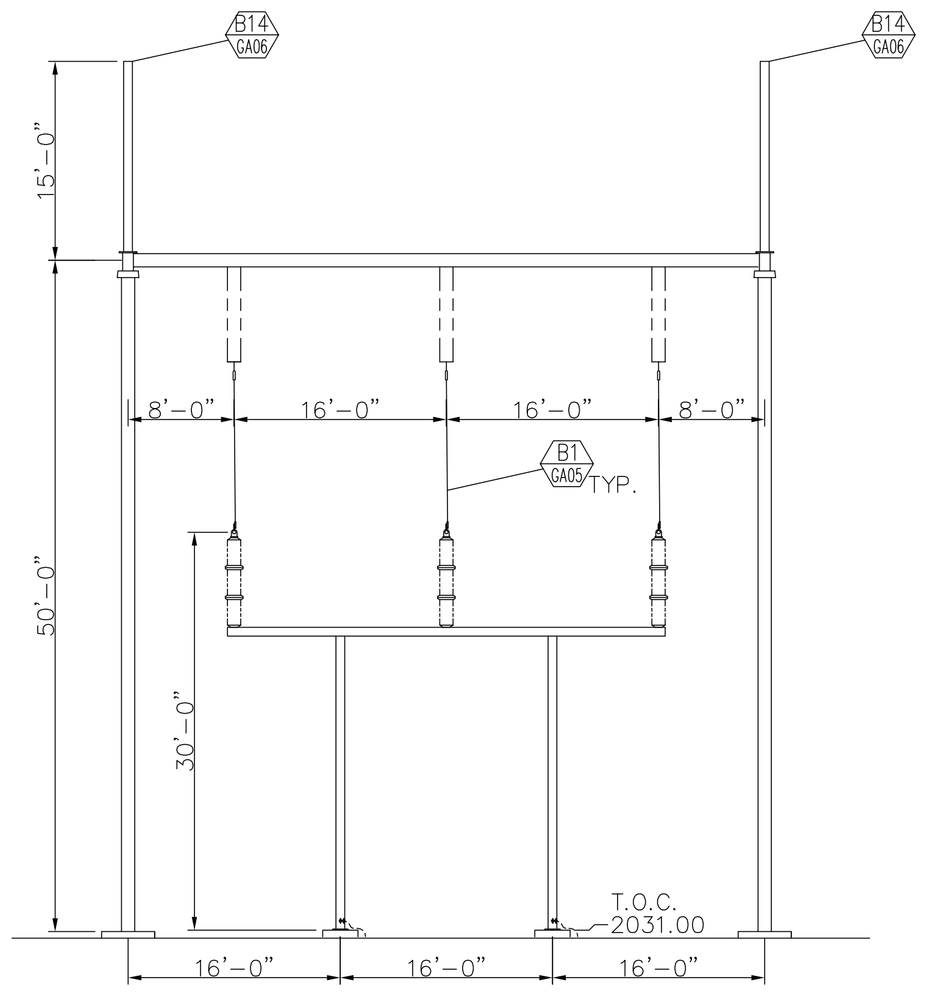
0 1" 2"

FILENAME	TWEND-GA-03
SCALE	1/8"=1'

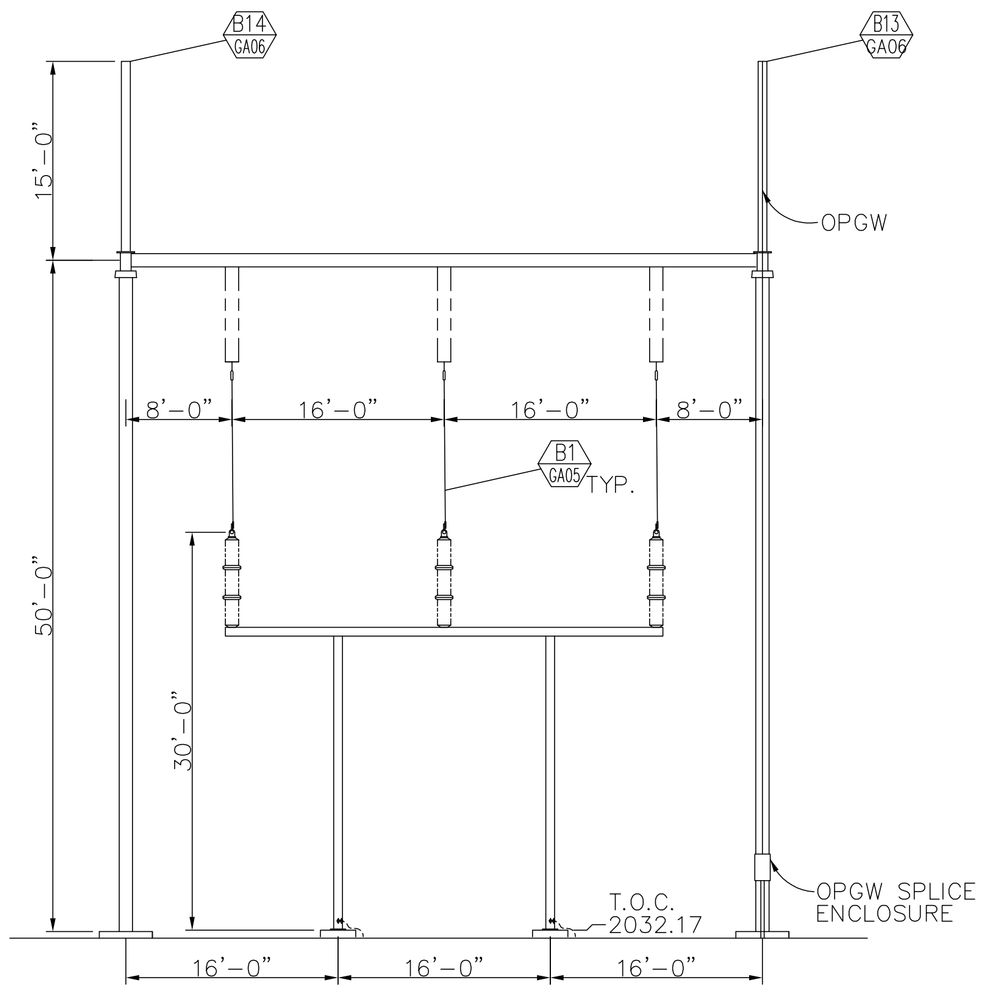
SHEET GA-03



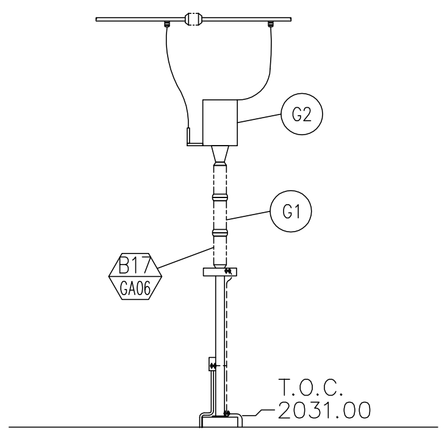
SECTION E GA01



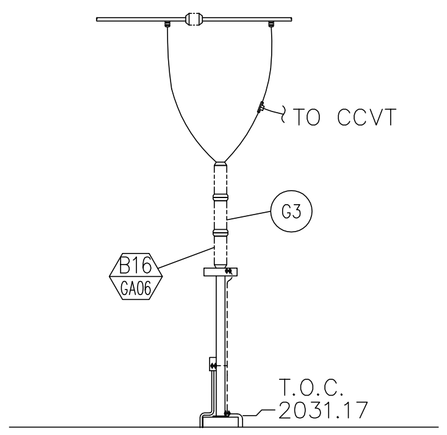
SECTION F GA01



SECTION G GA01



SECTION H GA01



SECTION I GA01

NOTES

1. BUS HEIGHT IS FROM BOTTOM OF STEEL BASEPLATE TO CENTER-LINE OF BUS.
2. T.O.C. IS 'TOP OF CONCRETE'

LEGEND

S – SLIP
F – FIXED
E – EXPANSION
C – APPROXIMATE COUPLER LOCATION
F.S. – FARSIDE
N.S. – NEARSIDE

B1 / GA05 ——— BUS CONNECTION DETAIL NUMBER
——— REFER TO DRAWING TWEND-GA-05

B1 ——— BILL OF MATERIAL ITEM NUMBER
REFER TO DRAWING TWEND-GA-08

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
1	06-14-07	REVISED T.O.C. ELEVATIONS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

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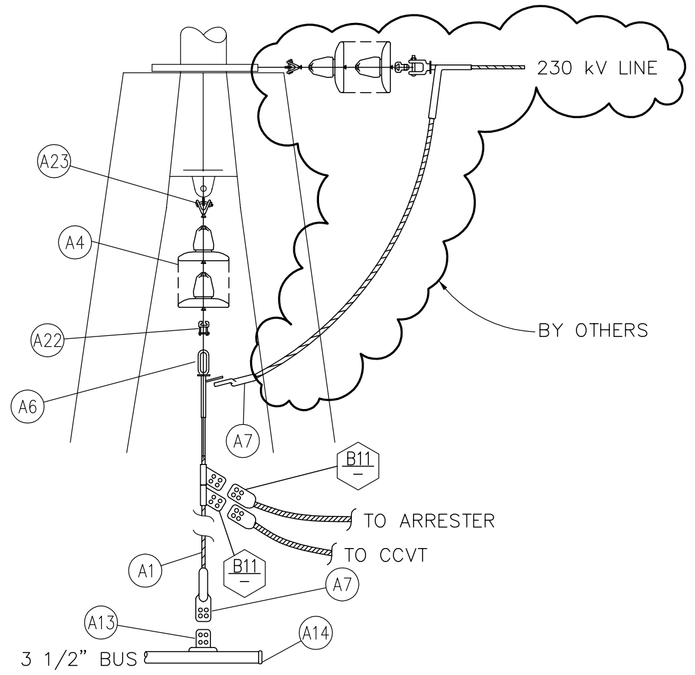
TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION SECTIONS E, F, G H & I

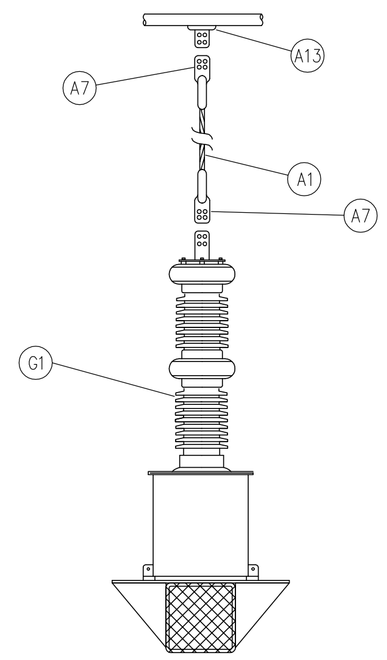
0 1" 2"

FILENAME	TWEND-GA-04
SCALE	1/8"=1'

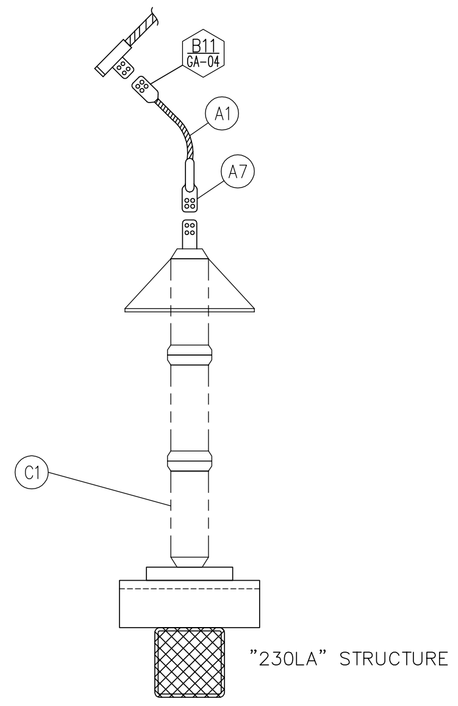
SHEET GA-04



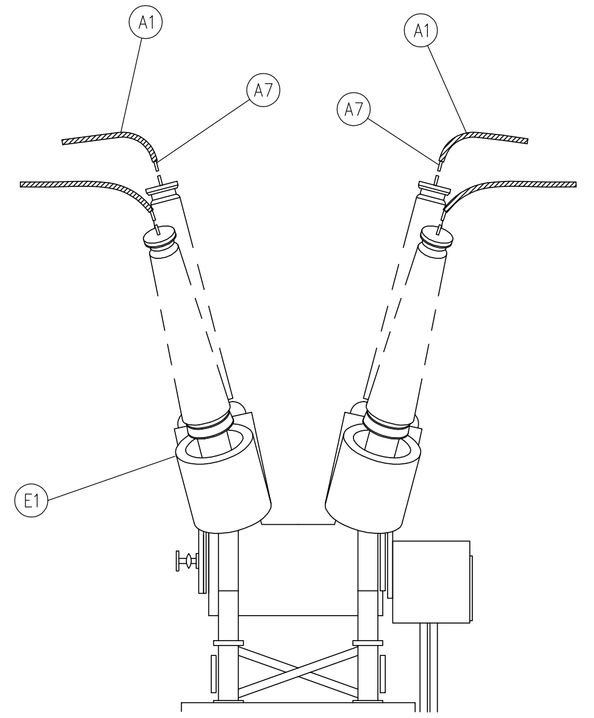
B1
230kV TAKEOFF STRUCTURE
LINE ATTACHMENT DETAIL



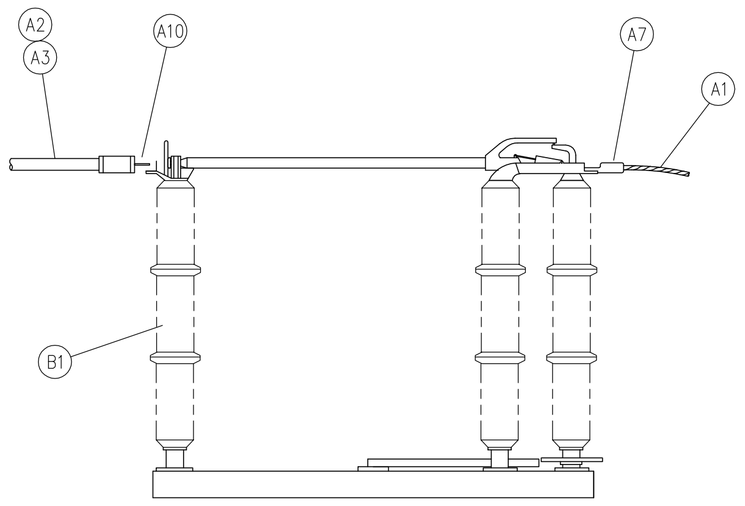
B2
230kV LINE CCVT CONNNECTION DETAIL



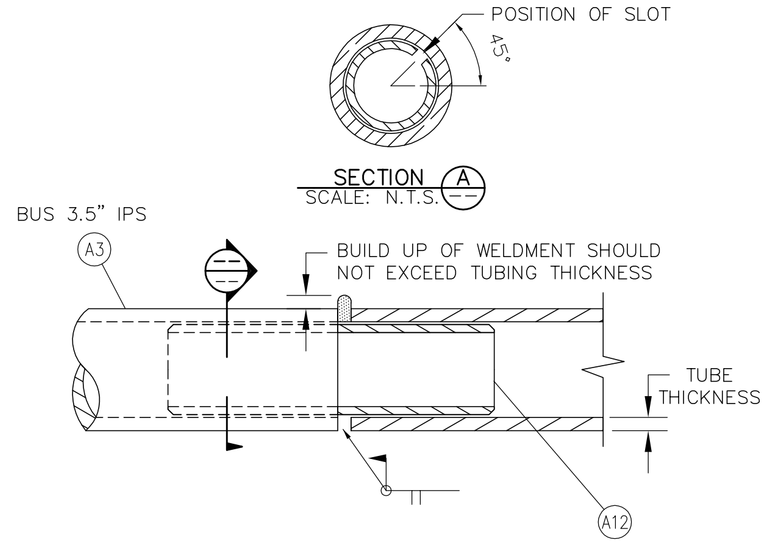
B3
230kV LIGHTNING ARRESTOR DETAIL



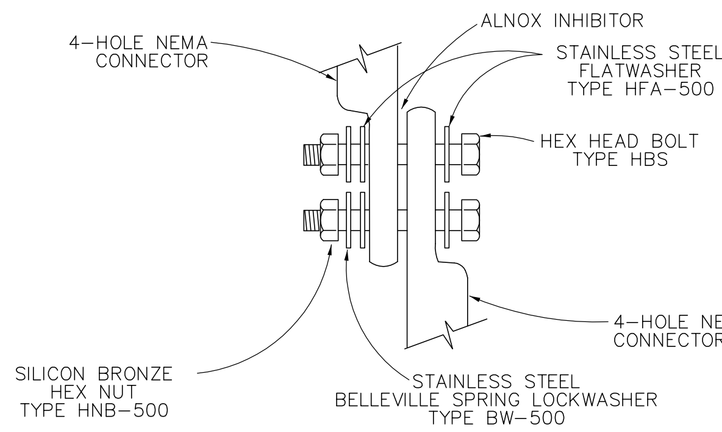
B4
230kV BREAKER DETAIL



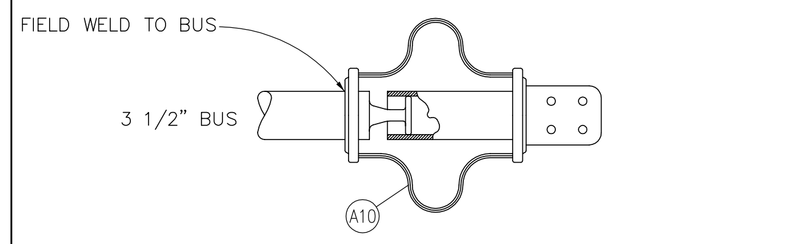
B5
230kV DISCONNECT SWITCH CONNECTION DETAIL



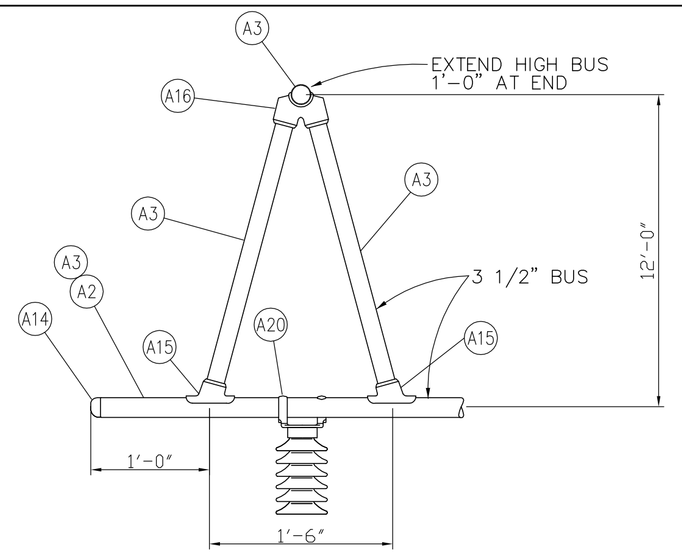
B6
230kV BUS COUPLER JOINT



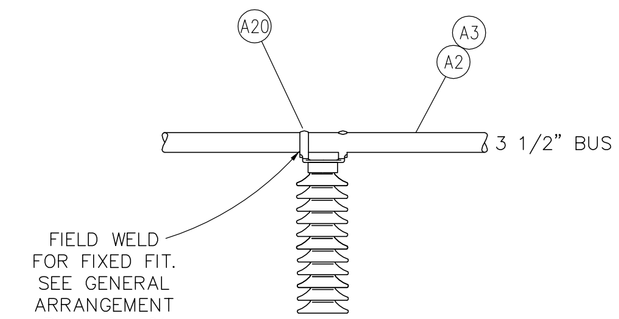
B7
ALL 4-HOLE NEMA PAD
CONNECTIONS



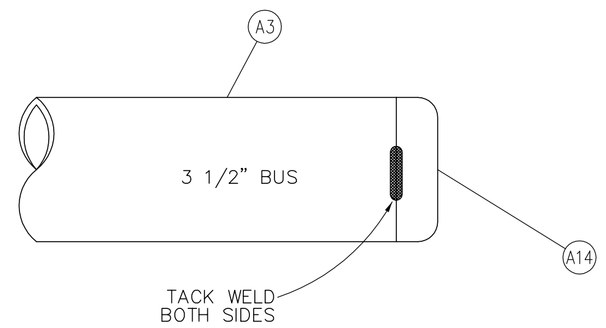
B8
230kV EXPANSION BUS
CONNECTION DETAIL



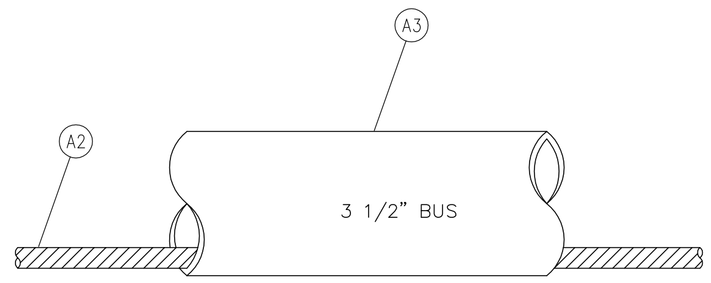
B9
230kV A-FRAME BUS SUPPORT
ASSEMBLY DETAIL



B10
230kV BUS SUPPORT
ASSEMBLY DETAIL



B11
END CAP DETAIL



B12
TYPICAL DAMPING CABLE DETAIL

MORTENSON

HDR
HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

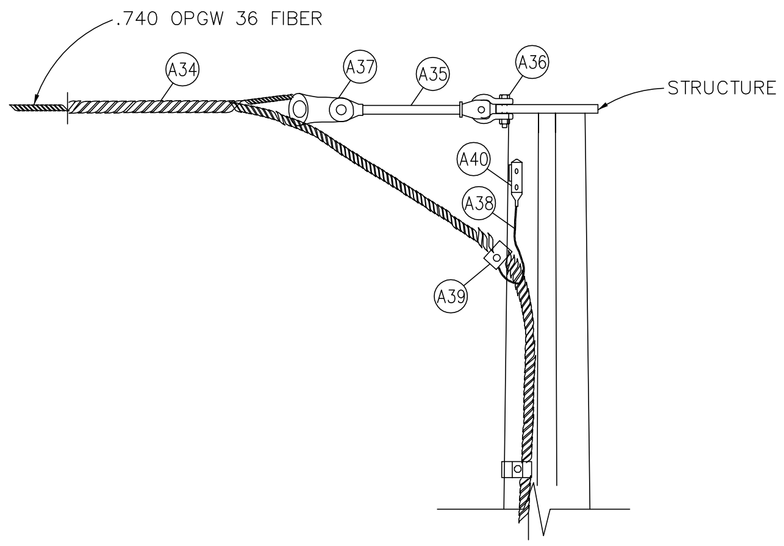
TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION
BUS DETAILS B1 THROUGH B12

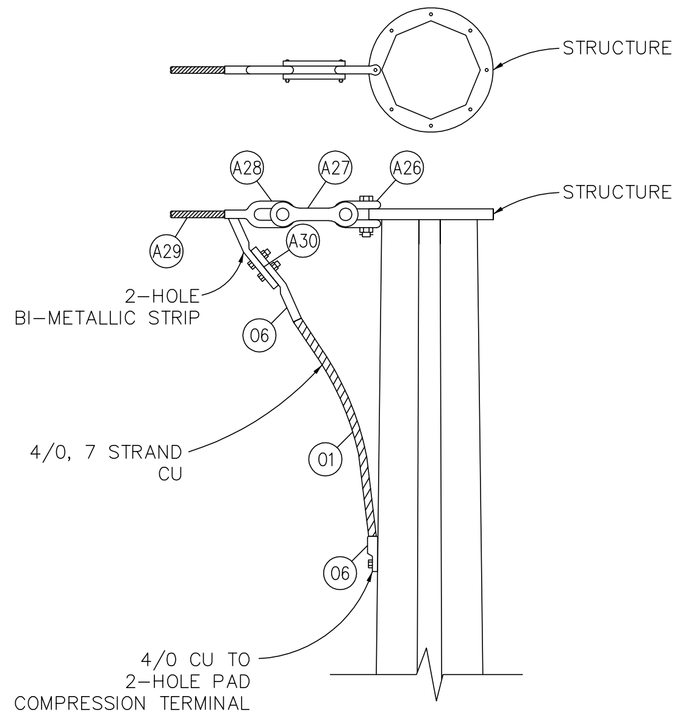
0 1" 2"

FILENAME	TWEND-GA-05
SCALE	3/16"=1'

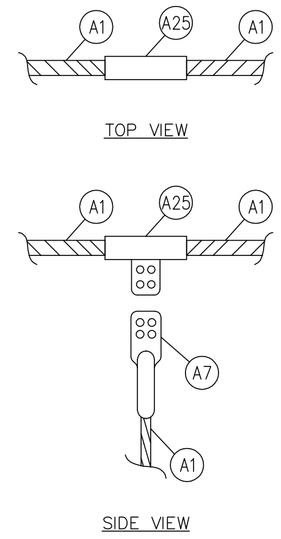
SHEET
GA-05



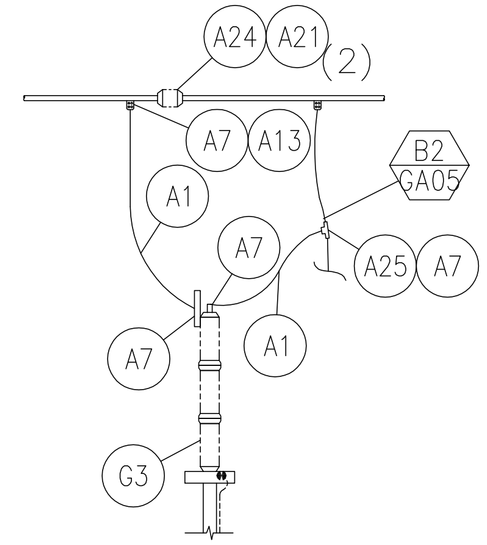
B13
FIBER OPTIC OPGW ATTACHMENT



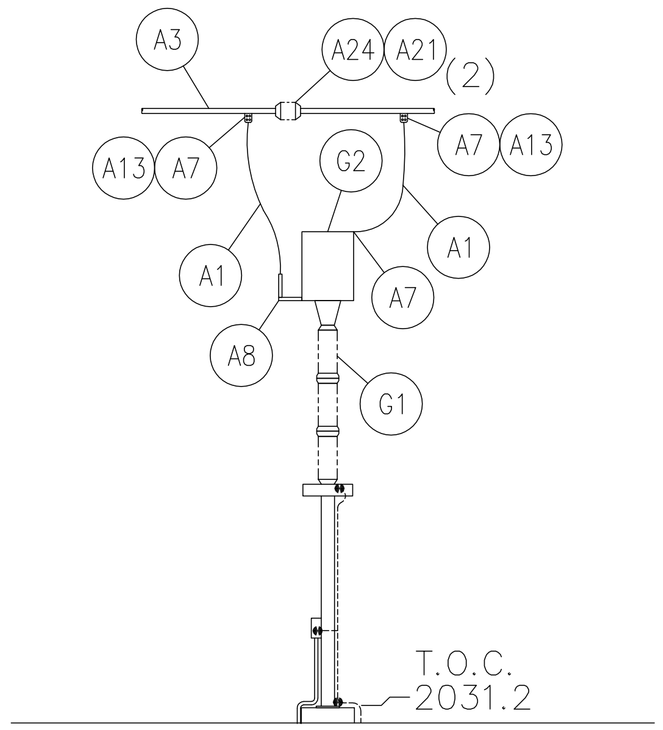
B14
STATIC CONNECTION DETAIL



B15
230kV STRAND BUS TAP



B16
OPTICAL CT CONNECTION DETAIL



B17
WAVE TRAP CONNECTION DETAIL

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

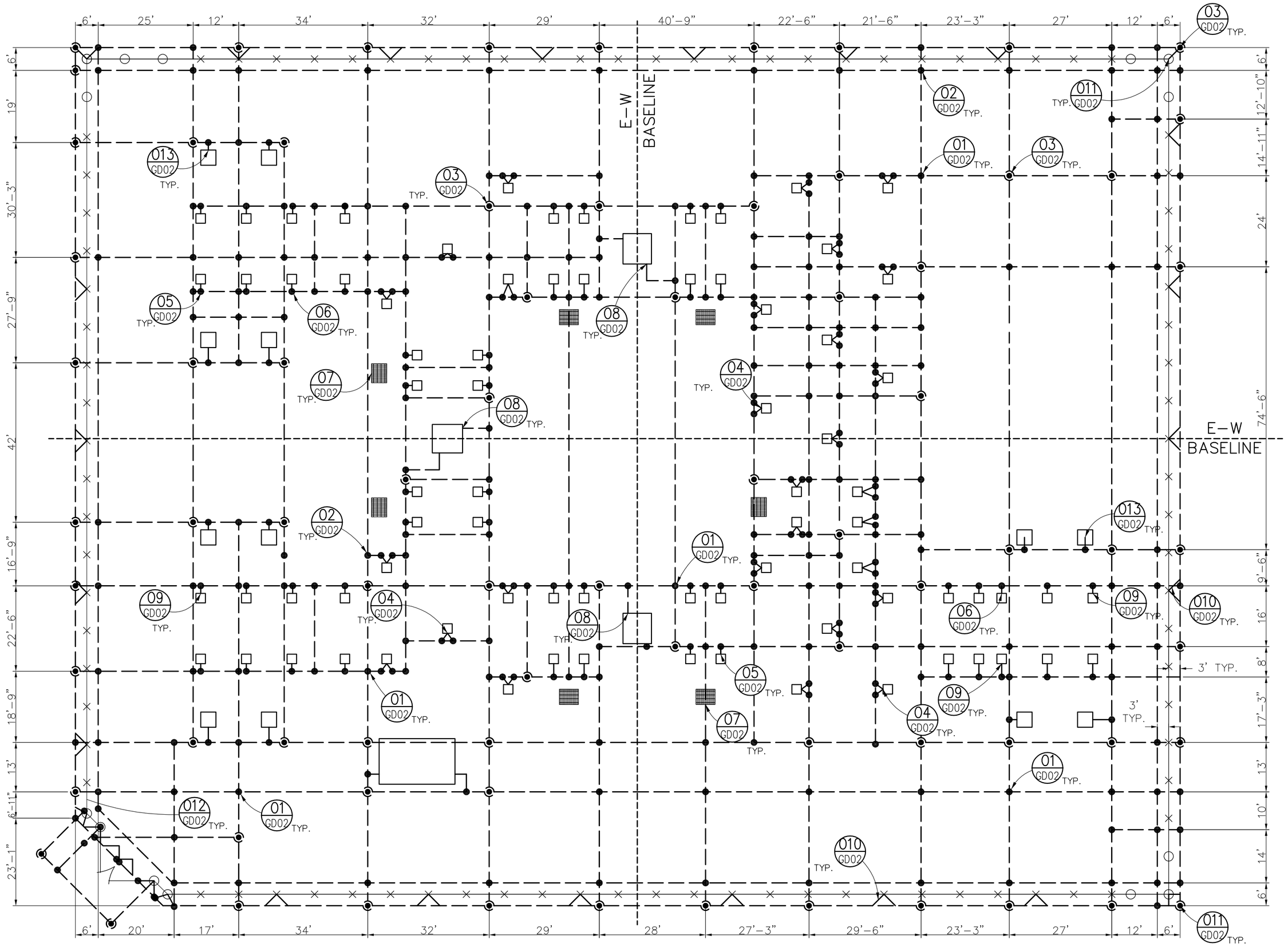
TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION BUS DETAILS B13 & B17

0 1" 2"

FILENAME	TWEND–GA–06
SCALE	3/16"=1'

SHEET
GA-06



N

SUBSTATION GROUNDING NOTES

MAIN GROUND SYSTEM

1. PROVIDE A CONTINUOUS GROUND SYSTEM WITH ONE CONDUCTOR LOCATED AROUND THE PERIMETER OF THE STATION AND WITH INTERTIES AND GROUND RODS AS SHOWN ON THE GROUNDING PLAN, TO EFFECTIVELY GROUND ALL STRUCTURES AND EQUIPMENT.
2. 4/0 BARE COPPER WIRE IS TO BE USED FOR THE MAIN GROUND SYSTEM, BURIED 18 INCHES BELOW SUBGRADE.
3. GROUND RODS SHALL BE LOCATED AS SHOWN ON THE GROUNDING PLAN AND SHALL BE FULLY DRIVEN BELOW THE SURFACE OF THE EARTH. IF POSSIBLE THE TOPS OF THE RODS SHOULD BE APPROXIMATELY ONE FOOT BELOW GRADE.

CONNECTIONS TO STEEL STRUCTURES AND EQUIPMENT

1. CONNECTIONS OF GROUND CABLES TO STEEL STRUCTURES AND EQUIPMENT SHALL BE SECURELY MADE WITH MECHANICAL CONNECTORS.
2. GROUND LEADS SHALL BE RUN UP OVER THE FOOTINGS AS INDICATED, AND UP THE STRUCTURES IN A NEAT AND WORKMAN- LIKE MANNER.
3. HOLES NECESSARY FOR ATTACHING CONNECTORS SHALL BE FIELD DRILLED AND TAPPED IF NECESSARY, WHERE NO PLATE OR TAB FOR ATTACHMENT HAS BEEN SUPPLIED.
4. WHERE CONNECTIONS TO THE GROUND MAT ARE STUBBED OUT AT EQUIPMENT FOOTINGS IN ADVANCE OF EQUIPMENT INSTALLATION, CARE SHALL BE TAKEN THAT SUFFICIENT LENGTH OF CABLE PLUS A REASONABLE MARGIN IS LEFT, SO THE LEAD MAY BE TRAINED UP ALONG THE WALL OF THE FOOTING AND MADE TO FOLLOW ALL SURFACES CLOSELY IN ROUTING CABLE TO THE POINT OF CONNECTIONS.
5. GROUND CABLES SHALL BE SUPPORTED APPROXIMATELY EVERY FOUR FEET WHEN EXTENDED UP THE STRUCTURE.
6. SINGLE-LEG STRUCTURES SHALL HAVE 2-4/0 GROUND WIRES RUN FROM DIFFERENT LOCATIONS ATTACHED TO THE SINGLE LEG. MULTI-LEG STRUCTURES SHALL BE GROUNDED WITH 1-4/0 GROUND PER LEG.

CONNECTIONS TO EQUIPMENT COMPARTMENTS, CONDUIT & CABLES

1. ALL EQUIPMENT COMPARTMENTS SHALL BE GROUNDED.
2. ALL STEEL CONDUITS SHALL BE EFFECTIVELY GROUNDED EITHER BY DIRECT GROUNDS OR BY ATTACHMENT TO METAL ENCLOSURES WHICH ARE ADEQUATELY GROUNDED.
3. ALL METALLIC POWER CABLE SHIELDS MUST BE SOLIDLY GROUNDED.

FENCE GROUNDING

1. ALL METALLIC FENCING SHALL BE SECURELY TIED TO MAIN GROUND SYSTEM AT EACH FENCE CORNER, AND AT INTERMEDIATE INTERVALS OF 40 FEET AS DETAILED ON THE GROUNDING PLAN.
2. THE PERIPHERAL CONDUCTOR OF THE MAIN GROUND GRID SHALL BE 4/0 BARE COPPER & LOCATED 3 FEET OUTSIDE OF, AND PARALLEL TO, THE FENCE AND SHALL BE BURIED 18 INCHES BELOW SUBGRADE.
3. EVERY 4TH FENCE POST SHALL BE CONNECTED TO THE MAIN GROUND GRID.
4. GROUND RODS SHALL BE DRIVEN ALONG THE CONDUCTOR AND BONDED TO EACH FENCE CORNER AND AT INTERVALS SHOWN ON THE GROUNDING PLAN.

SWITCH CONTROL HANDLES AND GROUND MATS

1. ALL GROUP-OPERATED SWITCH CONTROL HANDLES SHALL BE GROUNDED AND PROVIDED WITH A PROTECTIVE SWITCH PLATFORM.
2. SWITCH PLATFORMS SHALL BE CENTERED UNDER THE SWITCH CONTROL ROD AND PLACED ON THE CRUSHED ROCK SURFACE.
3. ALL GROUND CONNECTIONS TO PLATFORMS SHALL BE MADE ABOVE GROUND WITH ALL CABLE EXPOSED.

LEGEND

- 01 / GD02 — INDICATES GROUNDING DETAIL / INDICATES DRAWING NUMBER
- NEW GROUND GRID
- EQUIPMENT OPERATORS GROUND PLATFORMS (SEE EQUIPMENT GROUNDING DETAIL FOR PLATFORM INSTALLATION)
- FOUNDATION
- #4/0 CABLE TO GROUND ROD
- #4/0 CABLE TEE

NOTES:

1. SWITCH MECHANISMS INCLUDE GROUND BRAIDS AND PIPE CLAMPS.
2. REFER TO GROUNDING PLAN FOR DETAIL LOCATIONS.
3. REFER TO MATERIAL LIST FOR RECOMMENDED MANUFACTURER'S CATALOG NUMBERS AND DESCRIPTIONS.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

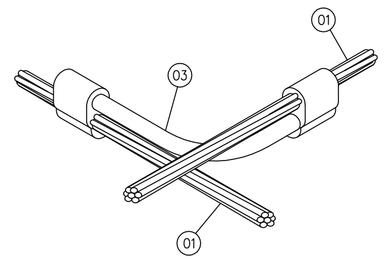
TATANKA WIND ENERGY

TATANKA 230KV INTERCONNECT SUBSTATION GROUNDING PLAN

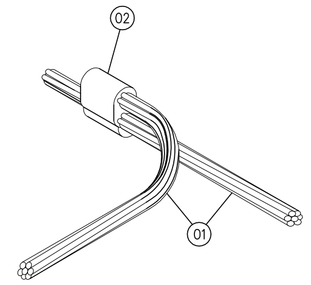
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SCALE	1/16"=1'

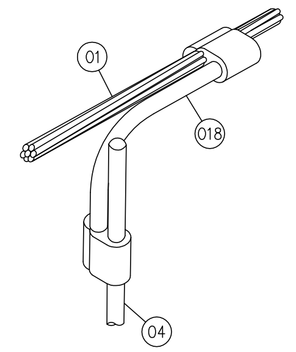
SHEET GD-01



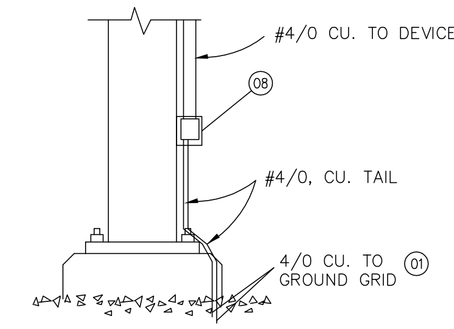
HORIZONTAL X CONNECTION 01 GD01
N.T.S.



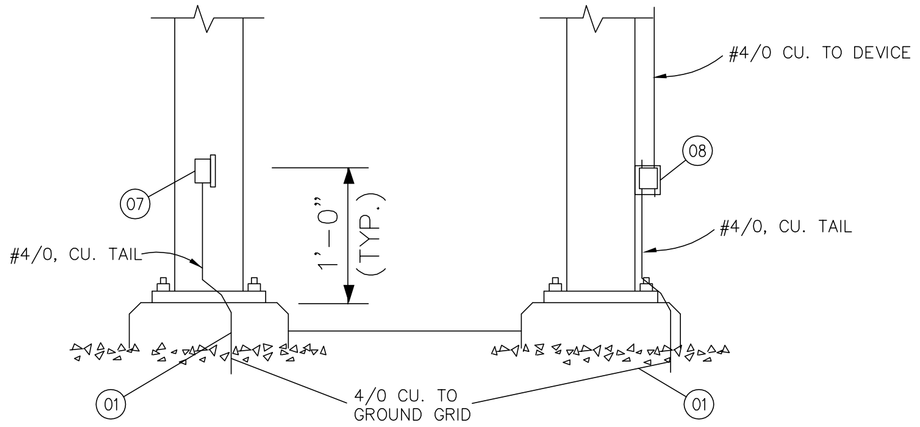
HORIZONTAL T CONNECTION 02 GD01
N.T.S.



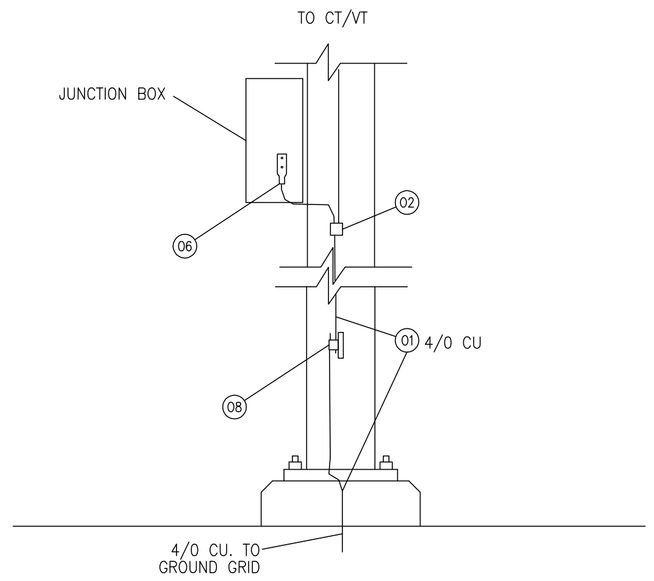
CABLE TO GROUND ROD CONNECTION 03 GD01
N.T.S.



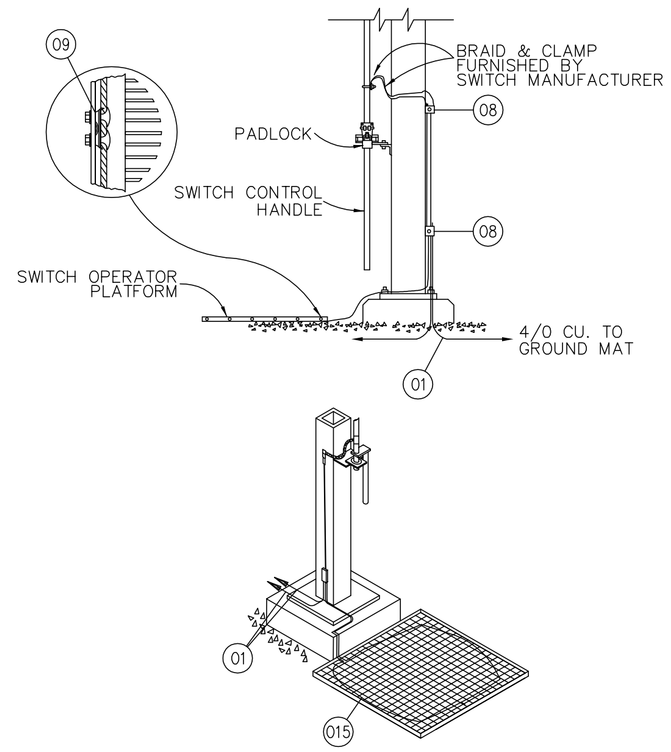
SINGLE – LEG STRUCTURE GROUNDING 04 GD01
N.T.S.



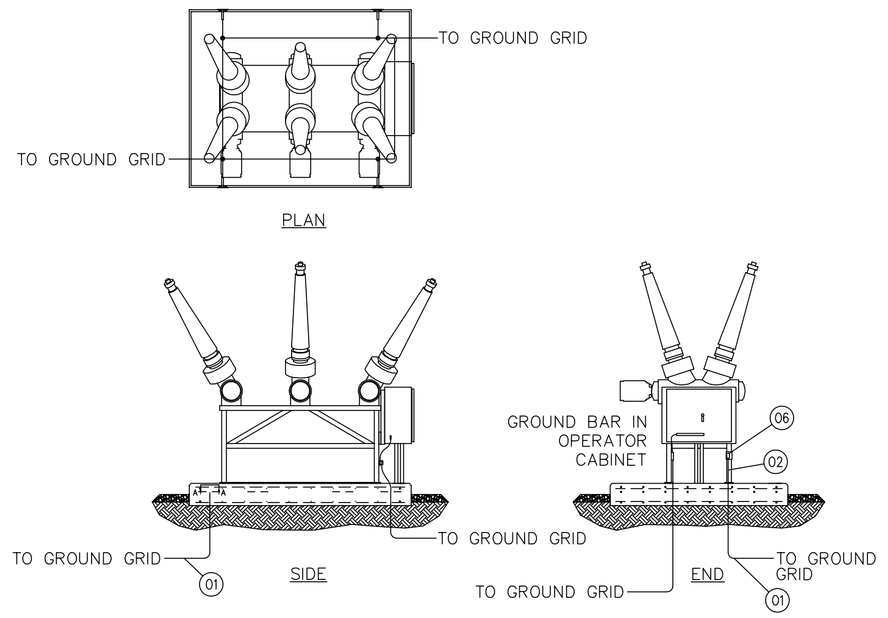
MULTI-LEG STRUCTURE GROUNDING 05 GD01
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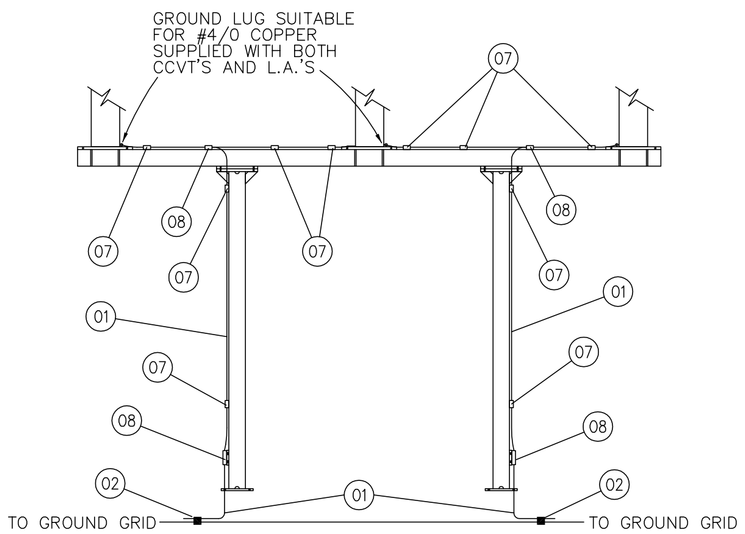
TYPICAL J-BOX GROUNDING 06 GD01
N.T.S.



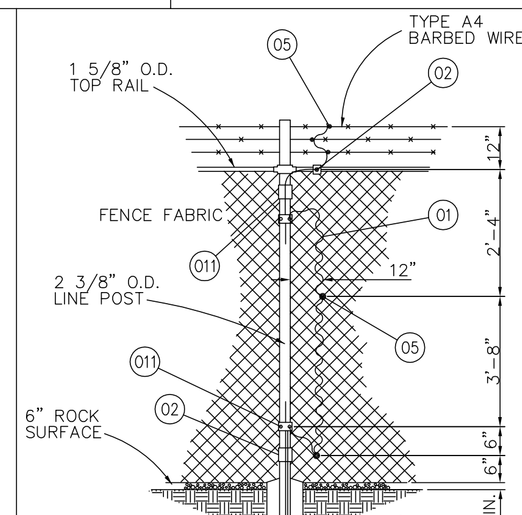
OPERATORS SWITCHING GROUND MAT 07 GD01
N.T.S.



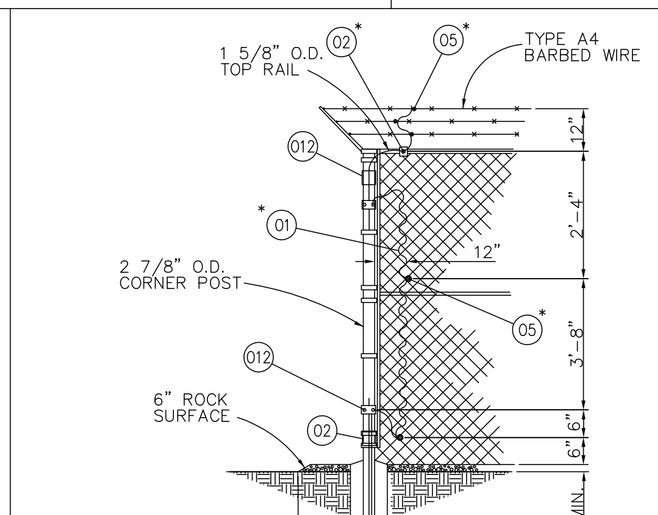
CIRCUIT BREAKER GROUNDING 08 GD01
N.T.S.



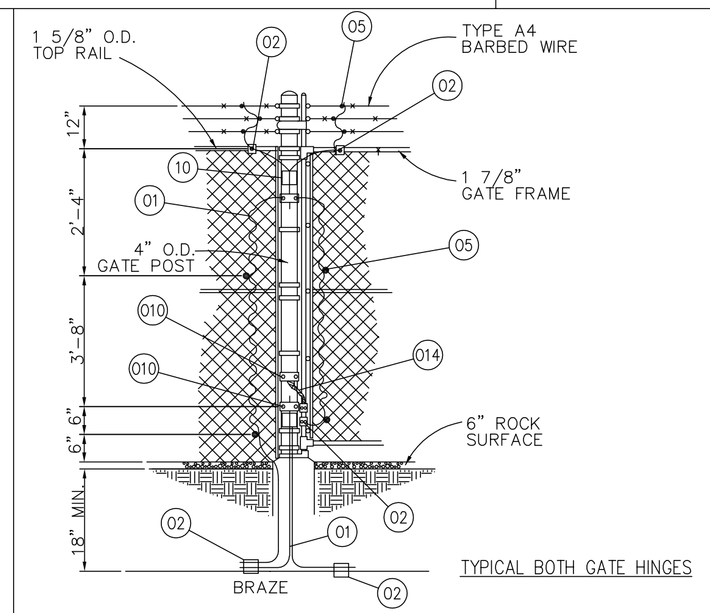
230kV CCVT & LIGHTNING ARRESTOR GROUNDING DETAIL 09 GD01
N.T.S.



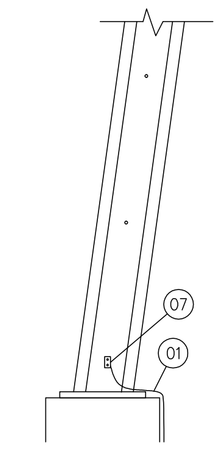
FENCE LINE POST GROUNDING 010 GD01
N.T.S.



FENCE CORNER POST GROUNDING 011 GD01
N.T.S.



LARGE GATE GROUNDING 012 GD01
N.T.S.



TUBULAR STEEL STRUCTURE GROUNDING 013 GD01
N.T.S.

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

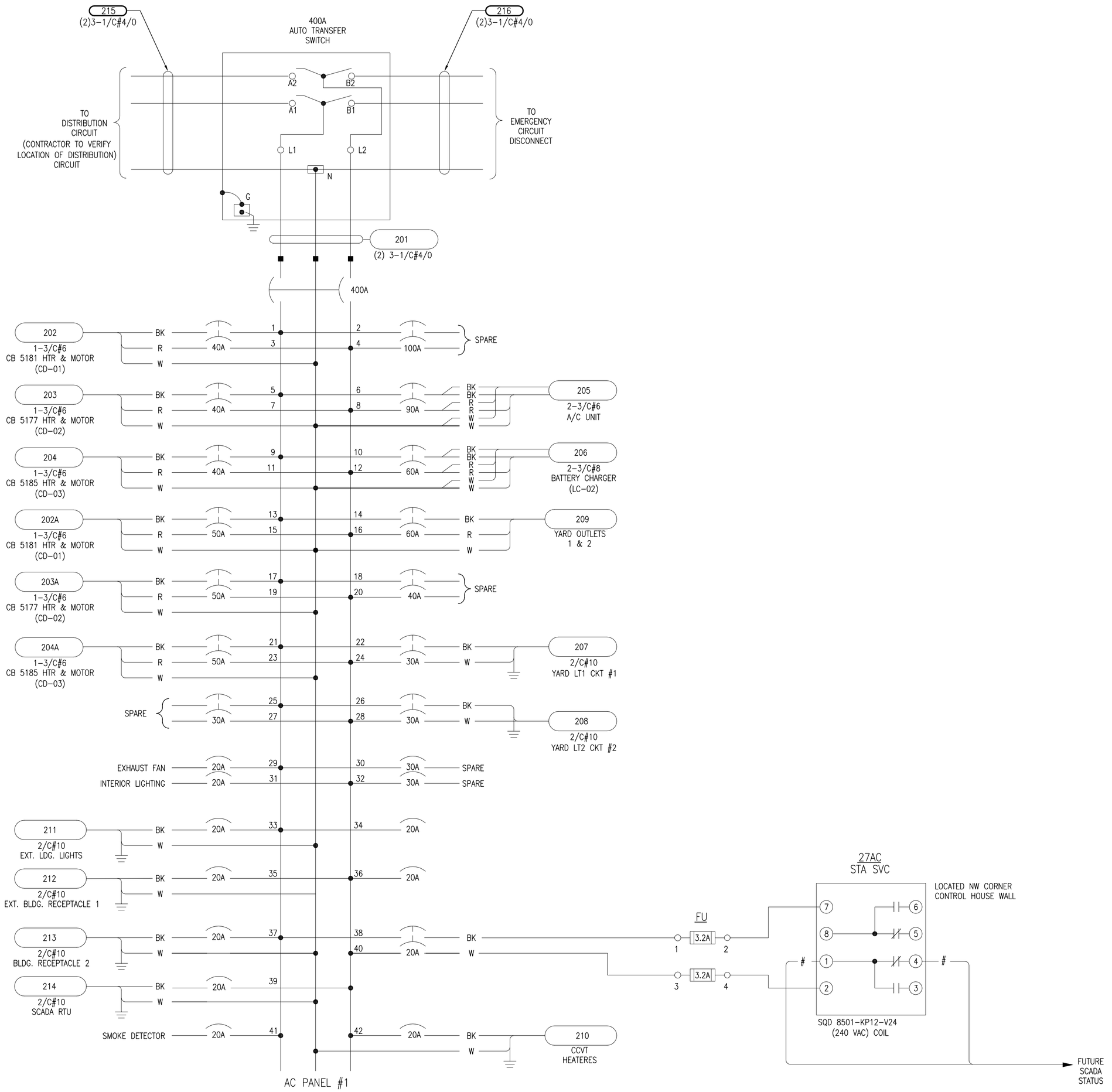
TATANKA WIND ENERGY

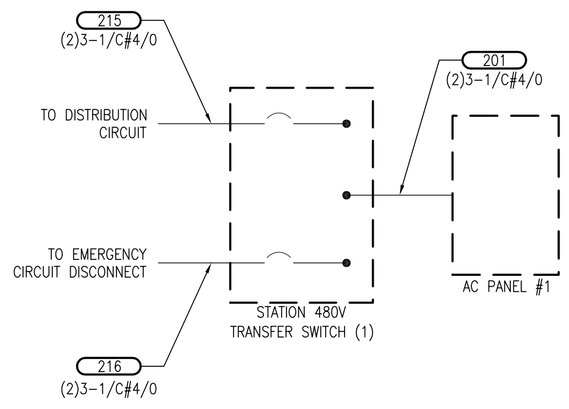
TATANKA 230kV INTERCONNECT SUBSTATION GROUNDING DETAILS 01 THROUGH 013

0 1" 2"

FILENAME	TWEND-GD-02
SCALE	NONE

SHEET GD-02





AC ONE-LINE DIAGRAM

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

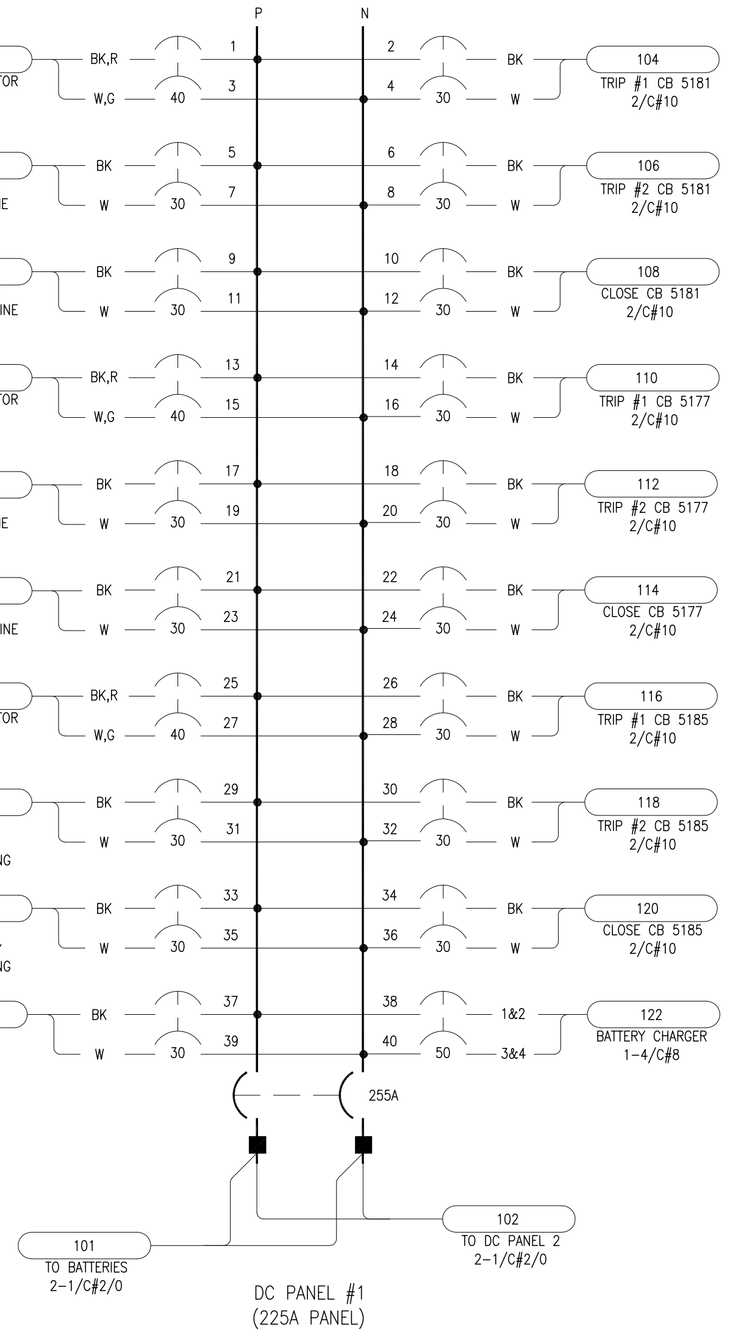
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
AC PANEL BOARD

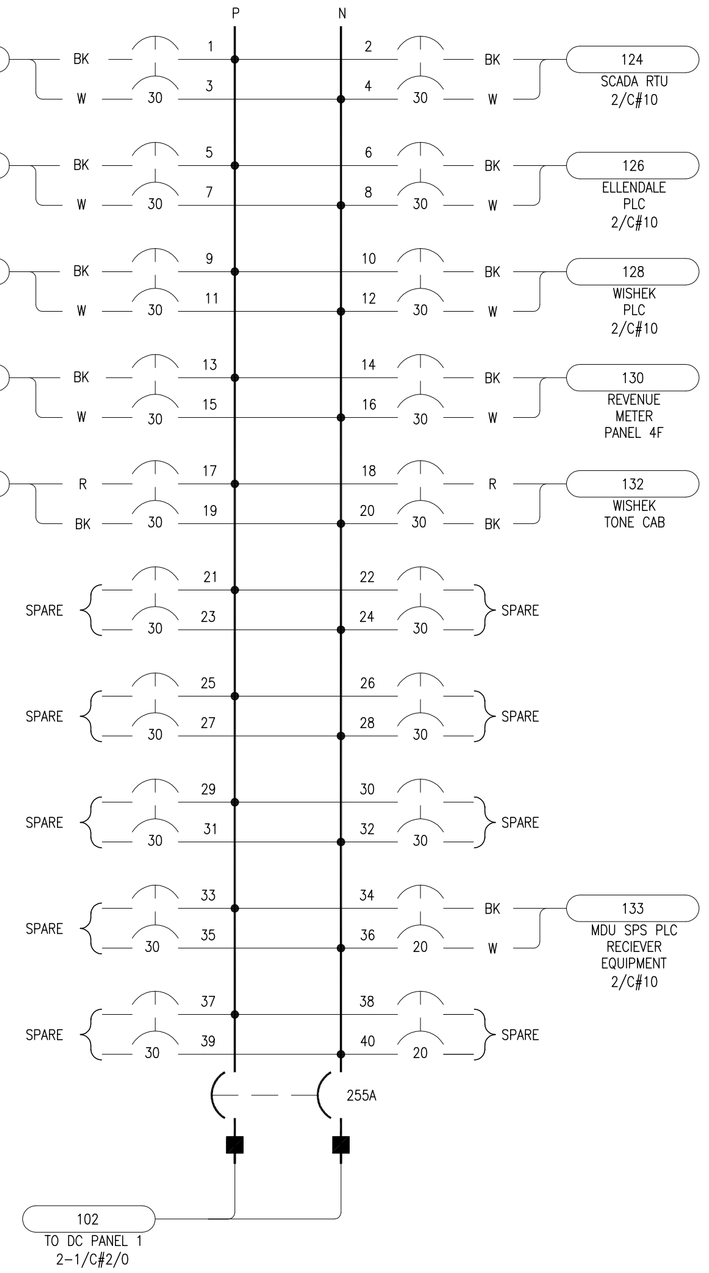
0 1" 2"

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SCALE	NONE

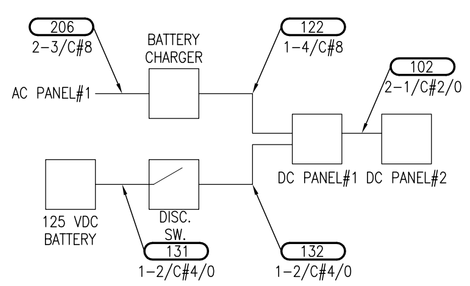
SHEET
LC-01



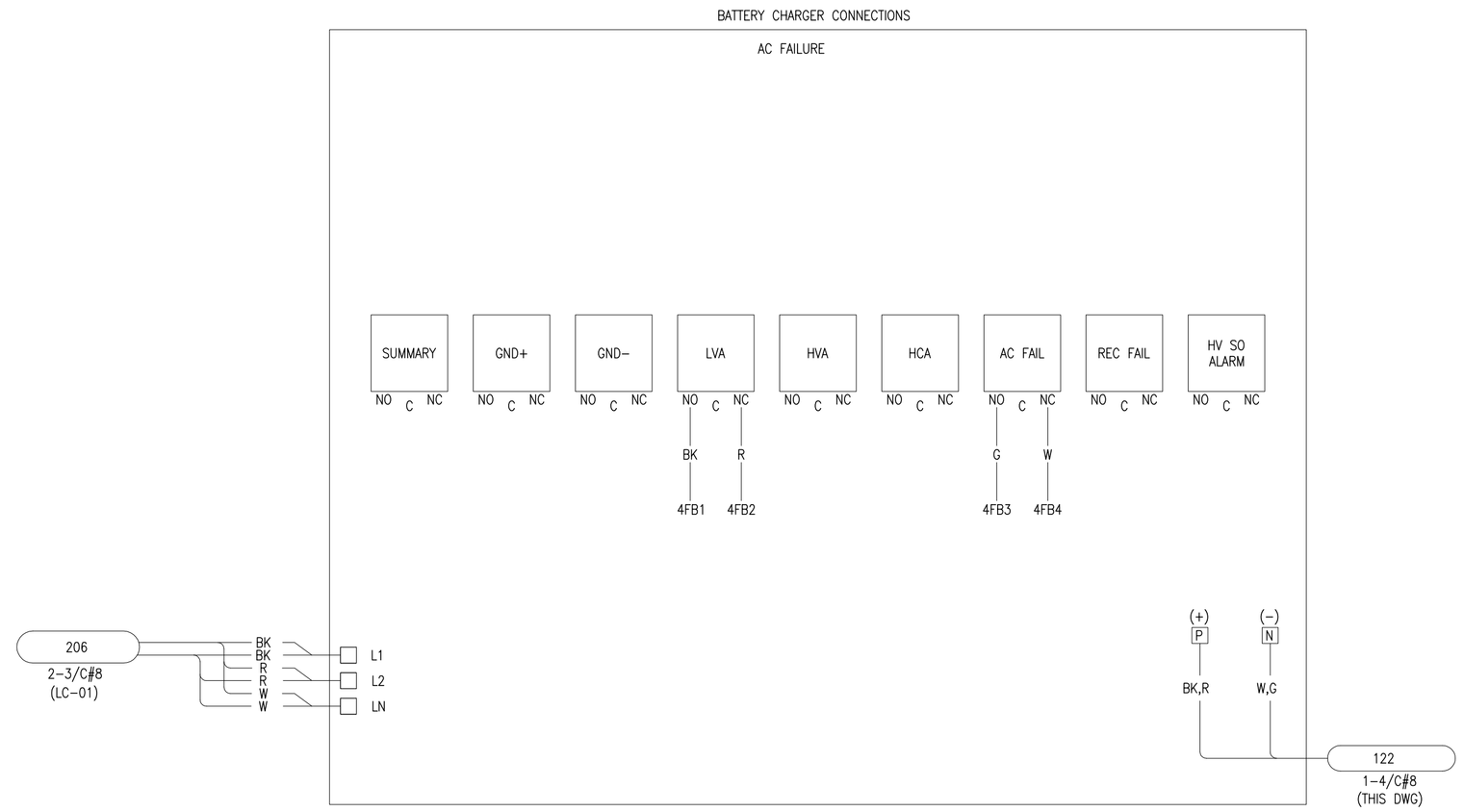
DC PANEL #1
(225A PANEL)



DC PANEL #2
(225A PANEL)



125 VDC ONE-LINE DIAGRAM



MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW - SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
DC PANEL BOARDS

0 1" 2"

FILENAME	TWEND-LC-02.DWG
SCALE	NONE

SHEET
LC-02

- CIRCUIT BREAKER
- CABINET LIGHT
- COIL
- CONTACT, NORMALLY CLOSED
- CONTACT, NORMALLY OPEN
- CONNECTOR
- DENSITY MONITOR
- DOOR SWITCH
- FUSE BLOCK
- FUSE BLOCK, SLUGGED
- FUSED DISCONNECT
- FUSED DISCONNECT, SLUGGED
- FUSE PULLOUT
- FUSE PULLOUT, SLUGGED
- INDICATOR LIGHT
- KNIFE SWITCH
- MOTOR
- PUSHBUTTON
- RESISTOR/ HEATER
- TERMINAL BLOCK
- TERMINAL BLOCK (AUXILIARY)
- THERMOSTAT
- THERMAL OVERLOAD
- TOGGLE SWITCH
- TRANSFORMER

STANDARD ANSI DESIGNATIONS

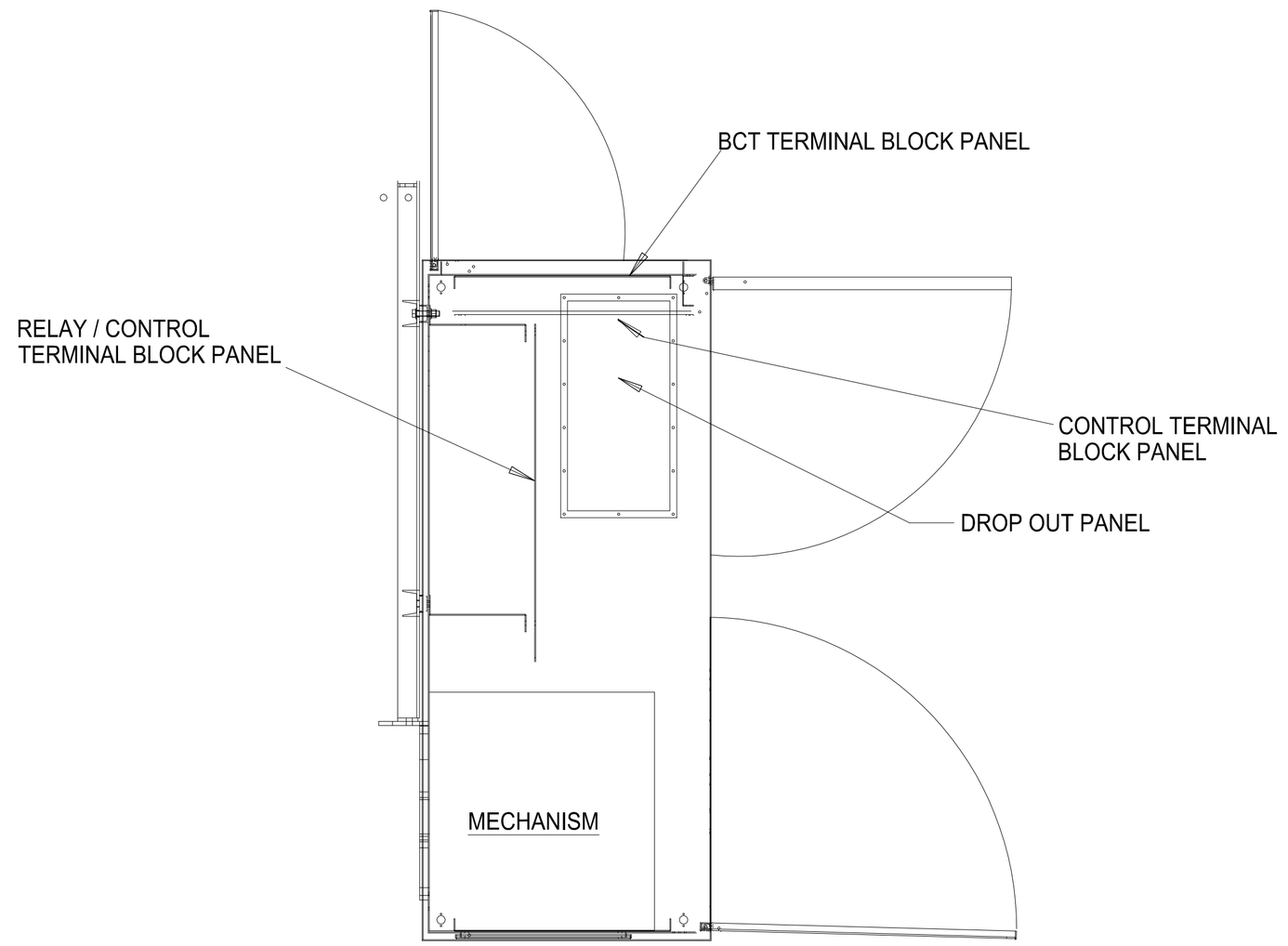
01CS BREAKER CONTROL SWITCH
23 THERMOSTAT
23X HEATER CONTACTOR
27X LOSS OF POWER RELAY
30 ANNUNCIATOR
37 UNDERCURRENT ALARM
43L/R LOCAL REMOTE TRANSFER SWITCH
49 MOTOR THERMAL OVERLOAD
52a,b BREAKER AUXILIARY SWITCH
52C CLOSE PUSHBUTTON
52CC BREAKER CLOSE COIL
52T TRIP PUSHBUTTON
52TC BREAKER TRIP COIL
52X CLOSING RELAY
52Y ANTIPUMP RELAY
52-MON BREAKER CONDITION MONITOR
63G SF6 PRESSURE / DENSITY GAUGE
63GX SF6 PRESSURE / DENSITY RELAY
69 PERMISSIVE CONTROL SWITCH
69-KI KEY INTERLOCK
74CC CLOSE COIL MONITOR
74TC TRIP COIL MONITOR
79X RECLOSE DELAY RELAY
83X MOTOR TRANSFER CONTACTOR
88 MOTOR
88F MOTOR FAILURE ALARM
88LS MOTOR LIMIT SWITCH
AIL AMBER INDICATOR LIGHT
GIL GREEN INDICATOR LIGHT
HTR HEATER
RIL RED INDICATOR LIGHT

28 /ES:14 /ES:A1

- 28: SOURCE PIN NUMBER
- /ES: DESTINATION DEVICE DESIGNATION
- 14: DESTINATION PIN NUMBER
- /ES:A1: SECOND DESTINATION IF APPLICABLE

WIRING KEY

TOP VIEW OF CONTROL CABINET



REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

LEGEND

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 1 OF 15

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

MORTENSON

HDR Engineering, Inc.

acciona

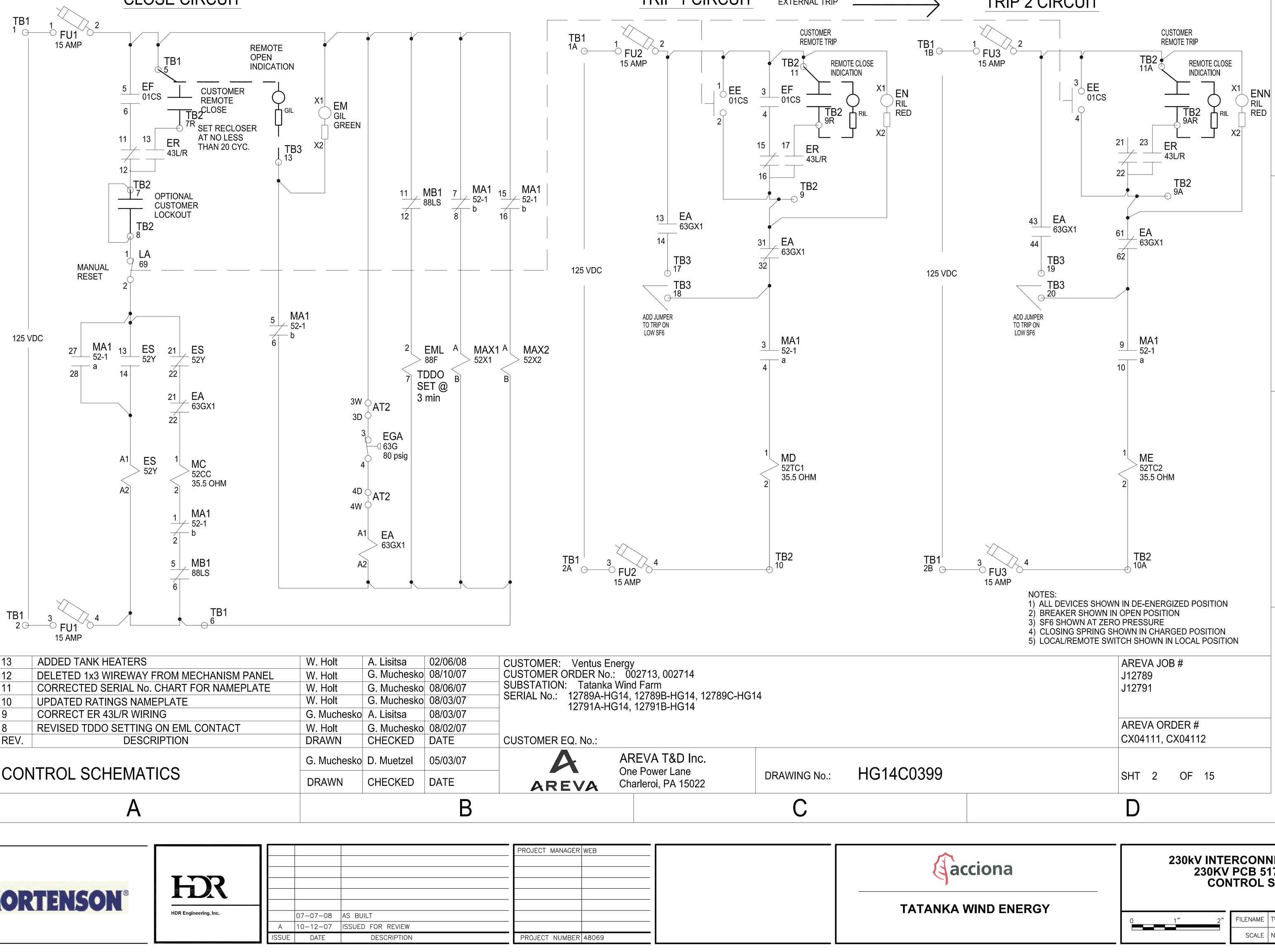
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
LEGEND

0 1" 2"

FILENAME: TWEND-MD-01.DWG
SCALE: NONE

SHEET
MD-01



NOTES:
1) ALL DEVICES SHOWN IN DE-ENERGIZED POSITION
2) BREAKER SHOWN IN OPEN POSITION
3) SF6 SHOWN AT ZERO PRESSURE
4) CLOSING SPRING SHOWN IN CHARGED POSITION
5) LOCAL/REMOTE SWITCH SHOWN IN LOCAL POSITION

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

CONTROL SCHEMATICS

DRAWN: G. Muchesko | CHECKED: D. Muetzel | DATE: 05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 2 OF 15

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

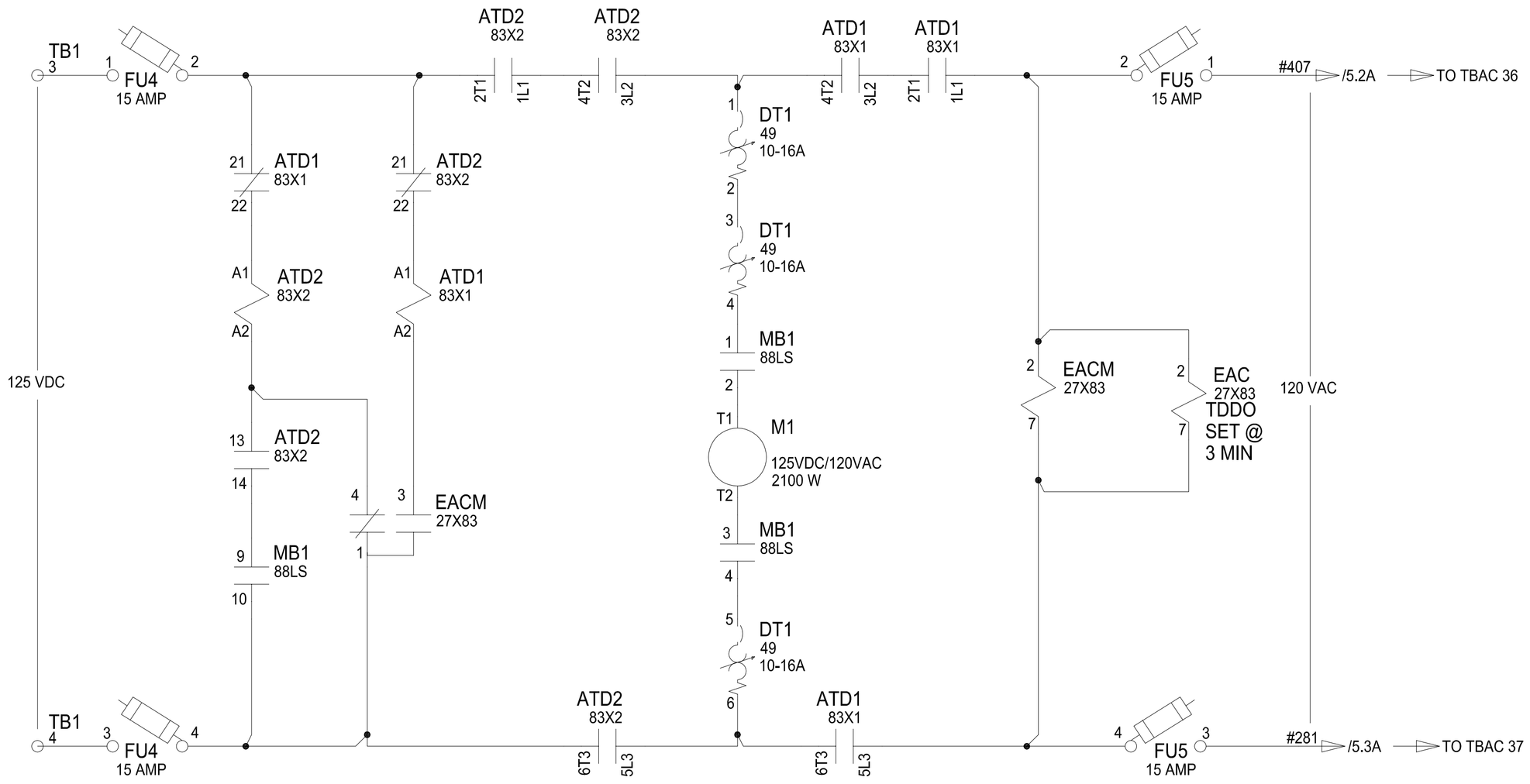
PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

MORTENSON
HDR Engineering, Inc.
acciona
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
CONTROL SCHEMATIC

FILENAME: TWEND-MD-02.DWG
SCALE: NONE
SHEET: MD-02

MOTOR CIRCUIT



NOTES:
1) ALL DEVICES SHOWN IN DE-ENERGIZED POSITION
2) BREAKER SHOWN IN OPEN POSITION
3) SF6 SHOWN AT ZERO PRESSURE
4) CLOSING SPRING SHOWN IN CHARGED POSITION
5) LOCAL/REMOTE SWITCH SHOWN IN LOCAL POSITION

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

CONTROL SCHEMATICS

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 3 OF 15

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

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TATANKA WIND ENERGY

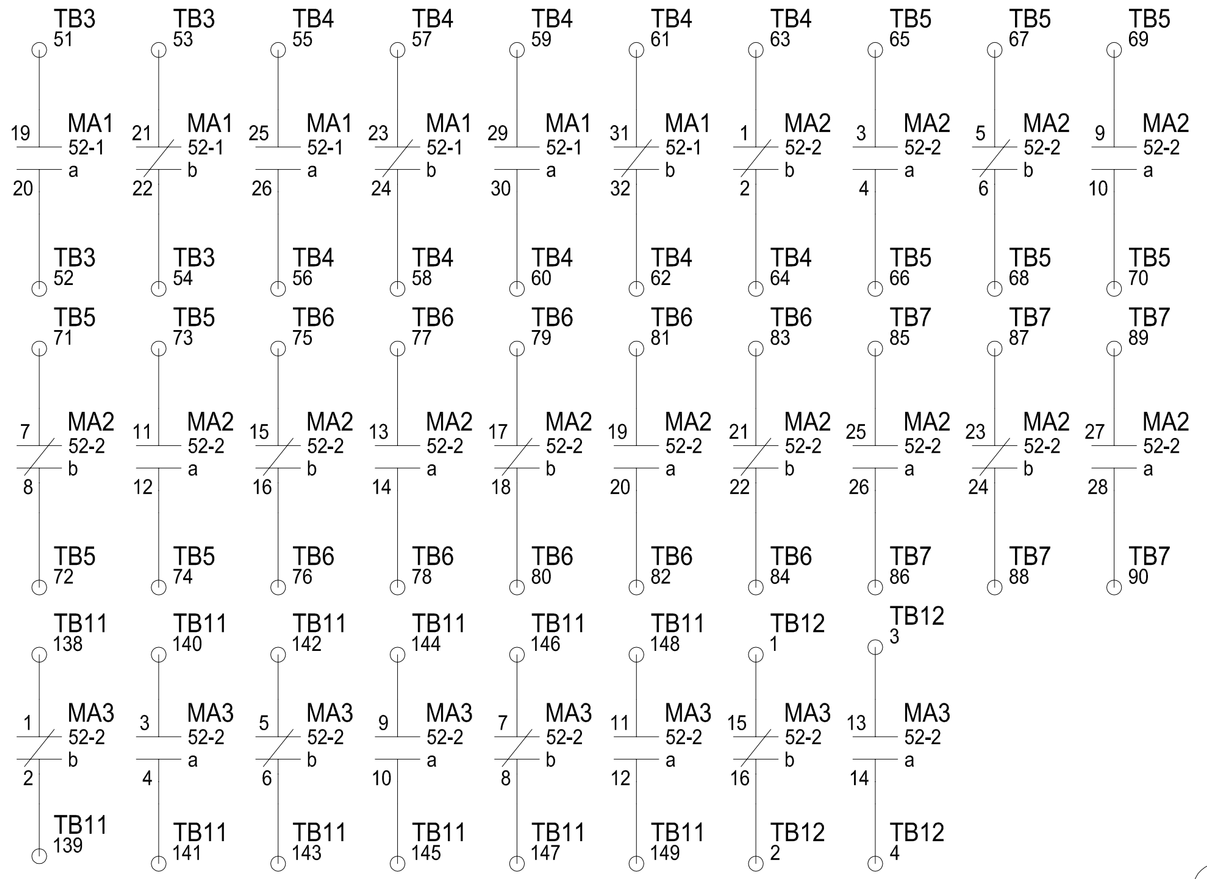
230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
CONTROL SCHEMATIC

0 1" 2"

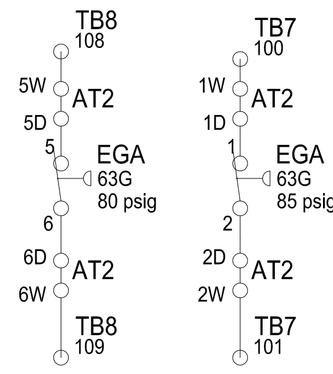
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SCALE	NONE

SHEET
MD-03

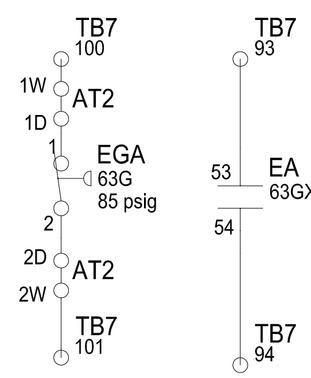
SPARE AUXILIARY SWITCHES FOR CUSTOMER USE



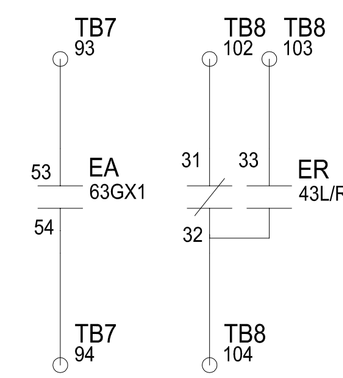
CUSTOMER ALARMS



LOW SF6 LOCKOUT

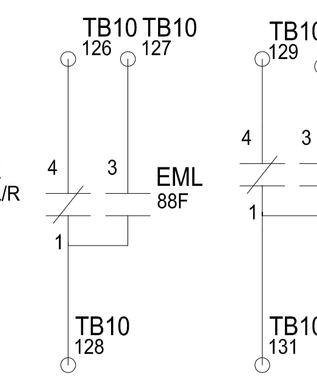


LOW SF6 ALARM

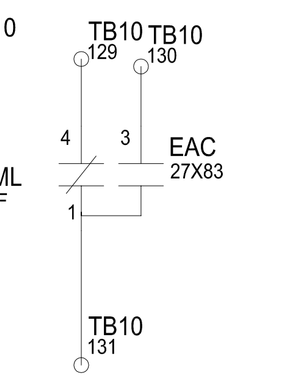


LOW SF6 LOCKOUT

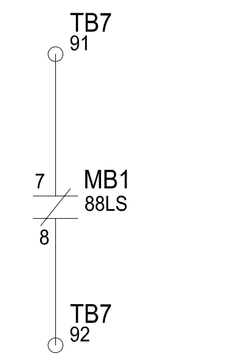
LOCAL/ REMOTE INDICATION



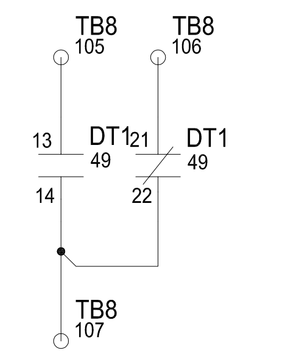
MOTOR TROUBLE TD RELAY 0.5 - 300 SEC



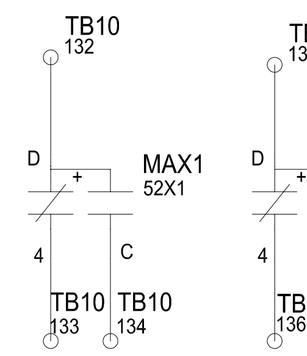
LOSS OF MOTOR AC TD RELAY 0.5 - 300 SEC



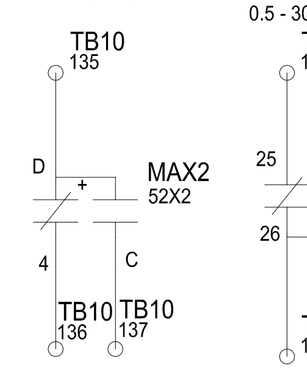
SPARE MOTOR LIMIT SWITCH CONTACTS



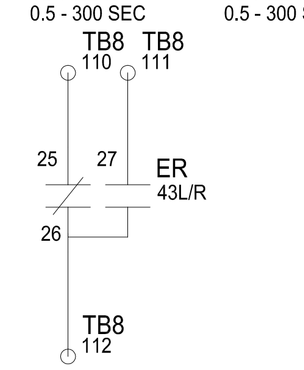
MOTOR THERMAL OVERLOAD



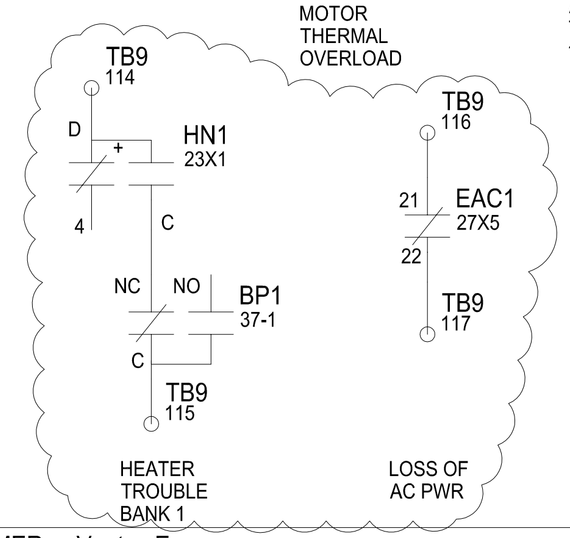
AUX CONTACT TD RELAY 1.5 TO 120 CYCLES



AUX CONTACT TD RELAY 1.5 TO 120 CYCLES



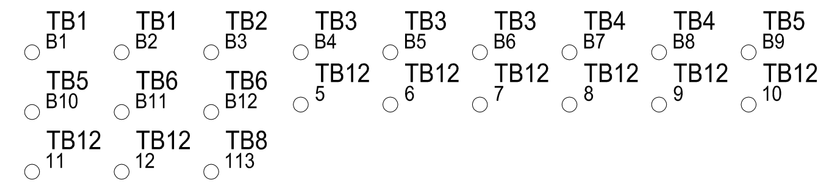
LOCAL/REMOTE INDICATION



HEATER TROUBLE BANK 1

LOSS OF AC PWR

SPARE TERMINAL BLOCKS FOR CUSTOMER USE



REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
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8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

BILL OF MATERIALS — G. Muchesko / D. Muetzel / 05/03/07 (DRAWN / CHECKED / DATE)

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB # J12789 J12791

AREVA ORDER # CX04111, CX04112

SHT 4 OF 15

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

MORTENSON

HDR Engineering, Inc.

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TATANKA WIND ENERGY

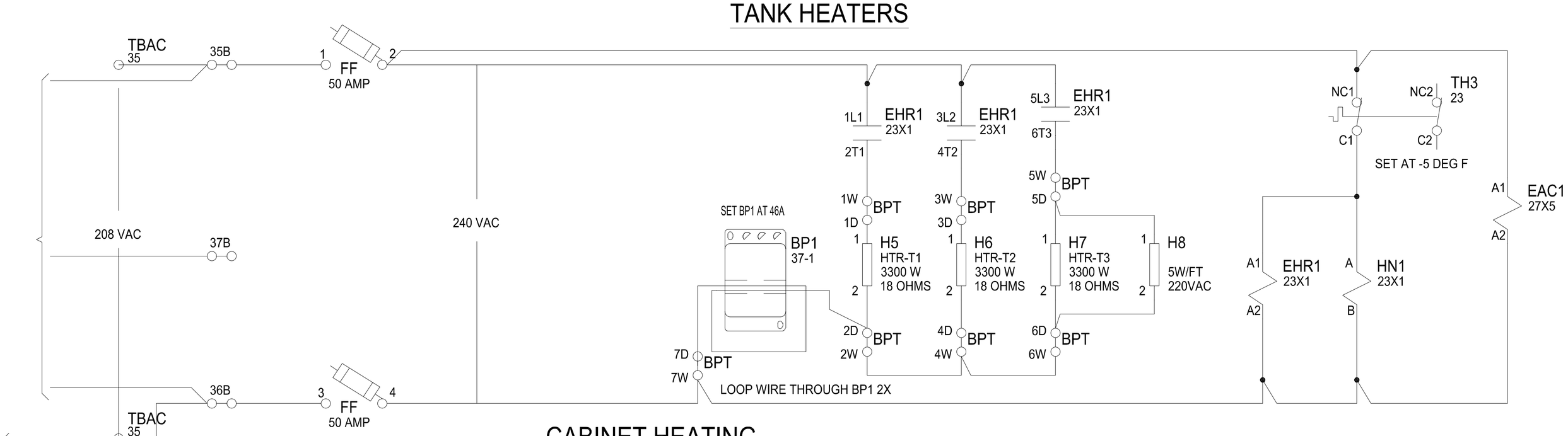
230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
ALARMS & AUX SWITCHES

0 1" 2"

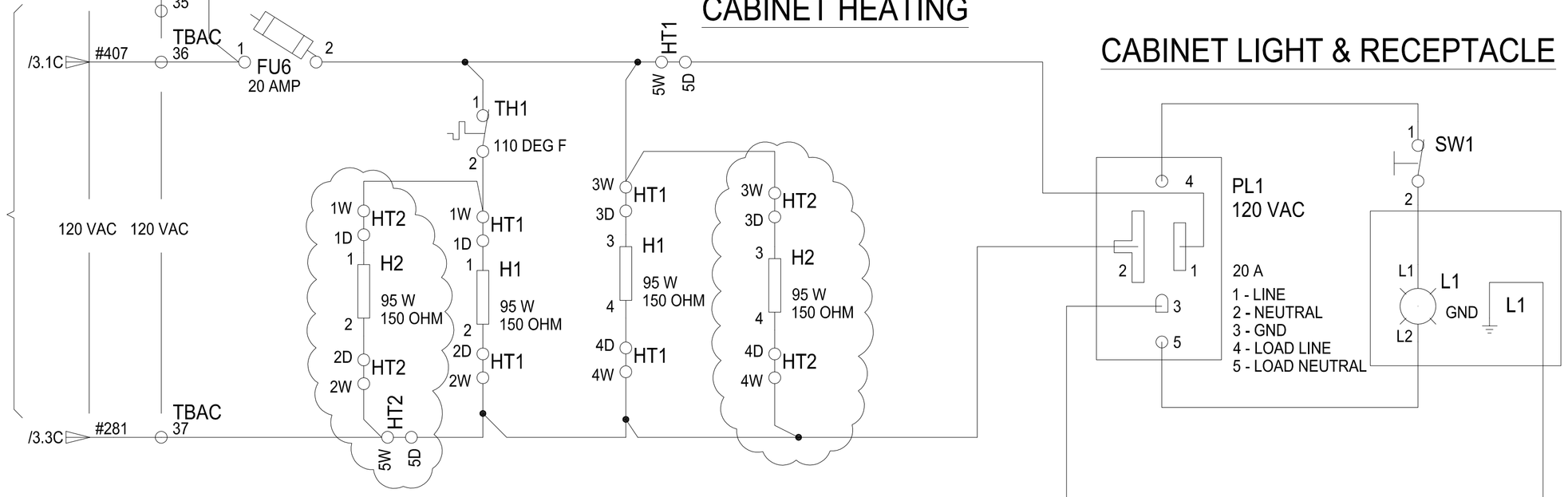
FILENAME: TWEND-MD-04.DWG
SCALE: NONE

SHEET: MD-04

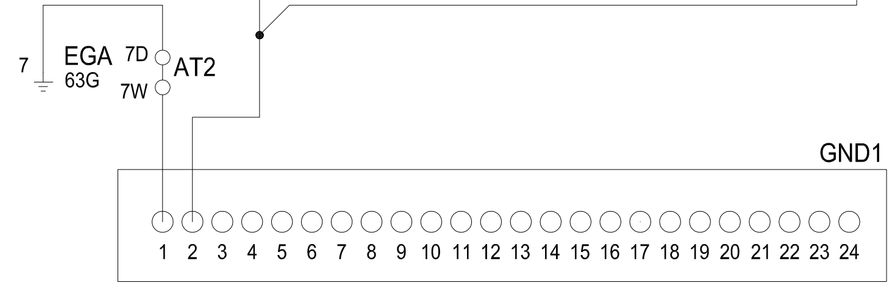
TANK HEATERS



CABINET HEATING



CABINET LIGHT & RECEPTACLE



REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
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10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

SF6 GAS PIPING/RATING NAMEPLATE

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 5 OF 15

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

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TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
CABINET HEATING

0 1" 2"

FILENAME	TWEND-MD-05.DWG
SCALE	NONE

SHEET
MD-05

RELAY PANEL WIRING
TERMINAL BLOCKS

TBACB

FF:1	35B	
FF:3	36B	
	37B	

TBAC

	35	
FU6:1,FU5:1	36	
HT1:2W,FU5:3	37	

TB1

	1	FU1:1
	2	FU1:3
	1A	FU2:1
	2A	FU2:3
	1B	FU3:1
	2B	FU3:3
	3	FU4:1
	4	FU4:3
	5	EM:X1,EF:5
	6	MB1:6,MAX2:B
	B1	
	B2	

TB2

	7	TB2:8,ER:12
	7R	ER:13
	8	LA:1,TB2:7
	9	ER:16,EA:31
	9R	ER:17
	9A	ER:22,EA:61
	9AR	ER:23
	10	FU2:4,MD:2
	10A	ME:2,FU3:4
	11	EN:X1,EF:3
	11A	EE:3,ENN:X1
	B3	

TB3

	13	EM:X2,MA1:5
	17	EA:14
	18	EA:32
	19	EA:44
	20	EA:62
	B4	
	51	MA1:19
	52	MA1:20
	53	MA1:21
	54	MA1:22
	B5	
	B6	

TB4

	55	MA1:25
	56	MA1:26
	57	MA1:23
	58	MA1:24
	59	MA1:29
	60	MA1:30
	61	MA1:31
	62	MA1:32
	63	MA2:1
	64	MA2:2
	B7	
	B8	

TERMINAL BLOCK PANEL
WIRING (CONTROL)

TB5

MA2:3	65	
MA2:4	66	
MA2:5	67	
MA2:6	68	
MA2:9	69	
MA2:10	70	
MA2:7	71	
MA2:8	72	
MA2:11	73	
MA2:12	74	
	B9	
	B10	

TB6

MA2:15	75	
MA2:16	76	
MA2:13	77	
MA2:14	78	
MA2:17	79	
MA2:18	80	
MA2:19	81	
MA2:20	82	
MA2:21	83	
MA2:22	84	
	B11	
	B12	

TB7

MA2:25	85	
MA2:26	86	
MA2:23	87	
MA2:24	88	
MA2:27	89	
MA2:28	90	
MB1:7	91	
MB1:8	92	
EA:53	93	
EA:54	94	
AT2:1W	100	
AT2:2W	101	

TB8

	102	ER:31
	103	ER:33
	104	ER:32
	105	DT1:13
	106	DT1:21
	107	DT1:14
	108	AT2:5W
	109	AT2:6W
	110	ER:25
	111	ER:27
	112	ER:26
	113	

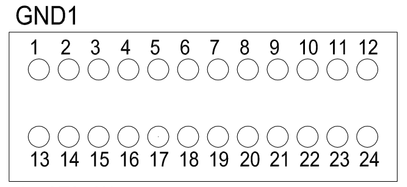
TB9

	114	
	115	
	116	
	117	
	118	
	119	
	120	
	121	
	122	
	123	
	124	
	125	

TB10

	126	EML:4
	127	EML:3
	128	EML:1
	129	EAC:4
	130	EAC:3
	131	EAC:1
	132	MAX1:D
	133	MAX1:4
	134	MAX1:C
	135	MAX2:D
	136	MAX2:4
	137	MAX2:C

GND1



1 AT2:7W
2 PL1:3,L1:GND

MECHANISM PANEL

TB11

MA3:1	138	
MA3:2	139	
MA3:3	140	
MA3:4	141	
MA3:5	142	
MA3:6	143	
MA3:9	144	
MA3:10	145	
MA3:7	146	
MA3:8	147	
MA3:11	148	
MA3:12	149	

TB12

MA3:15	1	
MA3:16	2	
MA3:13	3	
MA3:14	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	

NOTES:
1) ALL 120VAC WIRES ARE TO BE GRAY 12GA SIS. AND AC GROUND WIRES ARE TO BE GREEN 12GA SIS.
2) ALL 125VDC/120VAC MOTOR CIRCUIT WIRES ARE TO BE GRAY 12GA SIS.
3) ALL 208VAC WIRES ARE TO BE GRAY 10GA SIS.
4) ALL CONTROL WIRING IS TO BE GRAY 14GA SIS VW1.
5) WIRE MARKERS ARE TO BE SHRINK-TYPE AND ARE TO SHOW OPPOSITE END / SAME END DESIGNATION.
6) ALL WIRE LUGS TO BE INSULATED RING-TYPE (EXCEPT FOR DEVICES THAT DO NOT ACCEPT RING-TYPE TERMINALS).
7) ALL CT SECONDARY WIRING TO BE 10GA SIS.

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
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WIRING DIAGRAM

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
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AREVA ORDER #
CX04111, CX04112

SHT 6 OF 15

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
WIRING DIAGRAM

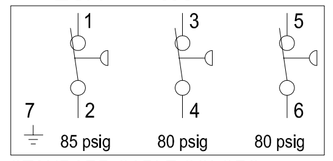
0 1" 2"

FILENAME	TWEND-MD-06.DWG
SCALE	NONE

SHEET
MD-06

MECHANISM WIRING

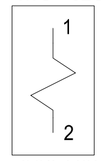
EGA 63G



1	AT2:1D
2	AT2:2D
3	AT2:3D
4	AT2:4D
5	AT2:5D
6	AT2:6D
7	AT2:7D

STANDARD CABLE COLORS
1 - BLK 4 - ORA 7 - GRN
2 - RED 5 - WHT
3 - BLU 6 - WHT/BLK or BRN

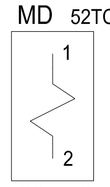
MC 52CC



1	EA:22
2	MA1:1

COIL VOLTAGE -125 VDC
COIL RESISTANCE -35.5 OHM

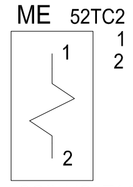
MD 52TC1



1	MA1:4
2	TB2:10

COIL VOLTAGE -125 VDC
COIL RESISTANCE -35.5 OHM

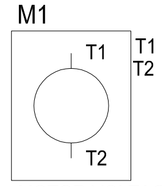
ME 52TC2



1	MA1:10
2	TB2:10A

COIL VOLTAGE -125 VDC
COIL RESISTANCE -35.5 OHM

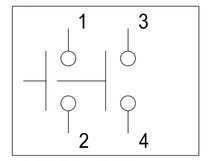
M1



T1	MB1:2
T2	MB1:3

MOTOR VOLTAGE - 125VDC/120VAC
WATTAGE - 2100 W

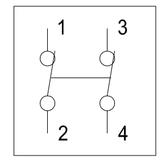
EE 01CS



1	EA:13,EF:3
2	ER:16
3	EA:43,TB2:11A
4	ER:22

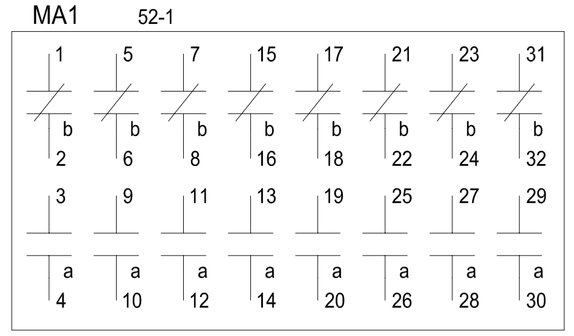
COLOR - BLK

LA 69



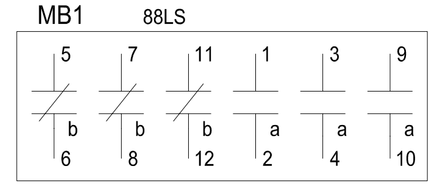
1	TB2:8
2	ES:13,MA1:27

MA1 52-1



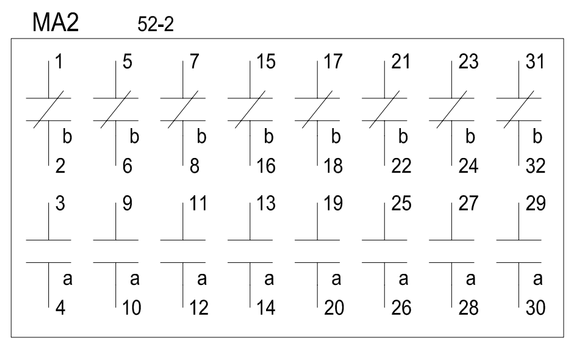
1	MC:2	25	TB4:55
2	MB1:5	26	TB4:56
3	EA:32	23	TB4:57
4	MD:1	24	TB4:58
5	TB3:13	27	LA:2
6	EA:A2	28	ES:A1
9	EA:62	31	TB4:61
10	ME:1	32	TB4:62
7	MB1:11,MA1:15	29	TB4:59
8	MAX1:A	30	TB4:60
15	MA1:7		
16	MAX2:A		
19	TB3:51		
20	TB3:52		
21	TB3:53		
22	TB3:54		

MB1 88LS



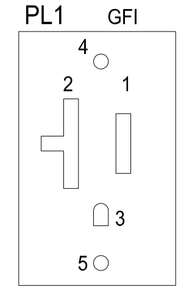
5	MA1:2
6	TB1:6,ES:A2
7	TB7:91
8	TB7:92
11	AT2:3W,MA1:7
12	EML:2
1	DT1:4
2	M1:T1
3	M1:T2
4	DT1:5
9	ATD2:14
10	FU4:4

MA2 52-2



1	TB4:63	17	TB6:79
2	TB4:64	18	TB6:80
3	TB5:65	19	TB6:81
4	TB5:66	20	TB6:82
5	TB5:67	21	TB6:83
6	TB5:68	22	TB6:84
9	TB5:69	25	TB7:85
10	TB5:70	26	TB7:86
7	TB5:71	23	TB7:87
8	TB5:72	24	TB7:88
11	TB5:73	27	TB7:89
12	TB5:74	28	TB7:90
15	TB6:75		
16	TB6:76		
13	TB6:77		
14	TB6:78		

PL1 GFI

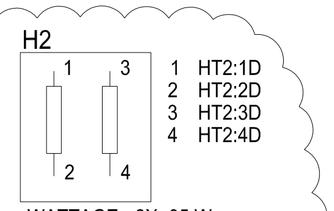


1	HT1:5D
2	HT1:4W
3	GND1:2
4	SW1:1
5	L1:L2

1 - LINE
2 - NEUTRAL
3 - GND
4 - LOAD LINE
5 - LOAD NEUTRAL

VOLTAGE - 120 VAC
AMP RATING -20 A

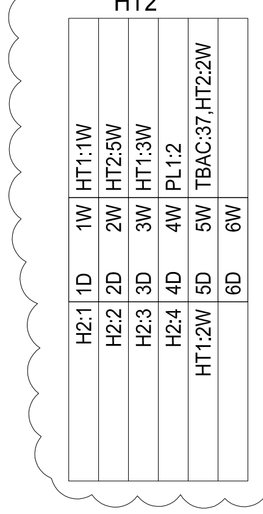
H2



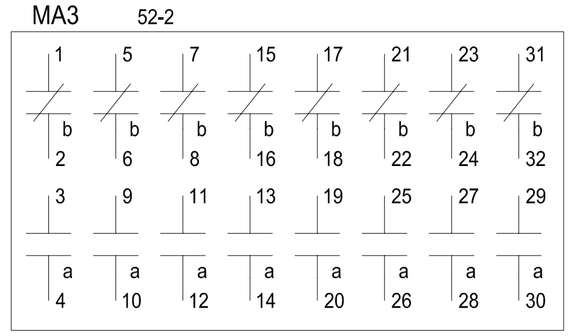
1	HT2:1D
2	HT2:2D
3	HT2:3D
4	HT2:4D

WATTAGE - 2X 95 W
RESISTANCE - 2X 150 OHM

HT2



MA3 52-2



1	TB11:138
2	TB11:139
3	TB11:140
4	TB11:141
5	TB11:142
6	TB11:143
9	TB11:144
10	TB11:145
7	TB11:146
8	TB11:147
11	TB11:148
12	TB11:149
15	TB12:1
16	TB12:2
13	TB12:3
14	TB12:4

NOTES:
1) ALL 120VAC WIRES ARE TO BE GRAY 12GA SIS. AND AC GROUND WIRES ARE TO BE GREEN 12GA SIS.
2) ALL 125VDC/120VAC MOTOR CIRCUIT WIRES ARE TO BE GRAY 12GA SIS.
3) ALL 208VAC WIRES ARE TO BE GRAY 10GA SIS.
4) ALL CONTROL WIRING IS TO BE GRAY 14GA SIS VW1.
5) WIRE MARKERS ARE TO BE SHRINK-TYPE AND ARE TO SHOW OPPOSITE END / SAME END DESIGNATION.
6) ALL WIRE LUGS TO BE INSULATED RING-TYPE (EXCEPT FOR DEVICES THAT DO NOT ACCEPT RING-TYPE TERMINALS).
7) ALL CT SECONDARY WIRING TO BE 10GA SIS.

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

WIRING DIAGRAM

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 7 OF 15

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
WIRING DIAGRAM

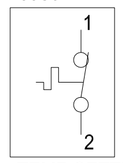
0 1" 2"

FILENAME	TWEND-MD-07.DWG
SCALE	NONE

SHEET
MD-07

RELAY PANEL WIRING

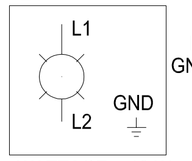
TH1



1 FU6:2
2 HT1:1W

TEMP SETTING -110 DEG F

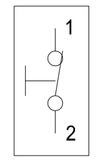
L1



L1 SW1:2
L2 PL1:5
GND GND1:2

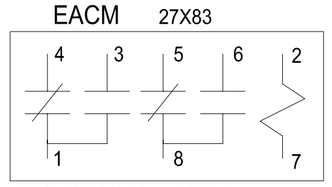
WATTAGE - 40 W

SW1



1 PL1:4
2 L1:L1

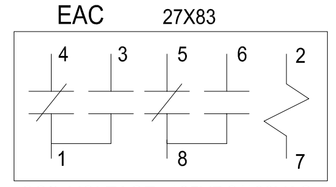
EACM 27X83



2 EAC:2,ATD1:1L1
7 EAC:7,ATD1:5L3
4 ATD2:A2
1 ATD2:6T3,FU4:4
3 ATD1:A2

COIL VOLTAGE -120VAC
COIL RESISTANCE - 2,250 OHMS

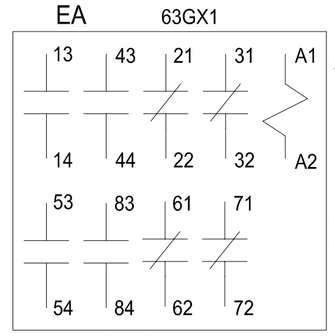
EAC 27X83



2 EACM:2
7 EACM:7
4 TB10:129
1 TB10:131
3 TB10:130

COIL VOLTAGE -125VDC/120VAC
COIL RESISTANCE - SOLID STATE

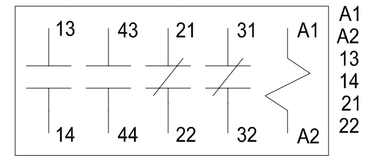
EA 63GX1



A1 AT2:4W
A2 MA1:6,EML:7
13 FU2:2,EE:1
14 TB3:17
21 ES:22
22 MC:1
31 TB2:9,EN:X2
32 MA1:3,TB3:18
43 FU3:2,EE:3
44 TB3:19
53 TB7:93
54 TB7:94
61 TB2:9A,ENN:X2
62 MA1:9,TB3:20

COIL VOLTAGE - 125VDC
COIL RESISTANCE - 4524 ohm

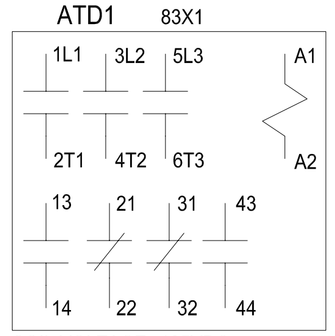
ES 52Y



A1 MA1:28,ES:14
A2 FU1:4,MB1:6
13 ES:21,LA:2
14 ES:A1
21 ES:13
22 EA:21

COIL VOLTAGE - 125VDC
COIL RESISTANCE - 4524 ohm

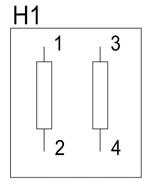
ATD1 83X1



A1 ATD2:22
A2 EACM:3
1L1 EACM:2,FU5:2
2T1 ATD1:3L2
3L2 ATD1:2T1
4T2 DT1:1
5L3 EACM:7,FU5:4
6T3 DT1:6
21 FU4:2
22 ATD2:A1

COIL VOLTAGE -125VDC
COIL RESISTANCE -2900 Ohm

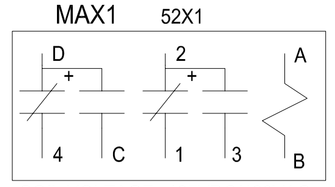
H1



1 HT1:1D
2 HT1:2D
3 HT1:3D
4 HT1:4D

WATTAGE - 2X 95 W
RESISTANCE - 2X 150 OHM

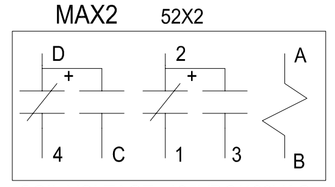
MAX1 52X1



A MA1:8
B MAX2:B,EML:7
D TB10:132
4 TB10:133
C TB10:134

COIL VOLTAGE -125VDC/120VAC
COIL RESISTANCE -SOLID STATE

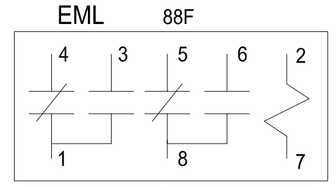
MAX2 52X2



A MA1:16
B TB1:6,MAX1:B
D TB10:135
4 TB10:136
C TB10:137

COIL VOLTAGE -125VDC/120VAC
COIL RESISTANCE -SOLID STATE

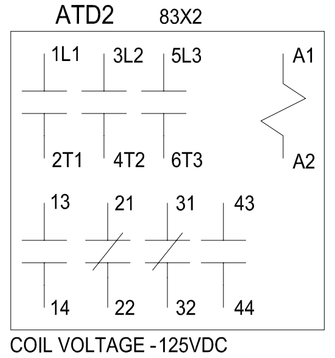
EML 88F



2 MB1:12
7 EA:A2,MAX1:B
4 TB10:126
1 TB10:128
3 TB10:127

COIL VOLTAGE -125VDC/120VAC
COIL RESISTANCE - SOLID STATE

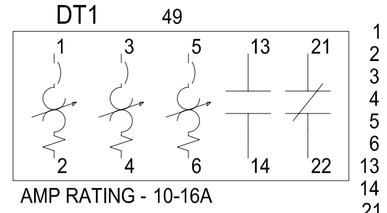
ATD2 83X2



A1 ATD1:22
A2 EACM:4,ATD2:13
1L1 ATD2:4T2
2T1 FU4:2,ATD2:21
3L2 DT1:1
4T2 ATD2:1L1
5L3 DT1:6
6T3 EACM:1
13 ATD2:A2
14 MB1:9
21 ATD2:2T1
22 ATD1:A1

COIL VOLTAGE -125VDC
COIL RESISTANCE -2900 Ohm

DT1 49



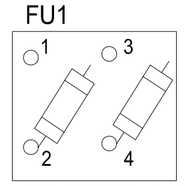
1 ATD1:4T2,ATD2:3L2
2 DT1:3
3 DT1:2
4 MB1:1
5 MB1:4
6 ATD1:6T3,ATD2:5L3
13 TB8:105
14 DT1:22,TB8:107
21 TB8:106
22 DT1:14

AMP RATING - 10-16A

HT1

H1:1	1D	1W	TH1:2				
H1:2	2D	2W	TBAC:37,HT1:4W				
H1:3	3D	3W	HT1:5W				
H1:4	4D	4W	PL1:2,HT1:2W				
PL1:1	5D	5W	HT1:3W,FU6:2				
	6D	6W					

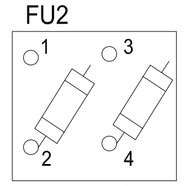
FU1



1 TB1:1
2 EF:5
3 TB1:2
4 ES:A2

AMP RATING - 15 AMP

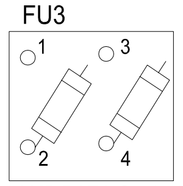
FU2



1 TB1:1A
2 EA:13
3 TB1:2A
4 TB2:10

AMP RATING - 15 AMP

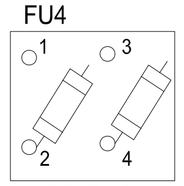
FU3



1 TB1:1B
2 EA:43
3 TB1:2B
4 TB2:10A

AMP RATING - 15 AMP

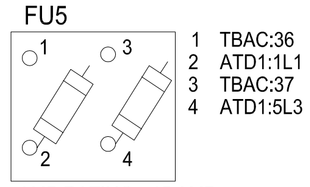
FU4



1 TB1:3
2 ATD2:2T1,ATD1:21
3 TB1:4
4 MB1:10,EACM:1

AMP RATING - 15 AMP

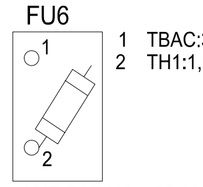
FU5



1 TBAC:36
2 ATD1:1L1
3 TBAC:37
4 ATD1:5L3

AMP RATING - 15 AMP

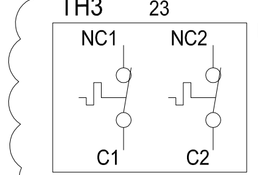
FU6



1 TBAC:36
2 TH1:1,HT1:5W

AMP RATING - 20 AMP

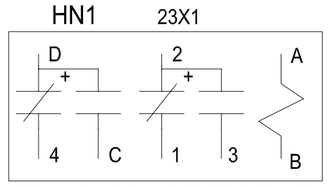
TH3 23



NC1 FF:2,EAC1:A1
C1 HN1:A

TEMP SETTING:

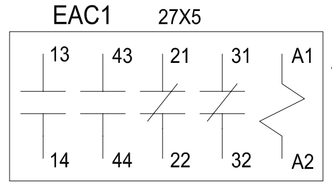
HN1 23X1



A TH3:C1,EHR1:A1
B EHR1:A2,EAC1:A2
D TB9:114
C BP1:NC

COIL VOLTAGE -250VDC/240VAC
COIL RESISTANCE -SOLID STATE

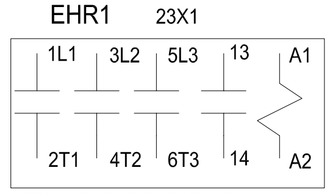
EAC1 27X5



A1 TH3:NC1
A2 HN1:B
21 TB9:116
22 TB9:117

COIL VOLTAGE - 240VAC
COIL RESISTANCE - 12 kohm

EHR1 23X1



A1 HN1:A
A2 HN1:B,BPT:7W
1L1 EHR1:3L2,FF:2
2T1 BPT:1W
3L2 EHR1:5L3,EHR1:1L1
4T2 BPT:3W
5L3 EHR1:3L2
6T3 BPT:5W

COIL VOLTAGE -240VAC
COIL RESISTANCE -9.7 KOHM

NOTES:
1) ALL 120VAC WIRES ARE TO BE GRAY 12GA SIS. AND AC GROUND WIRES ARE TO BE GREEN 12GA SIS.
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3) ALL 208VAC WIRES ARE TO BE GRAY 10GA SIS.
4) ALL CONTROL WIRING IS TO BE GRAY 14GA SIS VW1.
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6) ALL WIRE LUGS TO BE INSULATED RING-TYPE (EXCEPT FOR DEVICES THAT DO NOT ACCEPT RING-TYPE TERMINALS).
7) ALL CT SECONDARY WIRING TO BE 10GA SIS.

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

WIRING DIAGRAM

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 8 OF 15

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
WIRING DIAGRAM

0 1" 2"

FILENAME	TWEND-MD-08.DWG
SCALE	NONE

SHEET
MD-08

RELAY PANEL WIRING

EF 01CS

DECK	CONTACTS FRONT END	SWITCH POSITION PTL	TRIP	NORM	CLOSE
1	1		X	X	X
	2		X	X	X
2	3		X		
	4		X		
3	5				X
	6				X

3 EE:1,TB2:11
4 ER:15
5 TB1:5,FU1:2
6 ER:11

ER 43L/R

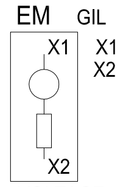
DECK	CONTACTS FRONT END		SWITCH POSITION LOCAL	REMOTE
1	12	11	X	
		13		X
	16	15	X	
		17		X
2	22	21	X	
		23		X
	26	25	X	
		27		X
3	32	31	X	
		33		X
	36	35	X	
		37		X

11 EF:6
12 TB2:7
13 TB2:7R
15 EF:4
16 TB2:9,EE:2
17 TB2:9R
22 TB2:9A,EE:4
23 TB2:9AR
25 TB8:110
26 TB8:112
27 TB8:111
31 TB8:102
32 TB8:104
33 TB8:103

AT2

EGA:1	1D	1W	TB7:100
EGA:2	2D	2W	TB7:101
EGA:3	3D	3W	EM:X1,MB1:11
EGA:4	4D	4W	EA:A1
EGA:5	5D	5W	TB8:108
EGA:6	6D	6W	TB8:109
EGA:7	7D	7W	GND1:1

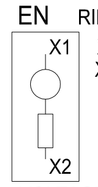
EM GIL



X1 AT2:3W,TB1:5
X2 TB3:13

VOLTAGE - 125V
RESISTANCE - 6250 OHM
COLOR - GREEN

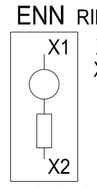
EN RIL



X1 TB2:11
X2 EA:31

VOLTAGE - 125V
RESISTANCE - 6250 OHM
COLOR - RED

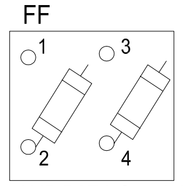
ENN RIL



X1 TB2:11A
X2 EA:61

VOLTAGE - 125V
RESISTANCE - 6250 OHM
COLOR - RED

FF

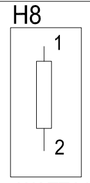


1 TBAC:35B
2 EHR1:1L1,TH3:NC1
3 TBAC:36B
4 BPT:7W

AMP RATING - 50 AMP

GAS PIPING HEATING

H8



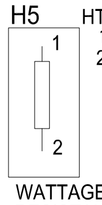
1 BPT:5D
2 BPT:6D

WATTAGE - 5W/FT
RESISTANCE - 220VAC

FREE END OF HEAT TRACE TO BE INSULATED WITH HEAT SHRINK TUBING AND PROTECTED UNDER PIPING INSULATION

TANK HEATERS

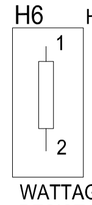
H5 HTR-T1



1 BPT:1D
2 BPT:2D

WATTAGE - 3300 W
RESISTANCE - 18 OHMS

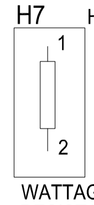
H6 HTR-T2



1 BPT:3D
2 BPT:4D

WATTAGE - 3300 W
RESISTANCE - 18 OHMS

H7 HTR-T3

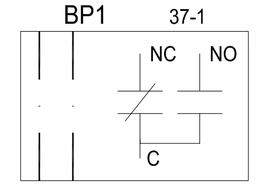


1 BPT:5D
2 BPT:6D

WATTAGE - 3300 W
RESISTANCE - 18 OHMS

CT PANEL

BP1 37-1



NC HN1:C
C TB9:115

SEE SCHEMATIC FOR CURRENT LOOP ROUTED THROUGH THIS DEVICE AND TERMINATED ON AUX TERMINAL

BPT

H5:1	1D	1W	EHR1:2T1
H5:2	2D	2W	BPT:4W
H6:1	3D	3W	EHR1:4T2
H6:2	4D	4W	BPT:6W,BPT:2W
H8:1,H7:1	5D	5W	EHR1:6T3
H8:2,H7:2	6D	6W	BPT:4W
	7D	7W	FF:4,EHR1:A2

NOTES:
1) ALL 120VAC WIRES ARE TO BE GRAY 12GA SIS. AND AC GROUND WIRES ARE TO BE GREEN 12GA SIS.
2) ALL 125VDC/120VAC MOTOR CIRCUIT WIRES ARE TO BE GRAY 12GA SIS.
3) ALL 208VAC WIRES ARE TO BE GRAY 10GA SIS.
4) ALL CONTROL WIRING IS TO BE GRAY 14GA SIS VW1.
5) WIRE MARKERS ARE TO BE SHRINK-TYPE AND ARE TO SHOW OPPOSITE END / SAME END DESIGNATION.
6) ALL WIRE LUGS TO BE INSULATED RING-TYPE (EXCEPT FOR DEVICES THAT DO NOT ACCEPT RING-TYPE TERMINALS).
7) ALL CT SECONDARY WIRING TO BE 10GA SIS.

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

WIRING DIAGRAM

G. Muchesko | D. Muetzel | 05/03/07
DRAWN | CHECKED | DATE

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
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12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 9 OF 15

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

MORTENSON

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
WIRING DIAGRAM

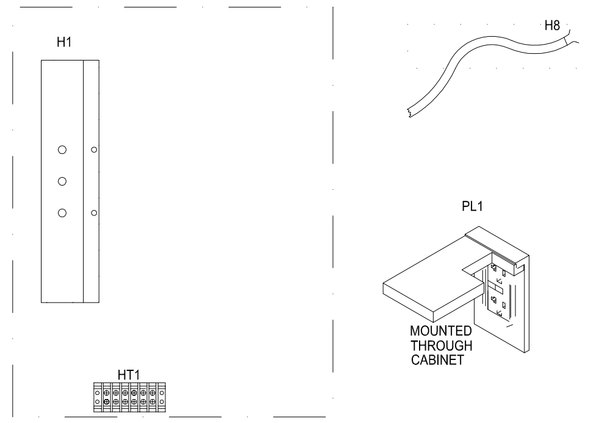
0 1" 2"

FILENAME TWEND-MD-09.DWG
SCALE NONE

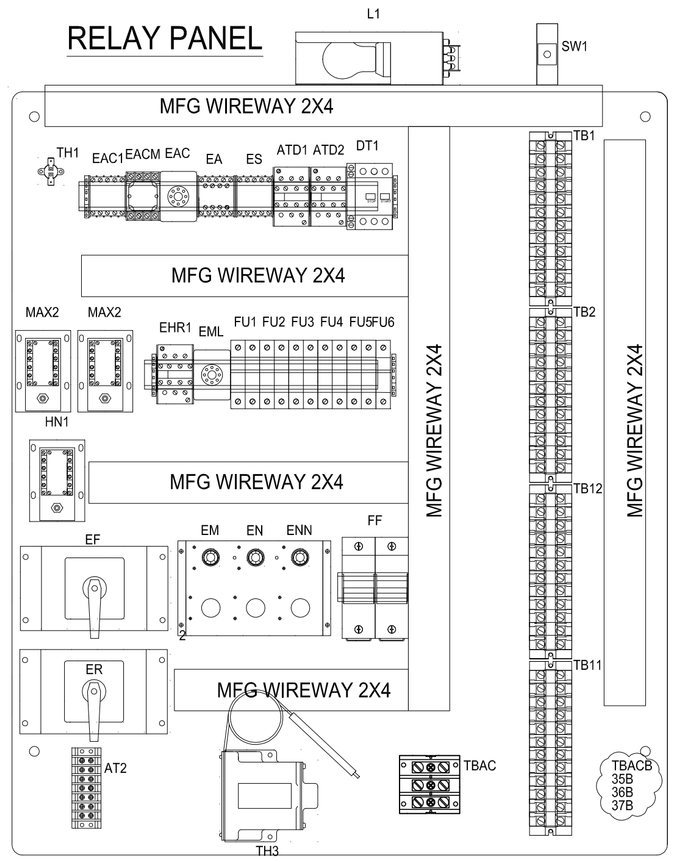
SHEET
MD-09

MFG. NOTES:
1) SEE 1-415-881 FOR DIN RAIL SPECIFICATIONS.

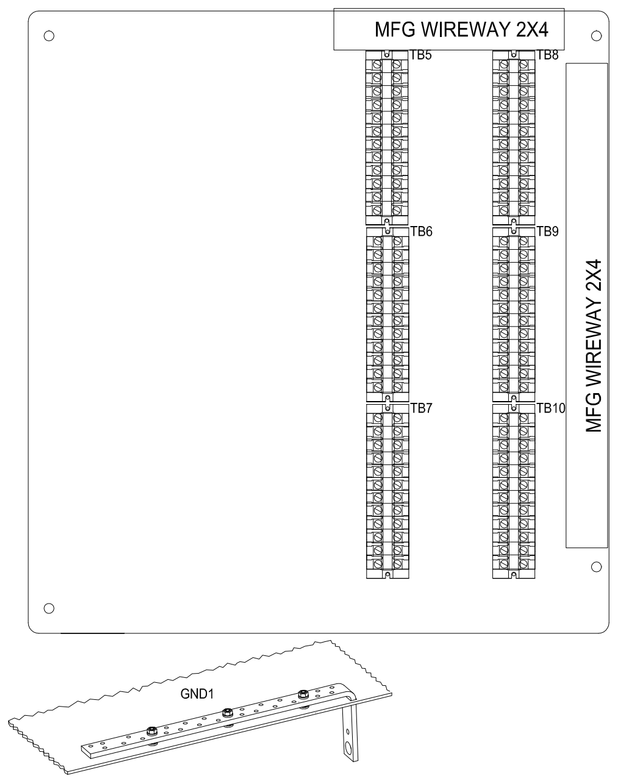
MOUNTED TO CABINET FLOOR
CLEAR OF WIRING



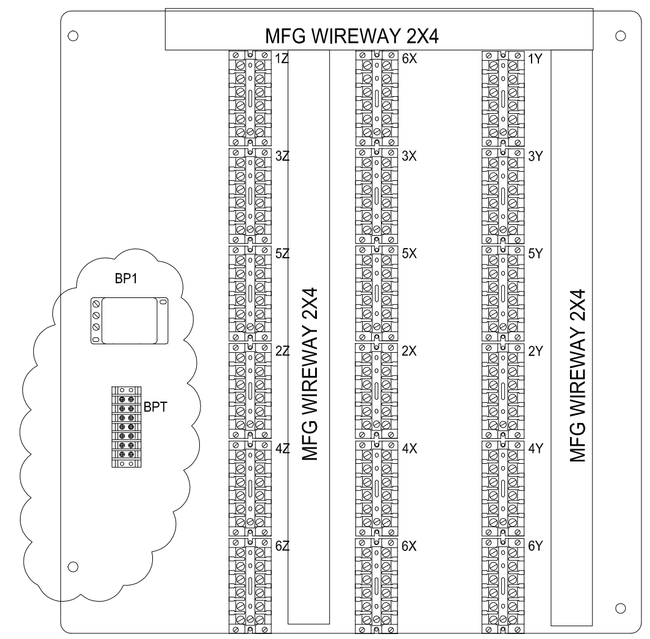
RELAY PANEL



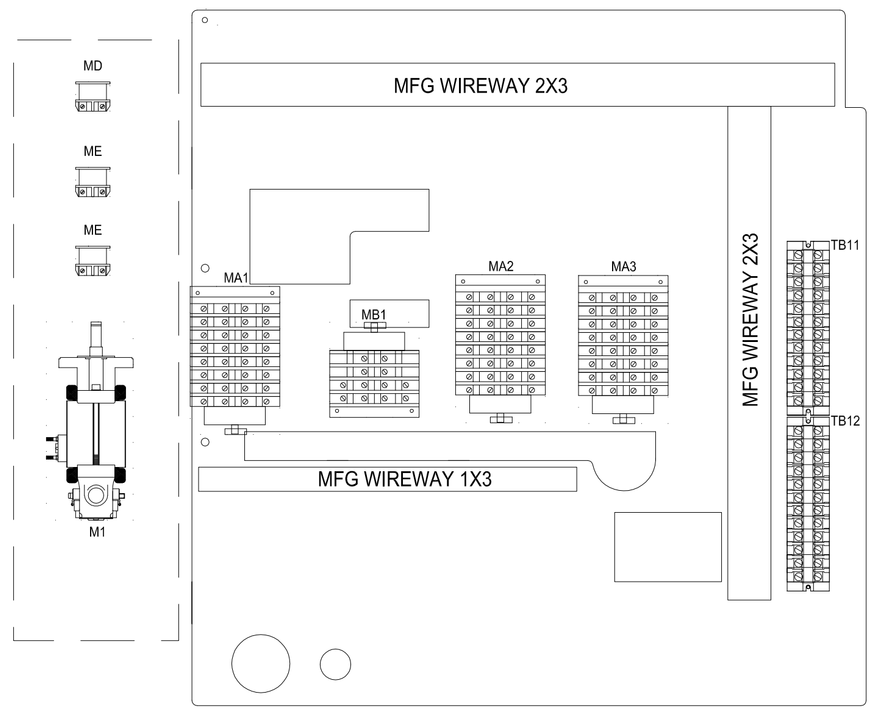
TERMINAL BLOCK PANEL (CONTROL)

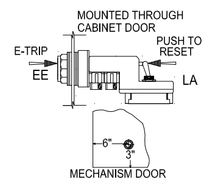


TERMINAL BLOCK PANEL (BCT)

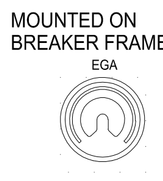


MECHANSM PANEL

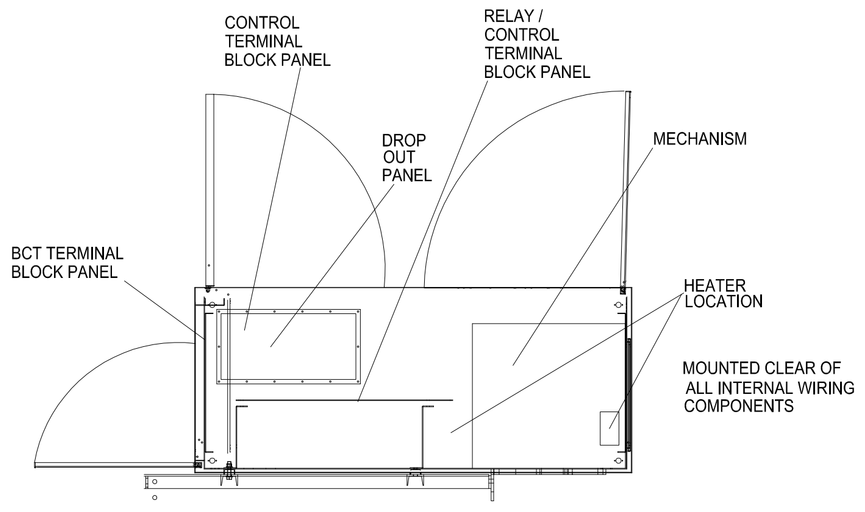


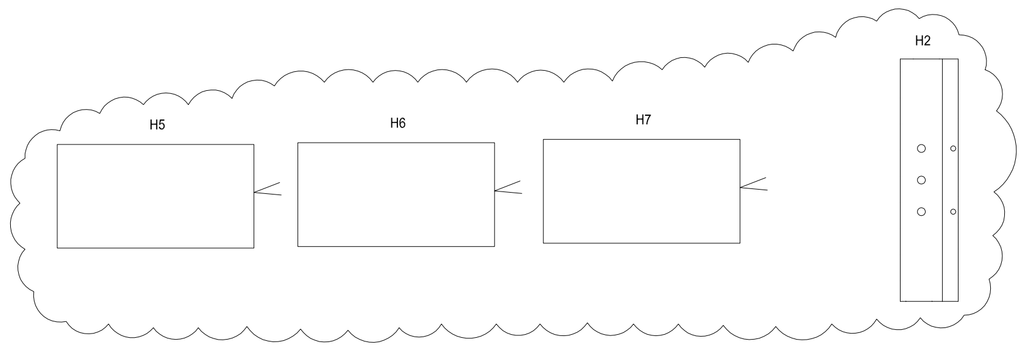


MOUNTED ON
BREAKER FRAME



TOP VIEW OF CONTROL CABINET





HT2

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
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10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

PANEL LAYOUT

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 10 OF 15

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON®

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
PANEL LAYOUT

0 1" 2"

FILENAME	TWEND-MD-10.DWG
SCALE	NONE

SHEET
MD-10

ITEM	QTY	AREVA #	MFR #	MFR	DESCRIPTION	DEVICE ID
001	001	13.102.164-01	13.102.164-01	AREVA	MOTOR LIMIT SWITCH - 40kA & 63kA	MB1
002	001	13.102.194-01	13.102.194-01	AREVA	3rd AUXILIARY SWITCH 40kA	MA3
003	002	13.102.194-01	13.102.194-01	AREVA	AUXILIARY SWITCH 63kA	MA1, MA2
004	005	1_410_504_P5	MAR1512STD73796	MARATHON	TERMINAL BLOCK 12PT	TB11, TB12, TB5, TB6, TB7
005	008	1_410_504_P5	MAR1512STD73796	MARATHON	TERMINAL BLOCK 12PT	TB1, TB10, TB13, TB2, TB3, TB4, TB8, TB9
006	001	1_410_508_P6	CR104	GENERAL ELECTRIC	CONTACT BLOCK	EE
007	001	1_410_629_P11	24203D 10D2L24A	ELECTROSWITCH	CONTROL SWITCH, LOCAL/REMOTE 3 STAGE	ER
008	001	1_410_629_P53	SB1	GE	CONTROL SWITCH, TRIP-OFF-CLOSE -PTL	EF
009	002	1_410_630_P50	MRL125DL48R-MPLLRD	C3CONTROLS	LED INDICATOR LIGHT, RED, 125VDC	EN, ENN
010	001	1_410_630_P53	MRL125DL48G-MPLLGN	C3CONTROLS	LED INDICATOR LIGHT, GREEN, 125VDC	EM
011	001	1_410_632_P19	1-410-632-P19	AREVA	CABINET LIGHT	L1
012	001	1_417_123_P1	E69-30A	CHERRY	DOOR SWITCH	SW1
013	001	1_410_634_P7	STO-110	STANCOR	THERMOSTAT 110F	TH1
014	001	1_410_636_P2	7360K8	CUTLER HAMMER	PERMISSIVE CONTROL SWITCH	LA
015	001	1_410_640_P19	IH3-1	THOMAS & BETTS / RED DOT	RECEPTACLE, ENCLOSURE	PL1
016	001	1_410_640_P4	WPFS26	HUBBELL	RECEPTACLE, WEATHERPROOF COVER	PL1
017	001	1_410_640_P5	GF5352A OR =	HUBBELL	RECEPTACLE, GFI, 120VAC, 20A	PL1
018	001	1_410_640_P91	CG3150S	APPLETON	STRAIN RELIEF	TH3
019	004	1_410_641_P73	CLIPFIX35-5	PHOENIX	END CLAMP	END4, END5, END6, END7
020	010	1_410_650_P10	1-410-650-P10	AREVA	FUSE, 15A, CLASS TFNQ	FU1, FU1, FU2, FU2, FU3, FU3, FU4, FU4, FU5, FU5
021	001	1_410_650_P11	1-410-650-P11	AREVA	FUSE, 20A, CLASS TFNQ	FU6
022	002	1_410_650_P23	1-410-650-P23	AREVA	FUSE, 50A, CLASS J	FF, FF
023	001	1_410_651_P11	CF120-400-101	ITC	FUSED DISCONNECT 1 POLE 20A	FU6
024	005	1_410_651_P12	CF120-400-102	ITC	FUSED DISCONNECT 2 POLE 15A	FU1, FU2, FU3, FU4, FU5
025	001	1_410_651_P9	US6J2	GOULD	FUSED DISCONNECT 2 POLE 50A	FF
026	002	1_410_655_P51	3RT1325-1BG40	SIEMENS	CONTACTOR 125VDC	ATD1, ATD2
027	001	1_410_655_p9	LS4-CO	AEG	CONTACTOR	EHR1
028	001	1_410_669_p42	SS-600-61-BT	Swagelok	BULK HEAD FITTING 3/8"	TH3
029	002	1_410_669_p43	T-600-SET	Swagelok	TEFLON FERRULE	TH3, TH3
030	001	1_410_748_P10	1423123	MARATHON	TERMINAL BLOCK 3PT 200A	TBAC
031	001	1_410_748_P11	CC1423	MARATHON	TERMINAL BLOCK COVER	TBAC
032	001	1_410_749_P101	CS4C-22Z-110D	SPRECHER + SCHUH	CONTROL RELAY 2NO 2NC (125 VDC)	ES
033	001	1_410_749_P101	CS4C-22Z-110D	SPRECHER + SCHUH	CONTROL RELAY 4NO 4NC (125 VDC)	EA
034	002	1_410_749_P107	CS4-22Z-240	SPRECHER + SCHUH	CONTROL RELAY 2NO 2NC (240 VAC)	EAC1, EAC2
035	001	1_410_749_P108	CS4-P22	SPRECHER + SCHUH	AUXILIARY CONTACT	EA
036	001	1_410_749_p18	KRP11-AG-120	POTTER AND BRUMFIELD	CONTROL RELAY, 2 FORM "C", 120VAC	EACM
037	003	1_410_749_P25	27E-891	POTTER & BRUMFIELD	RELAY SOCKET, 8 PIN	EAC, EACM, EML
038	002	1_410_759_P7	1732	TIMEMARK	CURRENT SENSING RELAY	BP1, BP2
039	001	1_410_777_P1	E55a-E20BS	UNITED ELECTRONICS	ADJUSTABLE THERMOSTAT (EXT BULB)	TH3
040	001	1_410_906	1_410_906	AREVA	E-TRIP / 69 BLOCK	LA
041	002	1_411_074_P7	TDT-120-AKA-300	DIVERSIFIED	TIME DELAY RELAY 2 FORM "C", DIVERSIFIED TDT	EAC, EML
042	018	1_411_107_p3	1506 SC	MARATHON	TERMINAL BLOCK 6PT, SHORTING	2X, 2Y, 2Z, 3X, 3Y, 3Z, 4X, 4Y, 4Z, 5X, 1X, 5Y 5Z, 6X, 6Y, 6Z, 1Y, 1Z
043	001	1_412_182	1-412-182	AREVA	HGF MECHANISM PANEL (40KA)	PAN10
044	002	1_412_952	1-412-952	AREVA	CONTROL SWITCH BRACKET - 8.5"	1, 3
045	002	1_413_652_P2	1017SP7-B-4-B	KANSON	TIME DELAY RELAY, 2 FORM "C", 125V, 1.5-120 CYC	MAX1, MAX2
046	002	1_413_652_P6	1017SP7-C-7-B	KANSON	TIME DELAY RELAY, 2 FORM "C", 250V, 0.5-30 SEC	HN1, HN2
047	002	1_413_999_G4	CIR409NYXX 120VAC	CHROMALOX	ANTICONDENSATION HEATER ASSY 120VAC	H1, H2
048	001	1_415_866	1-415-866	AREVA	PUSH BUTTON / IND LITE BRACKET - HORIZONTAL	2
049	001	1_415_890	1-415-890	AREVA	HGF TERMINAL BLOCK PANEL	PAN5
050	001	1_415_891	1-415-891	AREVA	HGF RELAY PANEL	PAN6
051	001		382707	CHROMALOX	HEAT TRACE, 5W/FT	H8
052	001	1_416_202_P11	1-416-202-P11	WIKA	DENSITY MONITOR (98,85,80) COLOR SCALE - PURE SF6 40kA	EGA
053	001	1_417_056_P1	1-417-056-P1	AREVA	SWITCH BRACKET	SW1
054	003	1_417_075_P26	1-417-075-26	CHROMALOX	TANK HEATER (240VAC - 3300W)	H5, H6, H7
055	001	1_417_125_P1	GEL 40A15/120V 15199	GE	LIGHT BULB 40W 120VAC	L1

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10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

BILL OF MATERIALS

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

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AREVA ORDER #
CX04111, CX04112

SHT 11 OF 15

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
BILL OF MATERIALS

0 1" 2"

FILENAME	TWEND-MD-11.DWG
SCALE	NONE

SHEET
MD-11

ITEM	QTY	AREVA #	MFR #	MFR	DESCRIPTION	DEVICE ID
056	001	1_417_485_G1	1-417-485-G1	AREVA	ASSY FOR THIRD AUX SW. HGF 40KA	MA3
057	001	1_966_957	MBS 25	AEG	THERMAL OVERLOAD 10-16A	DT1
058	001	2_990_245_G1	2-990-245-G1	AREVA	HGF PANEL MOUNTING ASSY	PAN10
059	001	1_410_508_P1	CR104PBG10B1	GENERAL ELECTRIC	PUSHBUTTON, BLACK, 2NO	EE
060	002	1_410_748_P1	TB206	BUSSMAN	AUX. TERMINAL BLOCK, 6 PT	HT1, HT2
061	002	1_410_748_P3	TB207	BUSSMAN	AUX. TERMINAL BLOCK, 7 PT	AT2, BPT
062	001	48.127.121-00-02	49.101.018-02	GROSHOPP	SPRING CHARGE MOTOR	M1
063	003	49.102.110-20	49.102.110-20	AREVA	COIL (125 VDC)	MC, MD, ME
064	001		GROUND_BAR	AREVA	GROUND BAR, 24PT	GND1

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

BILL OF MATERIALS

G. Muchesko	D. Muetzel	05/03/07
DRAWN	CHECKED	DATE

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 12 OF 15

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
BILL OF MATERIALS

0 1" 2"

FILENAME	TWEND-MD-12.DWG
SCALE	NONE

SHEET
MD-12

BCT WIRING

1Z	
	1Z1	1Z-X1
	1Z2	1Z-X2
	1Z3	1Z-X3
	1Z4	1Z-X4
	1Z5	1Z-X5
	GND	GND

1X		
1X-X1	1X1	
1X-X2	1X2	
1X-X3	1X3	
1X-X4	1X4	
1X-X5	1X5	
GND	GND	

1Y	
1Y1	1Y-X1
1Y2	1Y-X2
1Y3	1Y-X3
1Y4	1Y-X4
1Y5	1Y-X5
GND	GND

3Z	
3Z1	3Z-X1
3Z2	3Z-X2
3Z3	3Z-X3
3Z4	3Z-X4
3Z5	3Z-X5
GND	GND

3X		
3X-X1	3X1	
3X-X2	3X2	
3X-X3	3X3	
3X-X4	3X4	
3X-X5	3X5	
GND	GND	

3Y	
3Y1	3Y-X1
3Y2	3Y-X2
3Y3	3Y-X3
3Y4	3Y-X4
3Y5	3Y-X5
GND	GND

5Z	
5Z1	5Z-X1
5Z2	5Z-X2
5Z3	5Z-X3
5Z4	5Z-X4
5Z5	5Z-X5
GND	GND

5X		
5X-X1	5X1	
5X-X2	5X2	
5X-X3	5X3	
5X-X4	5X4	
5X-X5	5X5	
GND	GND	

5Y	
5Y1	5Y-X1
5Y2	5Y-X2
5Y3	5Y-X3
5Y4	5Y-X4
5Y5	5Y-X5
GND	GND

2Z	
2Z1	2Z-X1
2Z2	2Z-X2
2Z3	2Z-X3
2Z4	2Z-X4
2Z5	2Z-X5
GND	GND

2X		
2X-X1	2X1	
2X-X2	2X2	
2X-X3	2X3	
2X-X4	2X4	
2X-X5	2X5	
GND	GND	

2Y	
2Y1	2Y-X1
2Y2	2Y-X2
2Y3	2Y-X3
2Y4	2Y-X4
2Y5	2Y-X5
GND	GND

4Z	
4Z1	4Z-X1
4Z2	4Z-X2
4Z3	4Z-X3
4Z4	4Z-X4
4Z5	4Z-X5
GND	GND

4X		
4X-X1	4X1	
4X-X2	4X2	
4X-X3	4X3	
4X-X4	4X4	
4X-X5	4X5	
GND	GND	

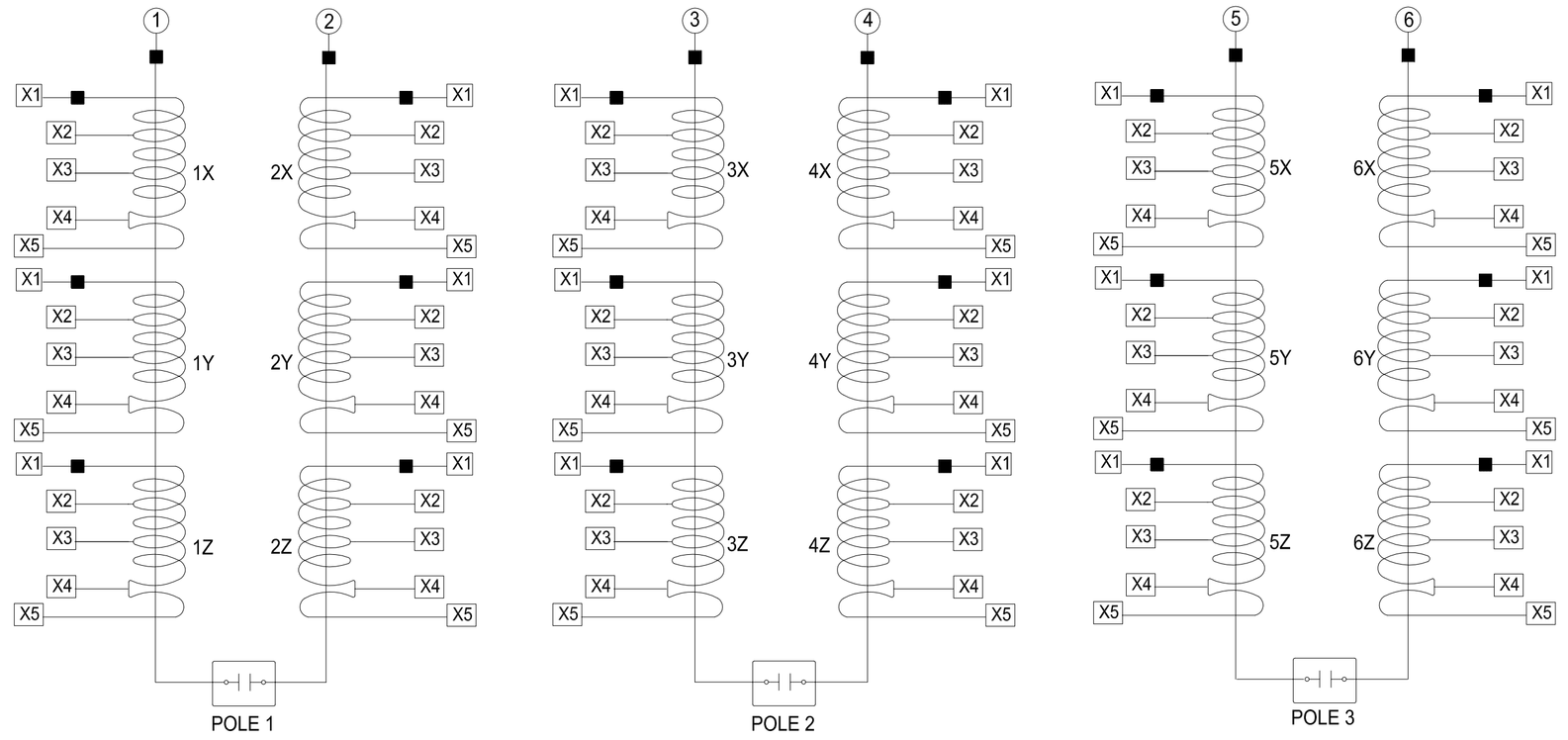
4Y	
4Y1	4Y-X1
4Y2	4Y-X2
4Y3	4Y-X3
4Y4	4Y-X4
4Y5	4Y-X5
GND	GND

6Z	
6Z1	6Z-X1
6Z2	6Z-X2
6Z3	6Z-X3
6Z4	6Z-X4
6Z5	6Z-X5
GND	GND

6X		
6X-X1	6X1	
6X-X2	6X2	
6X-X3	6X3	
6X-X4	6X4	
6X-X5	6X5	
GND	GND	

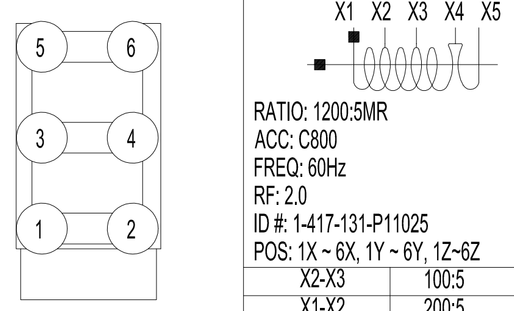
6Y	
6Y1	6Y-X1
6Y2	6Y-X2
6Y3	6Y-X3
6Y4	6Y-X4
6Y5	6Y-X5
GND	GND

CT WIRING NOTES:
1) LEADS TO BE TERMINATED WITH UNINSULATED TYPE LUGS.
2) ALL CT LEADS ARE TO BE SHORTED BEFORE SHIPMENT WHT-BLK-GND. (IF LEADS ARE NOT COLOR CODED SHORT THE FIRST LEAD-THE LAST LEAD-GROUND)
3) ALL BCT LEADS ARE 10GA WIRE.
4) ALL GROUND WIRES ARE 10GA GREEN SIS WIRE.

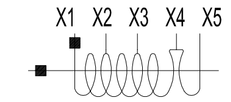


BCT NAMEPLATE

BCT NAMEPLATE NOTES:
1) MATERIAL: ALUMINUM
2) MOUNTED: INTERNALLY
3) NAMEPLATE DIMENSIONS AS SHOWN ON AREVA FABRICATION DRAWING 1_416_218_P3/P4



CT MFG: MERAMEC



RATIO: 1200:5MR
ACC: C800
FREQ: 60Hz
RF: 2.0
ID #: 1-417-131-P11025
POS: 1X ~ 6X, 1Y ~ 6Y, 1Z~6Z

BUSHING	1	2	3	4	5	6
UPPER	X	X	X	X	X	X
MIDDLE	Y	Y	Y	Y	Y	Y
LOWER	Z	Z	Z	Z	Z	Z

X2-X3	100:5
X1-X2	200:5
X1-X3	300:5
X4-X5	400:5
X3-X4	500:5
X2-X4	600:5
X1-X4	800:5
X3-X5	900:5
X2-X5	1000:5
X1-X5	1200:5

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
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8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

BCT WIRING / NAMEPLATE

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 13 OF 15

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

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TATANKA WIND ENERGY

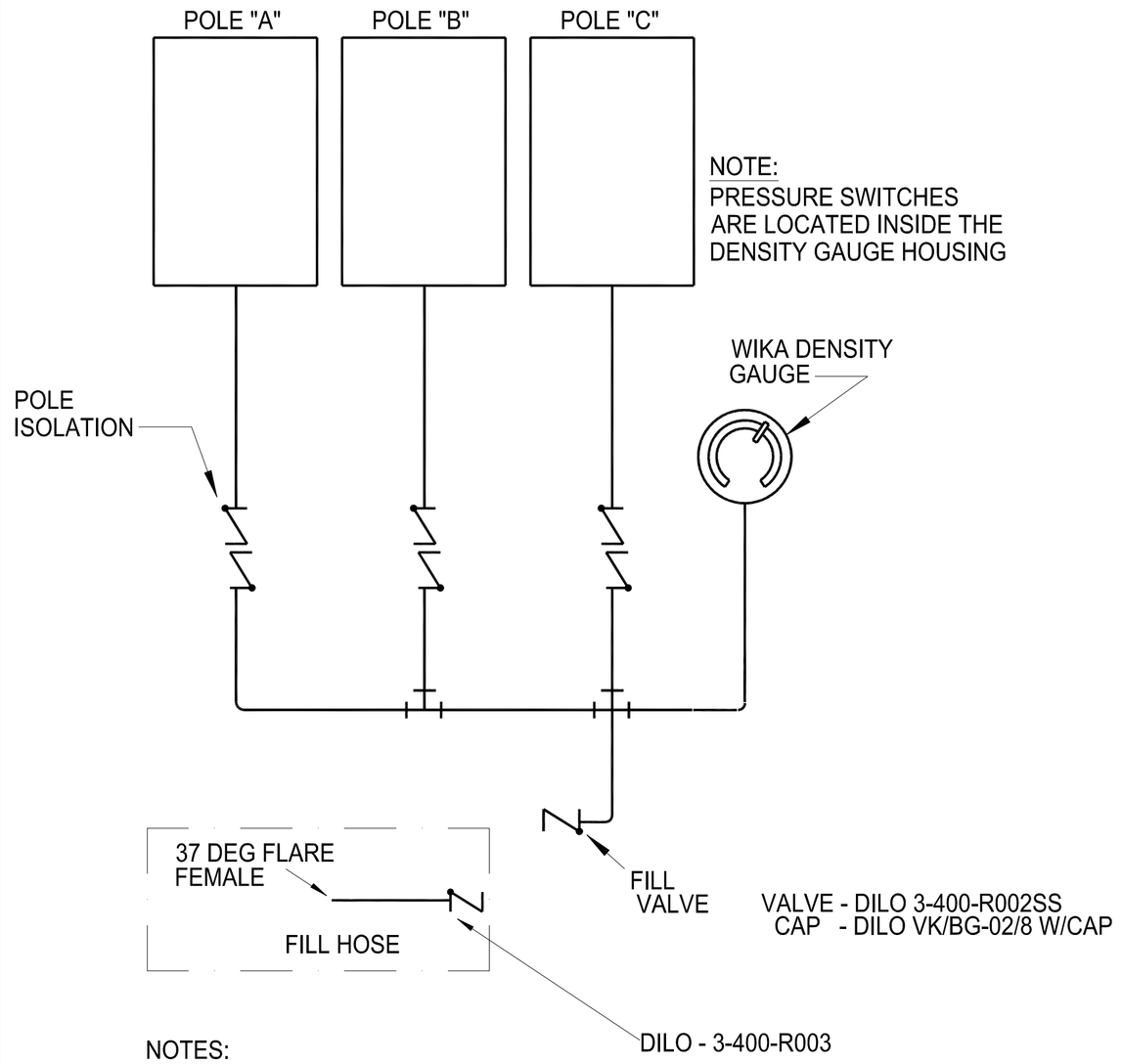
230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
BCT WIRING/NAMEPLATE

0 1" 2"

FILENAME	TWEND-MD-13.DWG
SCALE	NONE

SHEET
MD-13

GAS SCHEMATIC



NOTES:
1) ALL TUBING IS 3/8" STAINLESS.
2) GAS SAMPLING CAN BE DONE THROUGH FILL VALVE.
3) POLE ISOLATION VALVES USED TO ISOLATE TANK FROM GAS PIPING.

98.6 psig - NORMAL
85 psig - ALARM
80 psig - LOCKOUT

AREVA GAUGE No.
1_416_202_P11

RATINGS NAMEPLATE

AREVA

	TYPE: HGF 1014	CUSTOMER P.O.: XXXXXX
	SERIAL NUMBER: XXXXX-HG14	ORDER NUMBER: CX0XXXX
	MANUFACTURE DATE:	INSTRUCTION BOOK No.: HG12-IM
		PARTS LIST No.: HG14A0399
		WIRING DIAGRAM: HG14C0399
RATED MAXIMUM VOLTAGE 245 kV	RATED INTERRUPTING TIME 3.0 CYCLES	SF6 PRESSURE (@ 20ø C / 68ø F) RELATIVE PRESSURE -NORMAL OPERATING PRESSURE 98.6 psig
RATED VOLTAGE RANGE FACTOR (K) 1.0	RATED SHORT CIRCUIT CURRENT -TERMINAL FAULT 40 kA	-LOW PRESSURE ALARM 85 psig
RATED FREQUENCY 60 Hz	-90% SLF WITH 0nFL_g CAPACITANCE (WITHIN 100m) 40 kA	-MINIMUM PRESSURE 80 psig
DUTY CYCLE O-0.3s-C0-15s-C0	-CLOSE & LATCH 108 kA	WEIGHT OF GAS 206 lb
RATED CONTINUOUS CURRENT 1200 A	TEMPERATURE RANGE -50ø C to +40ø C	TOTAL WEIGHT 12494 lb
CAPACITANCE CURRENT SWITCHING -OVERVOLTAGE FACTOR 2.0 -LINE CHARGING 200 A -ISOLATED BANK 400 A -BACK-TO-BACK 400 A -INRUSH PEAK 20 kA -INRUSH FREQUENCY 4250 Hz	SHORT TIME CURRENT DURATION 2.57s % DC COMPONENT	MECHANISM TYPE FKF 2-9 SPRING
OUT-OF-PHASE SWITCHING 10 kA	FULL WAVE IMPULSE WITHSTAND 900 kV	CONTROL VOLTAGE -CLOSING 125VDC, 3.1A -TRIPPING (EACH) 125VDC, 3.1A -MOTOR 120VAC / 125VDC, 2100W -SPACE HEATER 120VAC, 190W -TANK HEATER 240VAC, 9.9kW
	SWITCHING IMPULSE WITHSTAND -TERMINAL-TO-GROUND N/A -TERMINAL-TO-TERMINAL N/A	
AREVA T&D INC., HIGH VOLTAGE SWITCHGEAR ONE POWER LANE - CHARLEROI, PA 15022		MADE IN THE USA

RATINGS NAMEPLATE NOTES:
1) MATERIAL: ANODIZED ALUMINUM
2) NAMEPLATE TO BE MOUNTED: EXTERNALLY
3) NAMEPLATE DIMENSIONS AS SHOWN ON AREVA FABRICATION DRAWING 1_416_218_P1/P2
4) SERIAL No., MANUFACTURE DATE, CUSTOMER PO, & ORDER NUMBER TO BE FILLED IN PRIOR TO ENGRAVING. (SEE TABLE FOR SERIAL No., CUSTOMER PO, & ORDER NUMBER)

SERIAL NUMBER	CUSTOMER PO	ORDER NUMBER
12789A-HG14	002713	CX04111
12789B-HG14	002713	CX04111
12789C-HG14	002713	CX04111
12791A-HG14	002714	CX04112
12791B-HG14	002714	CX04112

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
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9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

SF6 GAS PIPING / RATING NAMEPLATE

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 14 OF 15

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
SF6 GAS PIPING/RATING NAMEPLATE

0 1" 2"

FILENAME TWEND-MD-14.DWG
SCALE NONE

SHEET
MD-14

AT2	ATD1 83X1	ATD2 83X2	DT1 49	EA 63GX1	EACM 27X83	EE 01CS	EF 01CS	EM GIL	EML 88F
EN RIL	ENN RIL	ER 43L/R	ES 52Y	FU1 15 AMP	FU2 15 AMP	FU3 15 AMP	FU4 15 AMP	FU5 15 AMP	FU6 20 AMP
H1 2X 95 W	HT1	L1	LA 69	M1	MA1 52-1	MA2 52-2	MA3 52-2	TH1	EAC 27X83
MAX1 52X1	MAX2 52X2	MB1 88LS	MC 52CC	MD 52TC1	ME 52TC2	PL1 GFI	SW1		

EHR1 23X1	EAC1 27X5	BP1 37-1	BPT	FF 50 AMP	HN1 23X1	TH3 23	H2 2X 95 W	HT2

DEVICE TAG NOTES:
1) TAG MATERIAL: PLASTIC - BLACK WITH WHITE LETTERS
2) TAG DIMENSIONS AS SHOWN ABOVE

TB1	TB2	TB3	TB4	TB5	TB6	TB7	TB8	TB9	TB10	TB11	TB12	
1	7	13	55	65	75	85	102	114	126	138	1	
2	7R	17	56	66	76	86	103	115	127	139	2	
1A	8	18	57	67	77	87	104	116	128	140	3	
2A	9	19	58	68	78	88	105	117	129	141	4	
1B	9R	20	59	69	79	89	106	118	130	142	5	
2B	9A	B4	60	70	80	90	107	119	131	143	6	
3	9AR	51	61	71	81	91	108	120	132	144	7	
4	10	52	62	72	82	92	109	121	133	145	8	TBAC 35
5	10A	53	63	73	83	93	110	122	134	146	9	36
6	11	54	64	74	84	94	111	123	135	147	10	
B1	11A	B5	B7	B9	B11	100	112	124	136	148	11	37
B2	B3	B6	B8	B10	B12	101	113	125	137	149	12	
P4	P4	P4	P4	P4	P4	P4	P4	P4	P4	P4	P4	P10

TERMINAL MARKER STRIP NOTES:
1) STRIP MATERIAL: PLASTIC - BLACK WITH WHITE LETTERS
2) STRIP DIMENSIONS AS SHOWN ON AREVA FABRICATION DRAWING 1_417_376_P... (SEE P#'S FOR EACH STRIP)

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
13	ADDED TANK HEATERS	W. Holt	A. Lisitsa	02/06/08
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
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8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07

TERMINAL MARKER STRIPS

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 15 OF 15

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

acciona

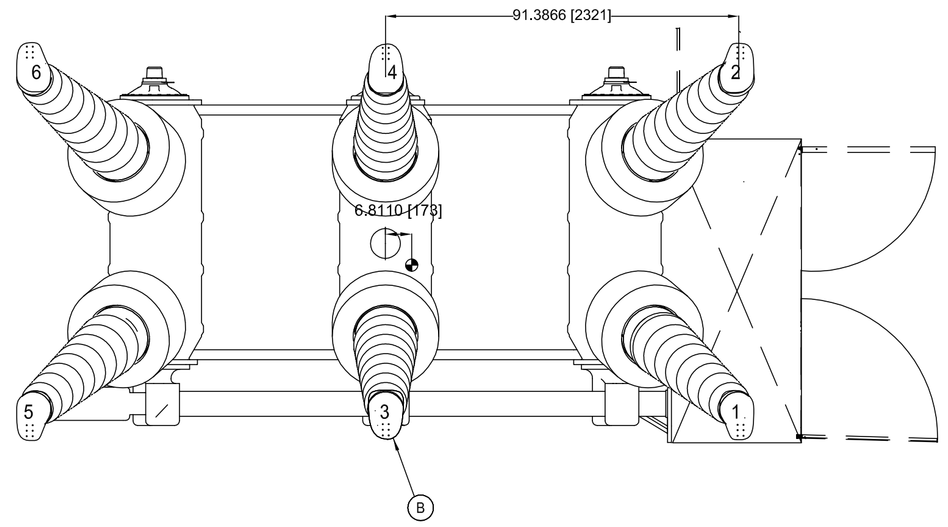
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
OUTLINE DRAWING

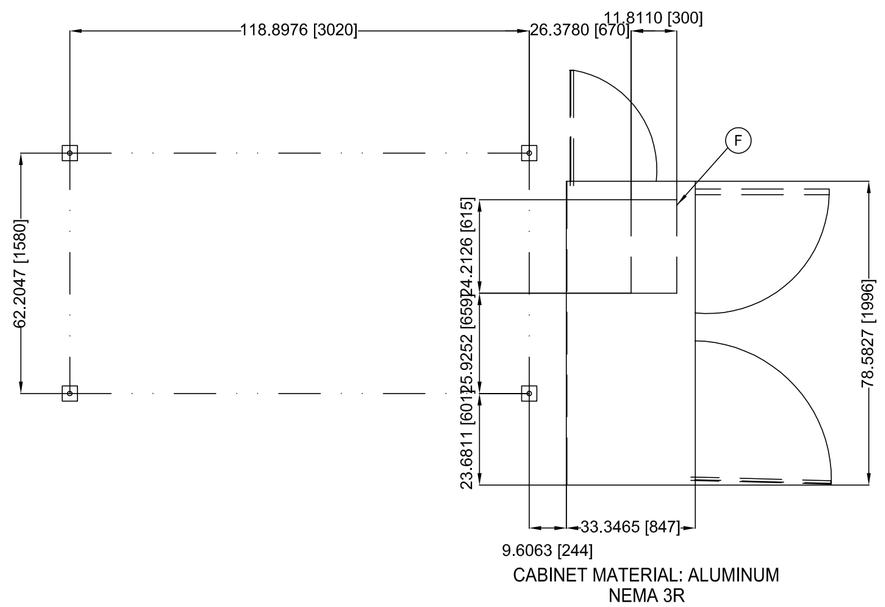
0 1" 2"

FILENAME: TWEND-MD-15.DWG
SCALE: NONE

SHEET
MD-15

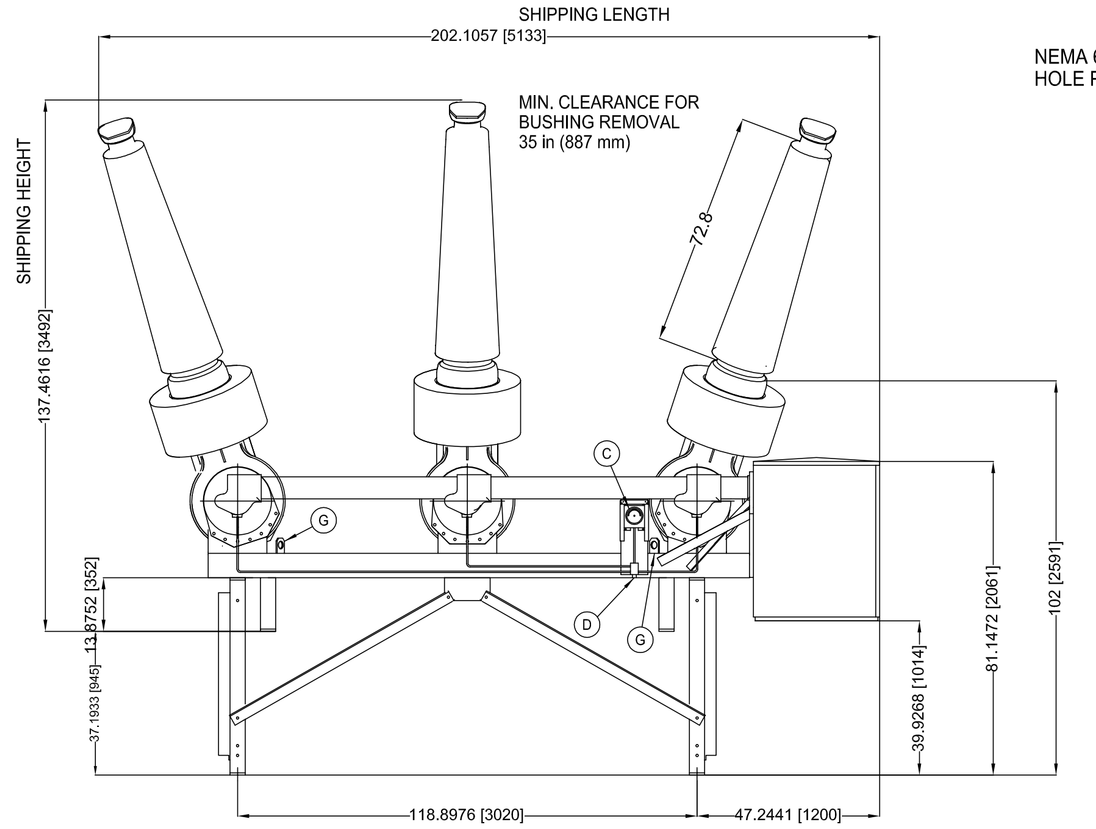


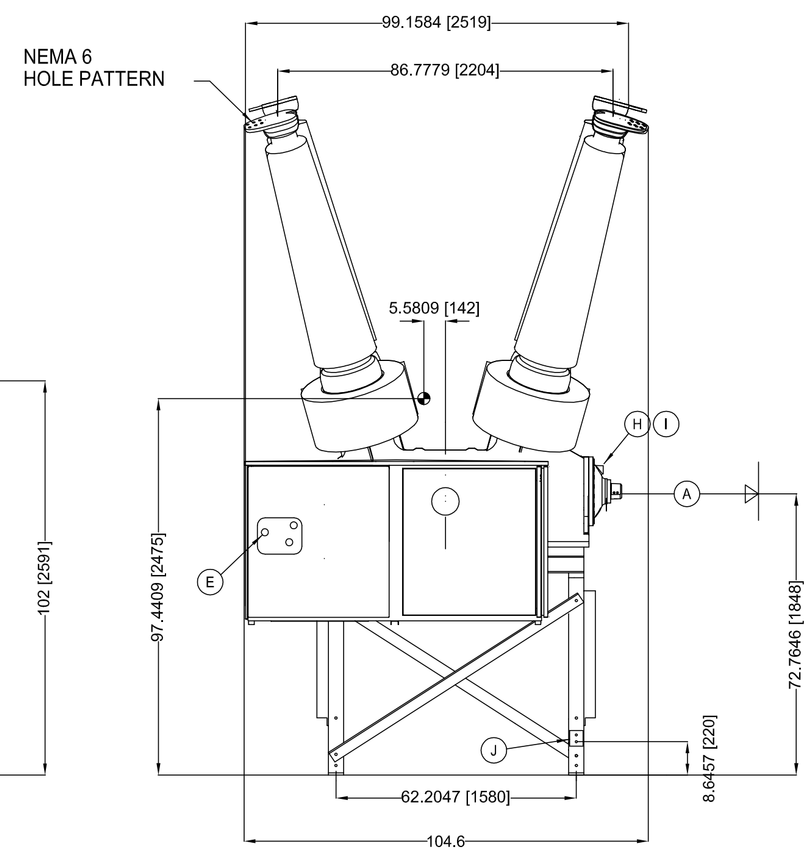
LOCATION OF DROP OUT PANELS
WITH RESPECT TO ANCHOR BOLTS



CABINET MATERIAL: ALUMINUM
NEMA 3R

FOUR (4) 1" DIAMETER ANCHOR BOLTS REQUIRED.
3.0" MINIMUM PROJECTION ABOVE FOUNDATION.
FOUNDATION TO BE LEVEL WITHIN 0.25" AT FOUR (4)
BASEPLATES. SHIM AND GROUT AS REQUIRED.
8300 lbs (3773 kg) (BREAKER WEIGHT)
+ 4194 lbs (1902 kg) (CT WEIGHT)
=12494 lbs (5675 kg) (TOTAL WEIGHT)
SEISMIC WITHSTAND CAPABILITY = 0.3 g
DYNAMIC REACTIVE FORCE PER BOLT = 15kN (3300lb)
PERMISSIBLE TERMINAL LOAD 3 kN = (660 lb) STATICALLY
PERMISSIBLE TERMINAL LOAD 4 kN = (880 lb) STATICALLY & DYNAMICALLY





LEGEND

- (A) MIN. DISTANCE FOR INTERRUPTER REMOVAL (63 inches 1608 mm)
- (B) NEMA 6 HOLE TERMINAL PAD
- (C) SF6 DENSITY MONITOR
- (D) SF6 FILL VALVE (DILO DN8)
- (E) STORED ENERGY/POSITION INDICATORS
- (F) CABLE ENTRANCE
- (G) LIFTING LUGS
- (H) PRESSURE RELIEF
- (I) MOLECULAR SIEVE
- (J) NEMA 2 GROUND PAD (DIAGONALLY OPPOSITE)

TYPE	HGF 1014
IMPULSE WITHSTAND	900 kV
MAXIMUM VOLTAGE	245kV
INTERRUPTER CURRENT RATING	40 kA
CURRENT RATING	1200 A

REV	DESCRIPTION	DRAWN	CHECKED	DATE

CUSTOMER: VENTUS ENERGY
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: TATANKA WIND FARM
SERIAL No(s): 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQUIPMENT No(s):

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

OUTLINE DRAWING

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C1399

SHT 1 OF 1

ISSUE	DATE	DESCRIPTION
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
230KV PCB 5177, 5181, 5185
OUTLINE DRAWING

0 1" 2"

FILENAME	TWEND-MD-16.DWG
SCALE	NONE

SHEET
MD-16

ELECTRICAL EQUIPMENT

ITEM NO.	QUANTITY REQUIRED	MANUFACTURER	CATALOG NUMBER	DESCRIPTION	REMARKS
B1	6			DISCONNECT SWITCH,THREE PHASE, GANG OPERATED, VERTICAL BREAK, 230 KV, 1200 AMP, 900 KV BIL	
C1	9			SURGE ARRESTER, STATION CLASS, 140 KV MCOV	
E1	3			POWER CIRCUIT BREAKER, SF6, 230 KV, 1200 AMP, 900 KV BIL, 40 KA INTERRUPT	
G1	9			CCVT, 230 KV, 900KV BIL	
G2	2			LINE TRAP, 0.265 MH, 1200 AMP, TO BE VERTICALLY MOUNTED ON 230 KV CCVT, ITEM G1	
G3	3	NXTPHASE		OPTICAL CURRENT SENSOR, 230 KV, UPRIGHT MOUNTING	
H2	1			DISTRIBUTION TRANSFORMER, POLE MOUNTED, SINGLE BUSHING, SINGLE PHASE, 100 KVA, 12.5 KV-120/240 VOLTS	
R	12	HOLOPHANE		SUBSTATION LIGHTING	

BUS MATERIAL

ITEM NO.	QUANTITY REQUIRED	MANUFACTURER	CATALOG NUMBER	DESCRIPTION	REMARKS
A1	AS REQ'D			CONDUCTOR, 1272 KCM AAC, 61 STRAND, "NARCISSUS"	
A2	AS REQ'D			CONDUCTOR, 397.5 KCM AAC, 19 STRAND, "CANNA", FOR VIBRATION DAMPING IN 3 1/2" AL BUS	
A3	AS REQ'D			CONDUCTOR, BUS, 3 1/2" IPS SCHEDULE 40 ALUMINUM, 6063-T6	
A4	126			INSULATOR, SUSPENSION, BALL-SOCKET FITTINGS, NEMA 52-5, 10", 30,000 LB, GRAY	
A5	43	LAPP	315304-70	INSULATOR, STATION POST, STANDARD STRENGTH, 230 KV, 900 KV BIL, TR-304, 5" BOLT CIRCLE, GRAY	
A6	9	ANDERSON	CO11414	CONNECTOR, COMPRESSION DEADEND, FOR 1272 KCM 61 STRAND NARCISSUS, WITH VERTICAL EYE AND 4-HOLE NEMA PAD	
A7	96	ANDERSON	CCLS-1300-D	CONNECTOR, COMPRESSION TERMINAL FOR 1272 KCM 61 STRAND "NARCISSUS" TO NEMA 4 HOLE PAD	
A8	5	ANDERSON	CCLS-1300-D-90	CONNECTOR, COMPRESSION TERMINAL FOR 1272 KCM 61 STRAND "NARCISSUS" TO 90 DEGREE NEMA 4 HOLE PAD	
A9	9	ANDERSON	WSTF-34-D	CONNECTOR, TERMINAL, AL, WELDED, FOR 3 1/2" IPS AL PIPE TO CENTERFORMED NEMA 4-HOLE PAD	
A10	18	ANDERSON	WSTF-334-D-CF	CONNECTOR, TERMINAL, EXPANSION, AL, WELDED, FOR 3 1/2" IPS AL PIPE TO CENTERFORMED NEMA 4-HOLE PAD	
A11				NOT USED	
A12	AS REQ'D	ANDERSON	WCI-3434	COUPLER, AL, WELDED, FOR 3 1/2" TO 3 1/2" IPS AL PIPE	
A13	23	ANDERSON	WTTFR-30-60-D	CONNECTOR, TEE, AL, WELDED, FOR 3 1/2" IPS PIPE TO NEMA 4-HOLE PAD	
A14	18	ANDERSON	ACB-34	END PLUG, AL, WELDED, FOR 3 1/2" IPS AL PIPE	
A15	30	ANDERSON	WTT-15-3434	TEE, AL, WELDED, 15 DEGREE, FOR 1-3 1/2" IPS AL PIPE MAIN TO 1-3 1/2" IPS AL PIPE TAP	FOR A-FRAMES
A16	15	ANDERSON	WTT2-15-3434	TEE, AL, WELDED, 1-3 1/2" IPS AL PIPE MAIN TO 2-15 DEGREE 3 1/2" IPS AL PIPE TAPS	FOR A-FRAMES
A17				NOT USED	
A18				NOT USED	
A19				NOT USED	
A20	43	ANDERSON	WURF-34-5	BUS SUPPORT, AL, FOR 3 1/2" AL PIPE TO 5" BOLT CIRCLE	
A21	10	ANDERSON	WUDE-34-5	BUS SUPPORT, AL, FOR 3 1/2" AL PIPE TO 5" BOLT CIRCLE	FOR CT, CCVT SHUNT
A22	9	ANDERSON	SC-30	SOCKET CLEVIS, 30,000 LB	
A23	9	ANDERSON	YBC-30	Y-CLEVIS BALL, 30,000 LB	
A24	5	LAPP	315227-70	INSULATOR, STATION POST, HIGH STRENGTH, 23 KV, 150 KV BIL, TR-227, 5" BOLT CIRCLE, GRAY	FOR CT, CCVT SHUNT
A25	3	ANDERSON	ORT-2114	CONNECTOR, COMPRESSION TEE FOR 1272 KCM 61 STRAND "NARCISSUS" TO NEMA 4 HOLE PAD	FOR OPTICAL CURRENT SENSOR JUMPER
A26	6	ANDERSON	AS-25	CHAIN SHACKLE, 30,000 LB	
A27	6	ANDERSON	CFCC-30	CLEVIS-CLEVIS, 30,000 LB	
A28	6	ANDERSON	861225S	DEADEND, COMPRESSION, EYE FITTING WITH 2-HOLE PAD, FOR 3/8" EHS STATIC WIRE	
A29	AS REQ'D			3/8" EHS GALVANIZED STEEL STATIC WIRE	
A30	AS REQ'D	ANDERSON	TP-B	BI-METALLIC TRANSITION PLATE, NEMA 2-HOLE PAD, ALUMINUM TO COPPER CONNECTIONS	
A31				LOT OF ½" DIAMETER STAINLESS STEEL BOLTS WITH 2-STAINLESS STEEL FLAT WASHERS, 1-STAINLESS STEEL BELLEVILLE WASHER, AND 1-1/2" SILICON BRONZE NUT PER BOLT. LENGTH & QUANTITY TO BE AS REQUIRED.	
A33	9	ANDERSON	A2CF-9-C	TERMINAL, BOLTED. ALUMINUM, FOR TWO 397.5 KCM 26/7 STRAND CABLES (ONE "TZIBIS" CABLE) TO 4-HOLE PAD.	
A34	1	ALCOA		OPGW DEADEND UNIT, FOR 12 FIBER, SINGLE MODE, 1310 NM, OPT-GW AC-57/465, W/REINFORCING ROD, 120" MINIMUM LENGTH, WITH ITEMS A35 & A37	
A35	1	DULMISON/TYCO	11EL-12-30	EXTENSION LINK, WYE-CLEVIS EYE, 30,000LB	
A36	1	DULMISON/TYCO	11AS-30-L	ANCHOR SHACKLE	
A37	1	DULMISON/TYCO	11CT-100	CLEVIS THIMBLE	
A38	AS REQ'D			GROUND WIRE, #6 COPPER, STRANDED, BARE	
A39	1	BURNDY	UC33R	PARALLEL CLAMP FOR #6 CU TO OPGW	
A40	1	ANDERSON	VAUL-4-12BN	COMPRESSION TERMINAL, #6 CU TO NEMA 2-HOLE PAD	

CONDUIT MATERIAL

ITEM NO.	QUANTITY REQUIRED	MANUFACTURER	CATALOG NUMBER	DESCRIPTION	REMARKS
K1	AS REQ'D			CONDUIT, 1 1/4", RIGID STEEL GALVANIZED, SCH 40	
K2	AS REQ'D			CONDUIT, 2", RIGID STEEL GALVANIZED, SCH 40	
K3	AS REQ'D			CONDUIT, 3", RIGID STEEL GALVANIZED, SCH 40	
K4	AS REQ'D			CONDUIT, 2", PVC. SCH 40	
K5	AS REQ'D			CONDUIT, 3", PVC. SCH 40	
K6	AS REQ'D			CONDUIT, 4", HDPE, SMOOTH CORE	
K7	AS REQ'D			CONDUIT, 6", HDPE, SMOOTH CORE	
K8	AS REQ'D			CONDUIT, 2", INNERDUCT FOR FIBER OPTIC CABLE	
K9	AS REQ'D			ELBOW, 90 DEGREE, 24" RADIUS SWEEP, 2" PVC. SCH 80	
K10	AS REQ'D			ELBOW, 90 DEGREE, 24" RADIUS SWEEP, 3" PVC. SCH 80	
K11	AS REQ'D			ELBOW, 90 DEGREE, 48" RADIUS SWEEP, 4" HDPE, SMOOTH CORE	
K12	AS REQ'D			ELBOW, 90 DEGREE, 48" RADIUS SWEEP, 6" HDPE, SMOOTH CORE	
K13	AS REQ'D			END BELL FOR 2" PVC CONDUIT	
K14	AS REQ'D			END BELL FOR 3" PVC CONDUIT	
K15	AS REQ'D			COUPLER FOR 2" TO 2" PVC CONDUIT	
K16	AS REQ'D			COUPLER FOR 3" TO 3" PVC CONDUIT	
K17	AS REQ'D			COUPLER FOR 4" TO 4" HDPE SMOOTH CORE CONDUIT	
K18	AS REQ'D			COUPLER FOR 6" TO 6" HDPE SMOOTH CORE CONDUIT	
K19	AS REQ'D			COUPLER FOR 2" TO 2" PVC CONDUIT	
K20	AS REQ'D			GALV. LOCKWASHERS FOR 1 1/4" CONDUIT	
K22	AS REQ'D			GALV. LOCKWASHERS FOR 2" CONDUIT	
K23	AS REQ'D			GALV. LOCKWASHERS FOR 3" CONDUIT	
K24	AS REQ'D			GALV. GROUNDING BUSHINGS FOR 1 1/4" RIGID CONDUIT	
K25	AS REQ'D			GALV. GROUNDING BUSHINGS FOR 2" CONDUIT	
K26	AS REQ'D			GALV. GROUNDING BUSHINGS FOR 3" CONDUIT	
K27	AS REQ'D			GALV. WATERTIGHT GROUNDING CONDUIT HUBS FOR 1 1/4" CONDUIT	
K28	AS REQ'D			GALV. WATERTIGHT GROUNDING CONDUIT HUBS FOR 2" CONDUIT	
K29	AS REQ'D			GALV. WATERTIGHT GROUNDING CONDUIT HUBS FOR 3" CONDUIT	
K30	AS REQ'D			ADAPTER FOR 1 1/4" PVC CONDUIT TO 1 1/4" RIGID STEEL CONDUIT	
K31	AS REQ'D			ADAPTER FOR 2" PVC CONDUIT TO 2" RIGID STEEL CONDUIT	
K32	AS REQ'D			ADAPTER FOR 3" PVC CONDUIT TO 3" RIGID STEEL CONDUIT	
K33	AS REQ'D			LOT MINOR CONDUIT MATERIAL, CLAMPS, CABLE SUPPORTS, CONDULETS, ELLS, TEES, UNISTRUT, SPRING NUTS, BOLTS W/ NUTS, WASHERS, LOCKWASHERS, SELF-TAPPINGSCREWS, ETC. SIZE AND NUMBER AND LENGTH AS REQUIRED TO COMPLETE CONDUIT INSTALLATION PER NESC, NEC, AND ALL OTHER APPLICABLE CODES.	
K34	AS REQ'D			16" X 16" X 6" HINGED COVER NEMA 3R JUNCTION BOXES WITH INTERIOR MOUNTING PANELS, HOFFMAN CAT. NO. A16166HCR WITH A16P16 PANEL OR EQUAL	
K35	AS REQ'D			24" X 24" X 8" HINGED COVER NEMA 3R JUNCTION BOXES WITH INTERIOR MOUNTING PANELS, HOFFMAN CAT. NO. A24R248HCR WITH A24P24 PANEL OR EQUAL	
K36	AS REQ'D			AC/DC YARD PANELS	
K37	AS REQ'D			PRIMER/CEMENT/ADHESIVE FOR PVC/HDPE CONDUIT	
K38	AS REQ'D			CONDUIT, 1 1/4", PVC. SCH 40	
K39	AS REQ'D			ELBOW, 90 DEGREE, 24" RADIUS SWEEP, 1 1/4" PVC. SCH 80	
K40	AS REQ'D			END BELL FOR 1 1/4" PVC CONDUIT	
K41	AS REQ'D			COUPLER FOR 1 1/4" TO 1 1/4" PVC CONDUIT	
K42	1	ALCOA	OG03	FIBER OPTIC SPLICE BOX	
K43	1	T&B	LN-103	LOCKNUT FOR 1"RIGID CONDUIT	
K44	1	T&B	LS-103	SEALING LOCKNUT, 1"	
K45	1	T&B	1224	BUSHING, NYLON INSULATED, METALLIC, 1"	
K46	AS REQ'D			CONDUIT, GALVANIZED STEEL, 1", THREAD BOTH ENDS	
K47	1	CROUSE-HINDS	REC603	REDUCER, GALVANIZED STEEL, 2"-1"	
K48	1	ALCOA	11-112 SC	EQUIPMENT JUNCTION BOX & INTERNAL COMPONENTS, PART #912875-00-00 (IN CONTROL HOUSE)	
K49	1	CARLON	E943J	MALE TERMINAL ADAPTER FOR 2" PVC CONDUIT	
K50	AS REQ'D	ALUMA-FORM	BB-1511-H	OPGW MOUNTING BRACKET	
K51	AS REQ'D	T&B	TYS6-280	CABLE TIE, STAINLESS STEEL, SELF-LOCKING	
K52	AS REQ'D	3M	2170	BUFFER TUBE, HEAT SHRINK, FOR FUSION SPLICE	
K53	1	ALCOA	C8591	ENTRY CONNECTOR ASSEMBLY	
K56	1	3M	5016-FO	WARNING LABEL	
K57	10			BOLT, HEX HEAD, GALVANIZED STEEL, 5/8" X 2" W/NUT	
K58	2			FLAT WASHER, ROUND, GALVANIZED STEEL, 5/8"	
K59	10			SPLIT LOCKWASHER, GALVANIZED STEEL, 5/8"	
K60	1	ALCOA	OGST01-24	SPLICE ORGANIZER TRAY, 24 FUSION SPLICE CAPACITY	

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RLB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION MATERIAL LIST

0 1" 2"

FILENAME	TWEND-ML-01
SCALE	NONE

SHEET **ML-01**

YARD

ITEM NO.	QUANTITY REQUIRED	MANUFACTURER	CATALOG NUMBER	DESCRIPTION	REMARKS
	1 LOT			FENCE AS REQUIRED INCLUDING TWO (2) DRIVE GATES	
	1 LOT			SURFACE FINISHING -6" CRUSHED GRAVEL	
	1 LOT			FINISH GRADING	

GROUNDING MATERIAL

ITEM NO.	QUANTITY REQUIRED	MANUFACTURER	CATALOG NUMBER	DESCRIPTION	REMARKS
01	AS REQ'D			CONDUCTOR, GROUNDING, 4/0 CU, 7 STRAND, SOFT DRAWN	
02	AS REQ'D	BURNDY	YGHC29C29	CONNECTOR, TAP, GROUNDING, FOR 4/0 CU TO 4/0 CU	
03	AS REQ'D	BURNDY	YGLC29C29	CONNECTOR, CROSS, GROUNDING, FOR 4/0 CU TO 4/0 CU	
04	AS REQ'D			GROUND ROD, COPPER CLAD, 3/4" X 10'-0"	
05	AS REQ'D	BURNDY	UC2W28-L	PARALLEL CLAMP, FOR 4/0 CU TO GALV BARBED WIRE.	
06	AS REQ'D	BURNDY	YHA-28-2N	CONNECTOR, GROUNDING, 4/0 CU TO NEMA 2-HOLE PAD	
07	AS REQ'D	ANDERSON	GC-141A-G2	CLAMP, GROUNDING, FOR ONE 4/0 STRANDED OR #2 AWG SOLID CU CABLE TO FLAT	
08	AS REQ'D	ANDERSON	GC-143-G2	CLAMP, GROUNDING, FOR TWO 4/0 CU CABLES OR ONE 4/0 CU STRANDED TO #2 AWG SOLID CU TRANSITION TO FLAT	
09	AS REQ'D	ANDERSON	TLD-52	TERMINAL,BOLTED. FOR ONE OR TWO 4/0 CU CABLES TO FLAT	
010	AS REQ'D	ANDERSON	GC-111-142C	CLAMP, GROUNDING, FOR 4/0 CU CABLE TO 4" IPS FENCE PIPE	
011	AS REQ'D	ANDERSON	GC-110-82C	CLAMP, GROUNDING, FOR 4/0 CU CABLE TO 2 ½" IPS FENCE PIPE	
012	AS REQ'D	ANDERSON	GC-110-122C	CLAMP, GROUNDING, FOR 4/0 CU CABLE TO 3" IPS FENCE PIPE	
013	AS REQ'D			CONDUCTOR, GROUNDING, #2 AWG CU, SOLID, SOFT DRAWN	
014	AS REQ'D			CONDUCTOR, GROUNDING, 4/0 CU, EXTRA FLEXIBLE	
015	AS REQ'D	7		SWITCHING PLATFORM, GALVANIZED, 4' X 6'	
016	AS REQ'D			LOT MINOR GROUNDING MATERIAL INCLUDING NECESSARY BOLTS, WASHERS. LOCKWASHERS, MINOR COMPRESSION AND MECHANICAL CONNECTORS, TO INCLUDE ALL HARDWARE NECESSARY FOR A COMPLETE GROUNDING INSTALLATION PER NEC, NESC AND ALL OTHER ALL APPLICABLE CODES.	
017	AS REQ'D	BURNDY	YGH34C29	CONNECTOR, TAP, GROUNDING, FOR 4/0 CU TO 500 KCM CU	
018	AS REQ'D	BURNDY	YGLR29C34	CONNECTOR,3/4" GROUND ROD TO 4/0 COPPER GROUND GRID CONNECTOR	

CONTROL BUILDING

ITEM NO.	QUANTITY REQUIRED	MANUFACTURER	CATALOG NUMBER	DESCRIPTION	REMARKS
CH	1			20'X20' PREFAB CONTROL BUILDING WITH THE FOLLOWING:	
				125VDC BATTERIES AND BATTERY CHARGER	
				AC/DC PANELBOARDS	
				AC/DC LIGHTING	
				AUTOMATIC TRANSFER SWITCH	
				CONVENIENCE RECEPTACLES	
				HVAC UNIT AND DUCT WORK	
				CABLE TRAY SYSTEM	
				THREE (3) LINE RELAY PANELS	
				ONE (1) BREAKER CONTROL PANEL	
				RTU UNIT	

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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RLB
PROJECT NUMBER	48069

acciona

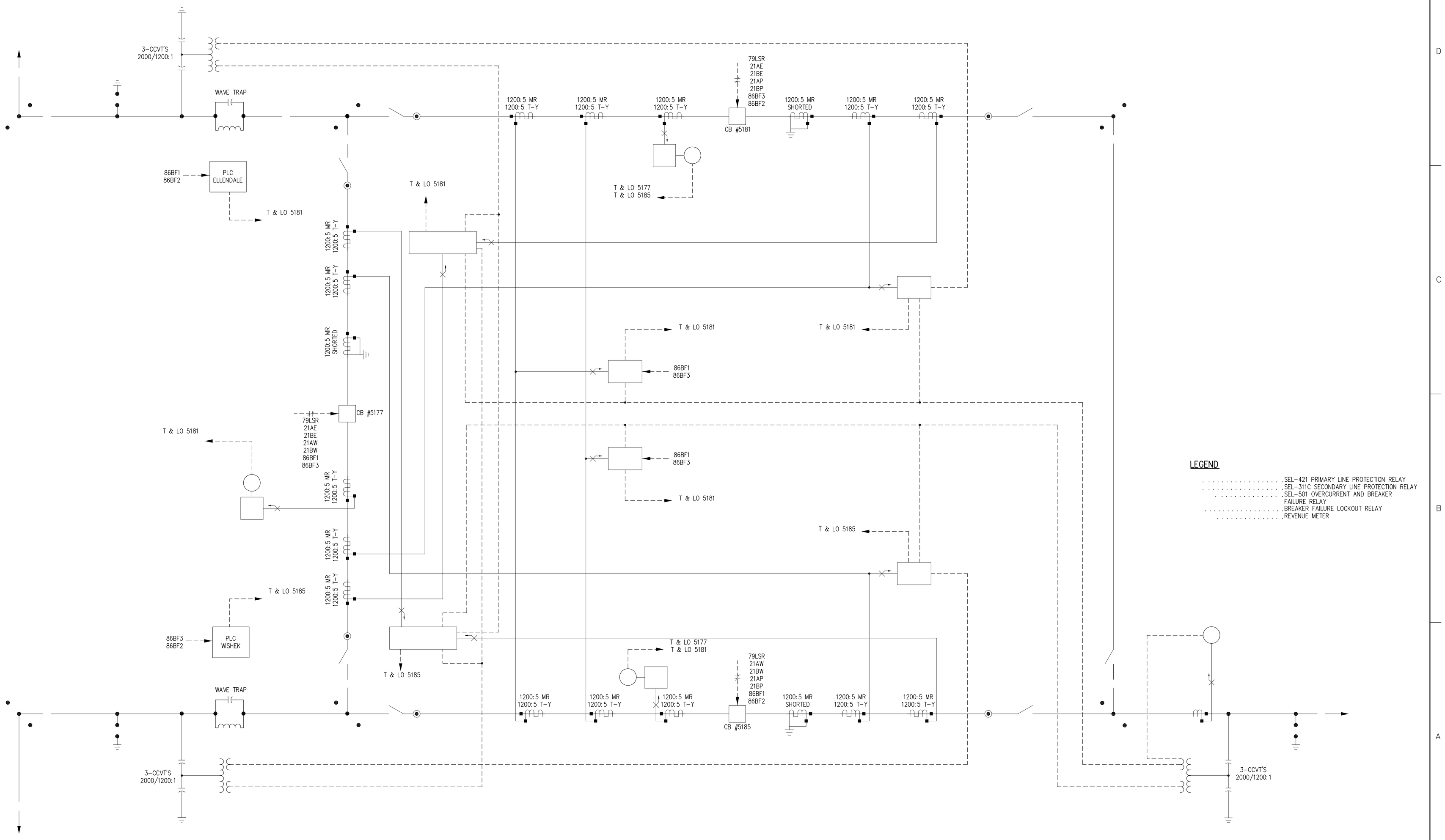
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION MATERIAL LIST

0 1" 2"

FILENAME	TWEND-ML-02
SCALE	NONE

SHEET **ML-02**



MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-06	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION RELAY ONE LINE DIAGRAM

0 1" 2"

FILENAME	TWEND-OL-01
SCALE	NONE

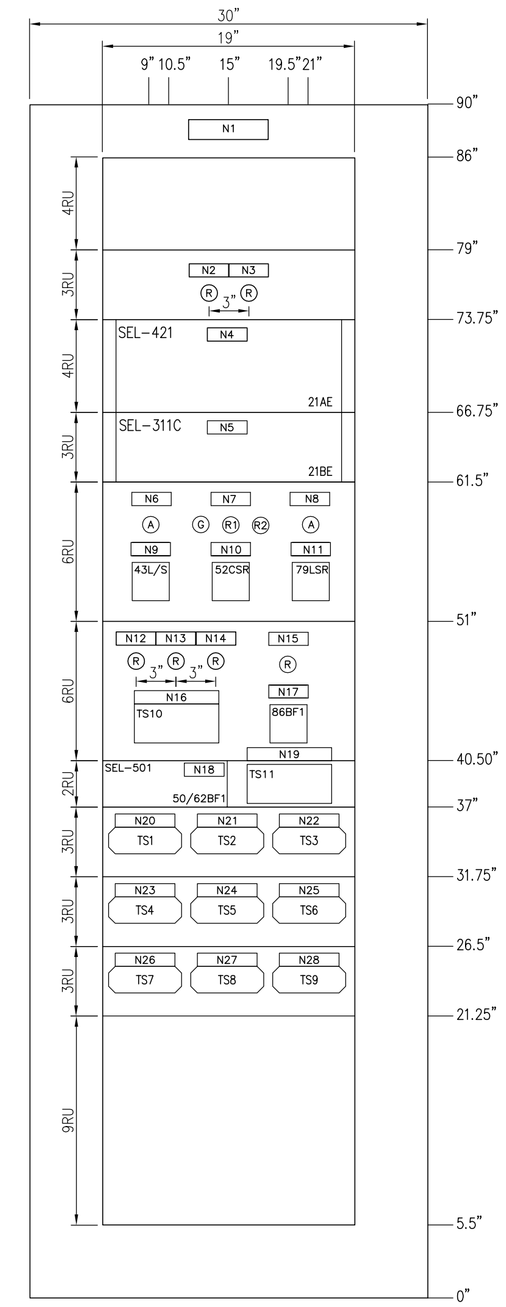
SHEET
OL-01

BILL OF MATERIALS

ITEM NO.	QTY	DESCRIPTION	MANUFACTURER	STYLE/TYPE	CATALOG NO.
21AE	1	RELAY, HIGH-SPEED LINE PROTECTION, 125VDC, 5A, 60HZ, 19" RACK MOUNT	SCHWEITZER	SEL-421	042124151XXB4H25XXXXX
21BE	1	RELAY, LINE PROTECTION, 125VDC, 5A, 60HZ, 19" RACK MOUNT	SCHWEITZER	SEL-311C	0311C01H232545X
50/62BF1	1	RELAY, DUAL OVERCURRENT, 125VDC, 5A, 60HZ, 19" RACK MOUNT WITH TEST SWITCH	SCHWEITZER	SEL-501	0501003X561CXB
TS1,TS2,TS3	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, TS1, TS2, (4P,6C), TS3 (10P)	ABB	FT-19R	FR3G119119001
TS4,TS5,TS6	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, TS4, TS5, TS6 (10P)	ABB	FT-19R	FR3G0010011001
TS7,TS8,TS9	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, TS7 (4P,6C), TS8, TS9 (10P)	ABB	FT-19R	FR3G119001001
TS10	1	FT-1 TEST SWITCH, 10 POLE, (10P)	ABB	FT-1	129A501G01
TS11	1	FT-1 TEST SWITCH, 10 POLE, (4P,6C)	ABB	FT-1	1586C42G05
43L/S	1	CONTROL SWITCH, DOUBLE THROW, NO OFF, 5 DECK, PISTOL GRIP HANDLE, ENGRAVING CODE 10D-2S20D (SUPERVISORY)	ELECTRO SWITCH	SERIES 24	24205B
52CSR	1	RELAY, CONTROL SWITCH, 125VDC, 5 DECK, PISTOL GRIP HANDLE, ENGRAVING CODE 18B-2B23 (BREAKER CONTROL)	ELECTRO SWITCH	SERIES 24 CSR	8857DB
79LSR	1	RELAY, LATCHING SWITCH, 125VDC, 3 DECK, PISTOL GRIP HANDLE, ENGRAVING CODE 10D-2R13C (RECLOSER)	ELECTRO SWITCH	SERIES 24 LSR	9203DB
86BF1	1	RELAY, LOCKOUT, 125VDC, 5 DECK, MANUAL RESET	ELECTRO SWITCH	SERIES 24 LOR	7805D
R	6	CIRCUIT MONITOR DEVICE, 125VDC	E-MAX	RAW-1D	632A304
A	2	LAMP, INDICATING, 125VDC, COMPLETE W/LAMP, LENS & HOLDER, AMBER	GECO	ET-16	116B6708G43A73A4
G	1	LAMP, INDICATING, 125VDC, COMPLETE W/LAMP, LENS & HOLDER, GREEN	GECO	ET-16	116B6708G43G73G4
R1, R2	2	LAMP, INDICATING, 125VDC, COMPLETE W/LAMP, LENS & HOLDER, RED	GECO	ET-16	116B6708G43R73R4

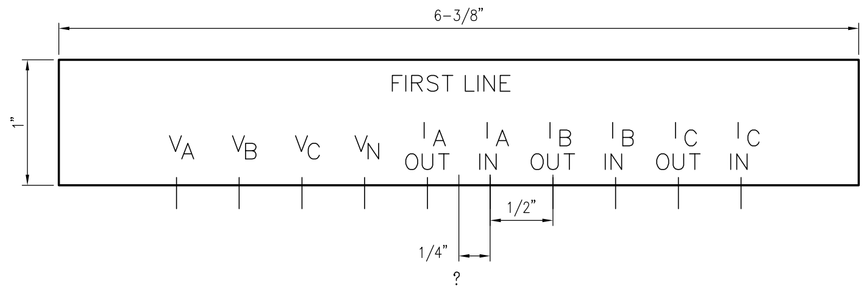
NAME-PLATE NO.	NAMEPLATE SIZE W x L	LETTER SIZE	FIRST LINE	SECOND LINE	THIRD LINE
1	1-1/2" x 6"	3/16"	ELLENDALE 230KV LINE	CB 5181	PANEL 1F
2	1" x 3"	1/8"	74DC-21AE		
3	1" x 3"	1/8"	74DC-21BE		
4	1" x 3"	1/8"	21AE-ELLENDALE	PRIMARY RELAYING	
5	1" x 3"	1/8"	21BE-ELLENDALE	SECONDARY RELAYING	
6	1" x 3"	1/8"	CB 5181 SUPERVISORY	CONTROL-OFF	
7	1" x 3"	1/8"	CB 5181	TRIPPED-CLOSED	
8	1" x 3"	1/8"	CB 5181 RECLOSER	CONTROL-OFF	
9	1" x 3"	1/8"	43L/S-5181	CONTROL SWITCH	
10	1" x 3"	1/8"	52CSR-5181	CONTROL SWITCH	
11	1" x 3"	1/8"	79LSR-5181	CONTROL SWITCH	
12	1" x 3"	1/8"	74DC-CC	CB 5181	
13	1" x 3"	1/8"	74DC-TC1	CB 5181	
14	1" x 3"	1/8"	74DC-TC2	CB 5181	
15	1" x 3"	1/8"	74DC-BF1	CB 5181	
16	1" x 6-3/8"	1/8"	86BF1-CONTROL TS10	(SEE DETAIL TS10)	
17	1" x 3"	1/8"	86BF1-5181	LOCKOUT RELAY	
18	1" x 3"	1/8"	50/62BF1	CB 5181	
19	1" x 6-3/8"	1/8"	50/62BF1-CONTROL & CURRENT TS11	(SEE DETAIL TS11)	
20	1" x 6-3/8"	1/8"	21AE-VOLTAGE & CURRENT TS1	(SEE DETAIL TS1)	
21	1" x 6-3/8"	1/8"	21AE-CURRENT TS2	(SEE DETAIL TS2)	
22	1" x 6-3/8"	1/8"	21AE & 21BE SYNC VOLTAGE TS3	(SEE DETAIL TS3)	
23	1" x 6-3/8"	1/8"	21AE-CONTROL TS4	(SEE DETAIL TS4)	
24	1" x 6-3/8"	1/8"	21AE-CONTROL TS5	(SEE DETAIL TS5)	
25	1" x 6-3/8"	1/8"	21AE-CONTROL TS6	(SEE DETAIL TS6)	
26	1" x 6-3/8"	1/8"	21BE-VOLTAGE & CURRENT TS7	(SEE DETAIL TS7)	
27	1" x 6-3/8"	1/8"	21BE-CONTROL TS8	(SEE DETAIL TS8)	
28	1" x 6-3/8"	1/8"	21BE-CONTROL TS9	(SEE DETAIL TS9)	

PANEL 1F

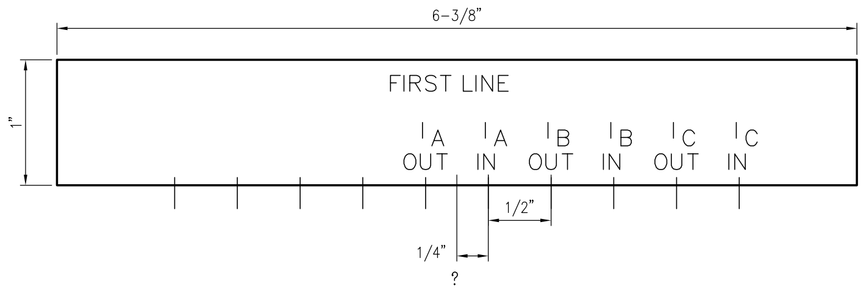


FRONT VIEW

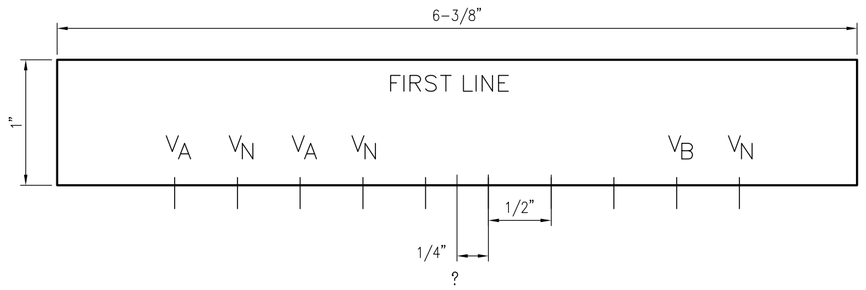
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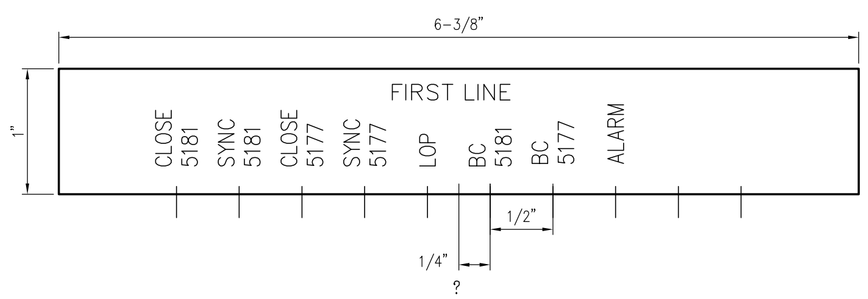
DETAIL TS1



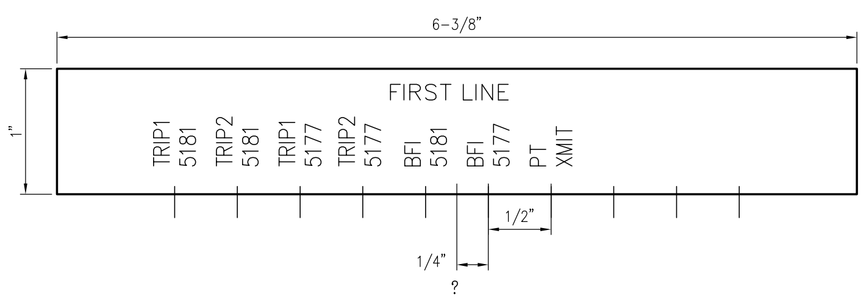
DETAIL TS2



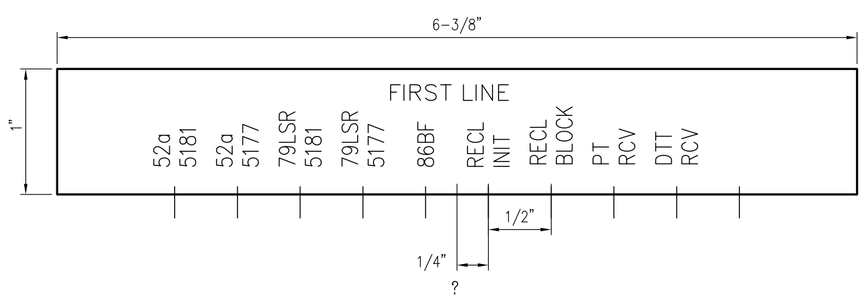
DETAIL TS3



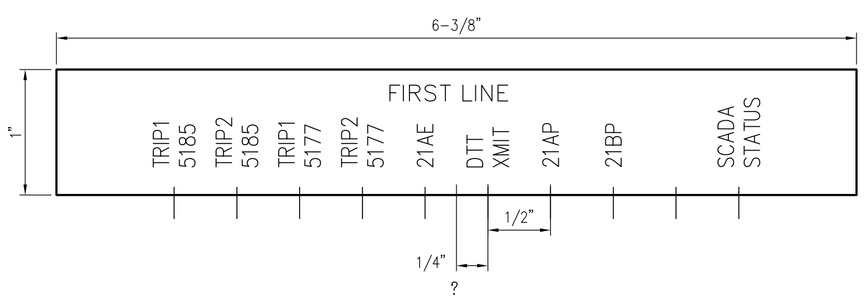
DETAIL TS4



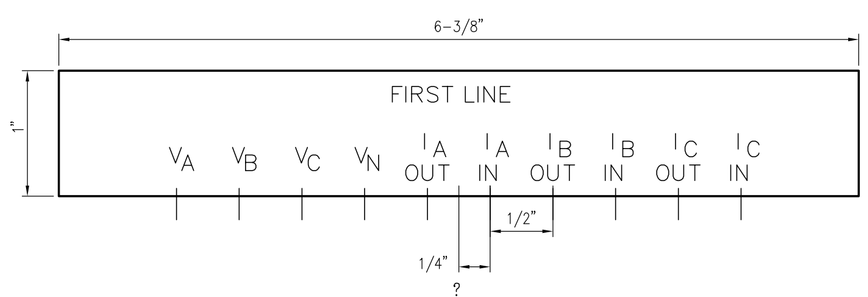
DETAIL TS5



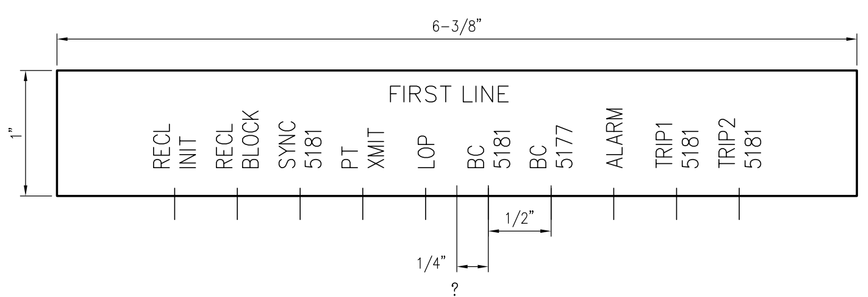
DETAIL TS6



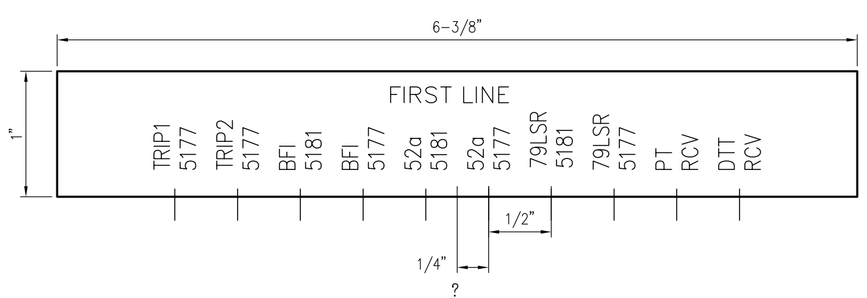
DETAIL TS10



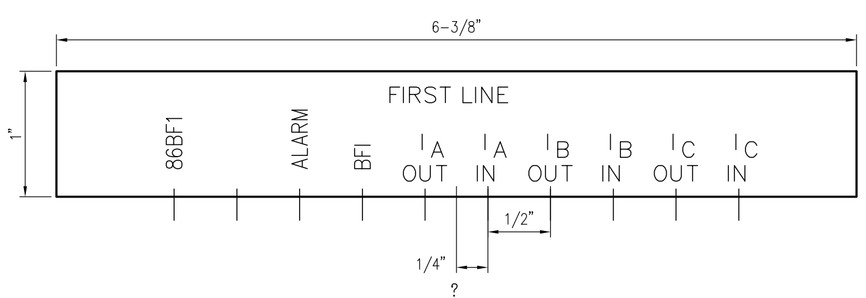
DETAIL TS7



DETAIL TS8



DETAIL TS9



DETAIL TS11

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION PANEL 1F LAYOUT, MATERIAL LIST & NAMEPLATE SCHEDULE

0 1" 2"

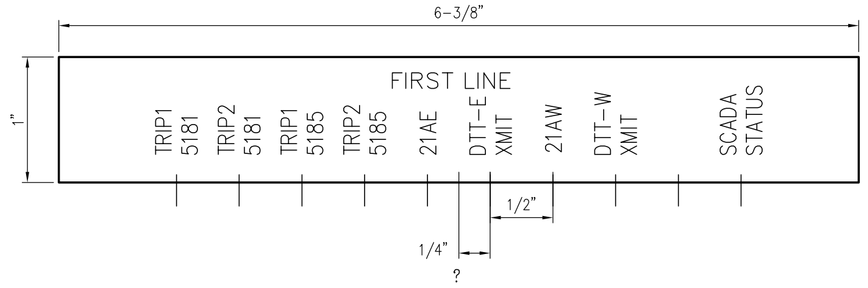
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SCALE	NONE

SHEET PL-01

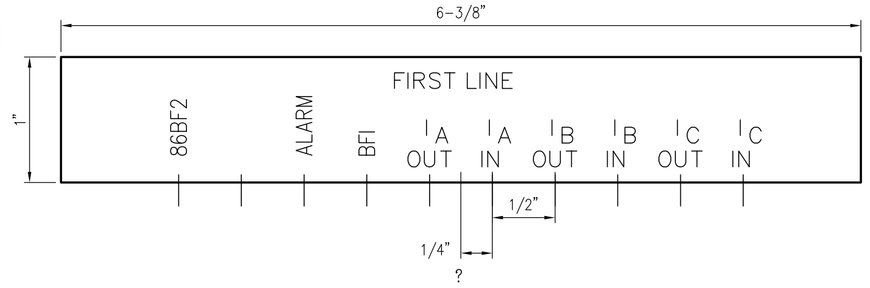
BILL OF MATERIALS

ITEM NO.	QTY	DESCRIPTION	MANUFACTURER	STYLE/TYPE	CATALOG NO.
50/62BF2	1	RELAY, DUAL OVERCURRENT, 125VDC, 5A, 60HZ, 19" RACK MOUNT WITH TEST SWITCH	SCHWEITZER	SEL-501	0501003X561CXB
TS1	1	FT-1 TEST SWITCH, 10 POLE, (10P)	ABB	FT-1	129A501G01
TS2	1	FT-1 TEST SWITCH, 10 POLE, (4P,6C)	ABB	FT-1	1586C42G05
43L/S	1	CONTROL SWITCH, DOUBLE THROW, NO OFF, 5 DECK, PISTOL GRIP HANDLE, ENGRAVING CODE 10D-2S20D (SUPERVISORY)	ELECTRO SWITCH	SERIES 24	24205B
52CSR	1	RELAY, CONTROL SWITCH, 125VDC, 5 DECK, PISTOL GRIP HANDLE, ENGRAVING CODE 18B-2B23 (BREAKER CONTROL)	ELECTRO SWITCH	SERIES 24 CSR	8857DB
79LSR	1	RELAY, LATCHING SWITCH, 125VDC, 3 DECK, PISTOL GRIP HANDLE, ENGRAVING CODE 10D-2R13C (RECLOSER)	ELECTRO SWITCH	SERIES 24 LSR	9203DB
86BF2	1	RELAY, LOCKOUT, 125VDC, 5 DECK, MANUAL RESET	ELECTRO SWITCH	SERIES 24 LOR	7805D
R	4	CIRCUIT MONITOR DEVICE, 125VDC	E-MAX	RAW-1D	632A304
A	2	LAMP, INDICATING, 125VDC, COMPLETE W/LAMP, LENS & HOLDER, AMBER	GECO	ET-16	116B6708G43A73A4
G	1	LAMP, INDICATING, 125VDC, COMPLETE W/LAMP, LENS & HOLDER, GREEN	GECO	ET-16	116B6708G43G73G4
R1, R2	2	LAMP, INDICATING, 125VDC, COMPLETE W/LAMP, LENS & HOLDER, RED	GECO	ET-16	116B6708G43R73R4
GPS	1	SATELLITE CLOCK WITH ANTENNA	SCHWEITZER	SEL-2407	24070001B
P1	1	COMMUNICATIONS PROCESSOR	SCHWEITZER	SEL-2030	203003X30XH0XX

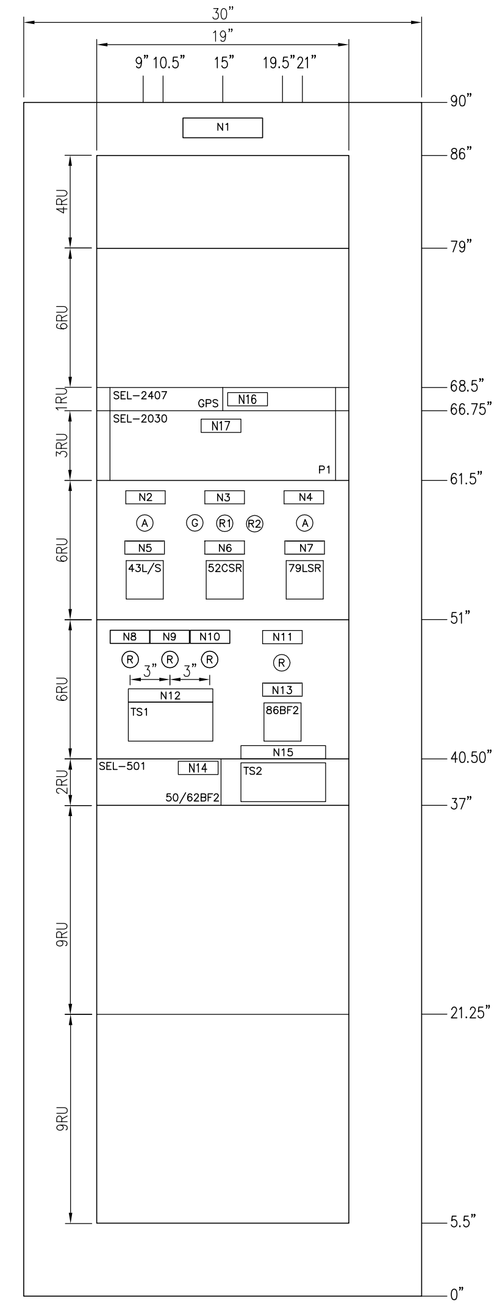
NAME-PLATE NO.	NAMEPLATE SIZE W x L	LETTER SIZE	FIRST LINE	SECOND LINE	THIRD LINE
1	1-1/2" x 6"	3/16"	ELLENDALE-WSHEK 230KV TIE	CB 5177	PANEL 2F
2	1" x 3"	1/8"	CB 5177 SUPERVISORY	CONTROL-OFF	
3	1" x 3"	1/8"	CB 5177	TRIPPED-CLOSED	
4	1" x 3"	1/8"	CB 5177 RECLOSER	CONTROL-OFF	
5	1" x 3"	1/8"	43L/S-5177	CONTROL SWITCH	
6	1" x 3"	1/8"	52CSR-5177	CONTROL SWITCH	
7	1" x 3"	1/8"	79LSR-5177	CONTROL SWITCH	
8	1" x 3"	1/8"	74DC-CC	CB 5177	
9	1" x 3"	1/8"	74DC-TC1	CB 5177	
10	1" x 3"	1/8"	74DC-TC2	CB 5177	
11	1" x 3"	1/8"	74DC-BF2	CB 5177	
12	1" x 6-3/8"	1/8"	86BF2-CONTROL TS1	(SEE DETAIL TS1)	
13	1" x 3"	1/8"	86BF2-5177	LOCKOUT RELAY	
14	1" x 3"	1/8"	50/62BF2	CB 5177	
15	1" x 6-3/8"	1/8"	50/62BF2-CONTROL & CURRENT TS2	(SEE DETAIL TS2)	
16	1" x 3"	1/8"	GPS	SATELLITE CLOCK	
17	1" x 3"	1/8"	P1	COMMUNICATIONS PROCESSOR	



DETAIL TS1



DETAIL TS2



FRONT VIEW

SCALE 0 4 8

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
PANEL 2F LAYOUT,
MATERIAL LIST & NAMEPLATE SCHEDULE

0 1" 2"

FILENAME	TWEND-PL-02.DWG
SCALE	NONE

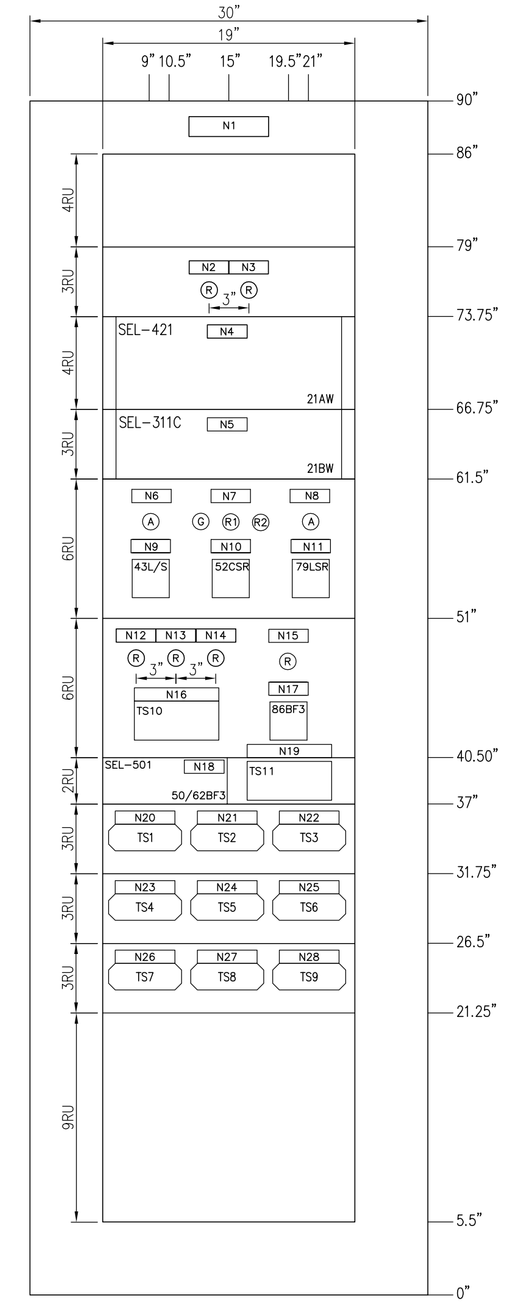
SHEET **PL-02**

BILL OF MATERIALS

ITEM NO.	QTY	DESCRIPTION	MANUFACTURER	STYLE/TYPE	CATALOG NO.
21AW	1	RELAY, HIGH-SPEED LINE PROTECTION, 125VDC, 5A, 60HZ, 19" RACK MOUNT	SCHWEITZER	SEL-421	042124151XXB4H25XXXXX
21BW	1	RELAY, LINE PROTECTION, 125VDC, 5A, 60HZ, 19" RACK MOUNT	SCHWEITZER	SEL-311C	0311C01H232545X
50/62BF3	1	RELAY, DUAL OVERCURRENT, 125VDC, 5A, 60HZ, 19" RACK MOUNT WITH TEST SWITCH	SCHWEITZER	SEL-501	0501003X561CXB
TS1,TS2,TS3	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, TS1, TS2, (4P,6C), TS3 (10P)	ABB	FT-19R	FR3G119119001
TS4,TS5,TS6	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, TS4, TS5, TS6 (10P)	ABB	FT-19R	FR3G001001001
TS7,TS8,TS9	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, TS7 (4P,6C), TS8, TS9 (10P)	ABB	FT-19R	FR3G119001001
TS10	1	FT-1 TEST SWITCH, 10 POLE, (10P)	ABB	FT-1	129A501G01
TS11	1	FT-1 TEST SWITCH, 10 POLE, (4P,6C)	ABB	FT-1	1586C42G05
43L/S	1	CONTROL SWITCH, DOUBLE THROW, NO OFF, 5 DECK, PISTOL GRIP HANDLE, ENGRAVING CODE 10D-2S20D (SUPERVISORY)	ELECTRO SWITCH	SERIES 24	24205B
52CSR	1	RELAY, CONTROL SWITCH, 125VDC, 5 DECK, PISTOL GRIP HANDLE, ENGRAVING CODE 18B-2B23 (BREAKER CONTROL)	ELECTRO SWITCH	SERIES 24 CSR	8857DB
79LSR	1	RELAY, LATCHING SWITCH, 125VDC, 3 DECK, PISTOL GRIP HANDLE, ENGRAVING CODE 10D-2R13C (RECLOSER)	ELECTRO SWITCH	SERIES 24 LSR	9203DB
86BF3	1	RELAY, LOCKOUT, 125VDC, 5 DECK, MANUAL RESET	ELECTRO SWITCH	SERIES 24 LOR	7805D
R	6	CIRCUIT MONITOR DEVICE, 125VDC	E-MAX	RAW-1D	632A304
A	2	LAMP, INDICATING, 125VDC, COMPLETE W/LAMP, LENS & HOLDER, AMBER	GECO	ET-16	116B6708G43A73A4
G	1	LAMP, INDICATING, 125VDC, COMPLETE W/LAMP, LENS & HOLDER, GREEN	GECO	ET-16	116B6708G43G73G4
R1, R2	2	LAMP, INDICATING, 125VDC, COMPLETE W/LAMP, LENS & HOLDER, RED	GECO	ET-16	116B6708G43R73R4

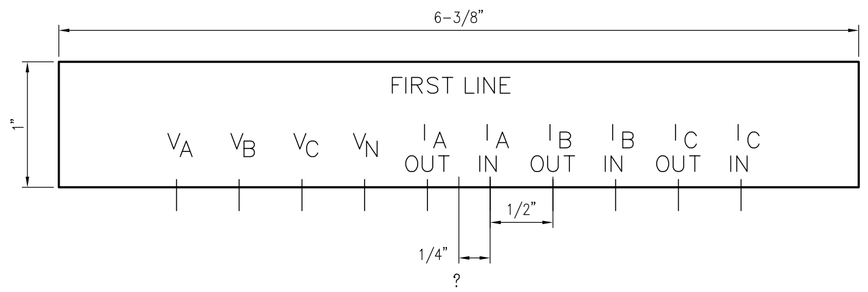
NAME-PLATE NO.	NAMEPLATE SIZE W x L	LETTER SIZE	FIRST LINE	SECOND LINE	THIRD LINE
1	1-1/2" x 6"	3/16"	WISHEK 230KV LINE	CB 5185	PANEL 3F
2	1" x 3"	1/8"	74DC-21AW		
3	1" x 3"	1/8"	74DC-21BW		
4	1" x 3"	1/8"	21AW-WISHEK	PRIMARY RELAYING	
5	1" x 3"	1/8"	21BW-WISHEK	SECONDARY RELAYING	
6	1" x 3"	1/8"	CB 5185 SUPERVISORY	CONTROL-OFF	
7	1" x 3"	1/8"	CB 5185	TRIPPED-CLOSED	
8	1" x 3"	1/8"	CB 5185 RECLOSER	CONTROL-OFF	
9	1" x 3"	1/8"	43L/S-5185	CONTROL SWITCH	
10	1" x 3"	1/8"	52CSR-5185	CONTROL SWITCH	
11	1" x 3"	1/8"	79LSR-5185	CONTROL SWITCH	
12	1" x 3"	1/8"	74DC-CC	CB 5185	
13	1" x 3"	1/8"	74DC-TC1	CB 5185	
14	1" x 3"	1/8"	74DC-TC2	CB 5185	
15	1" x 3"	1/8"	74DC-BF3	CB 5185	
16	1" x 6-3/8"	1/8"	86BF3-CONTROL TS10	(SEE DETAIL TS10)	
17	1" x 3"	1/8"	86BF3-5185	LOCKOUT RELAY	
18	1" x 3"	1/8"	50/62BF3	CB 5185	
19	1" x 6-3/8"	1/8"	50/62BF3-CONTROL & CURRENT TS11	(SEE DETAIL TS11)	
20	1" x 6-3/8"	1/8"	21AW-VOLTAGE & CURRENT TS1	(SEE DETAIL TS1)	
21	1" x 6-3/8"	1/8"	21AW-CURRENT TS2	(SEE DETAIL TS2)	
22	1" x 6-3/8"	1/8"	21AW & 21BW SYNC VOLTAGE TS3	(SEE DETAIL TS3)	
23	1" x 6-3/8"	1/8"	21AW-CONTROL TS4	(SEE DETAIL TS4)	
24	1" x 6-3/8"	1/8"	21AW-CONTROL TS5	(SEE DETAIL TS5)	
25	1" x 6-3/8"	1/8"	21AW-CONTROL TS6	(SEE DETAIL TS6)	
26	1" x 6-3/8"	1/8"	21BW-VOLTAGE & CURRENT TS7	(SEE DETAIL TS7)	
27	1" x 6-3/8"	1/8"	21BW-CONTROL TS8	(SEE DETAIL TS8)	
28	1" x 6-3/8"	1/8"	21BW-CONTROL TS9	(SEE DETAIL TS9)	

PANEL 3F

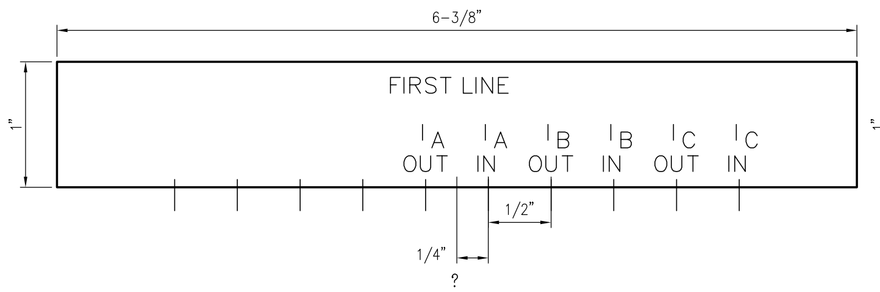


FRONT VIEW

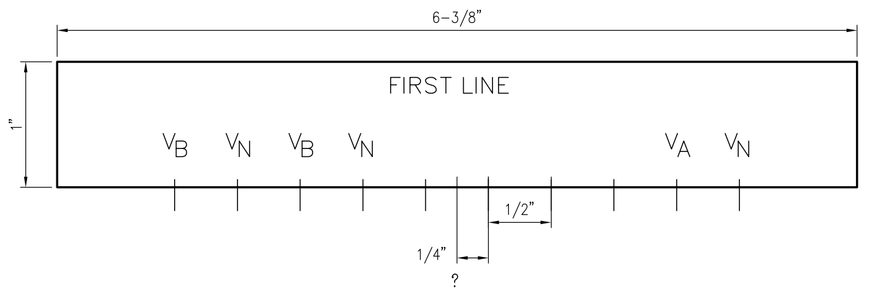
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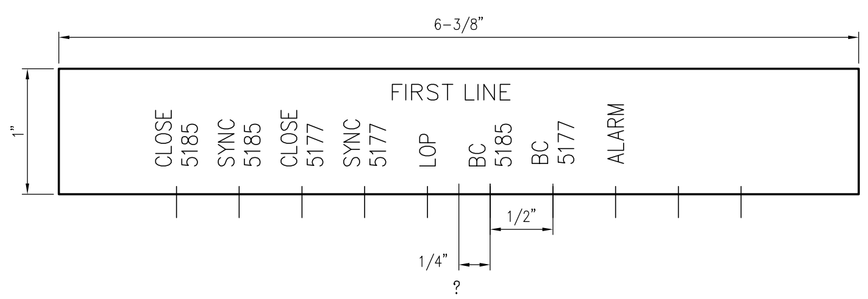
DETAIL TS1



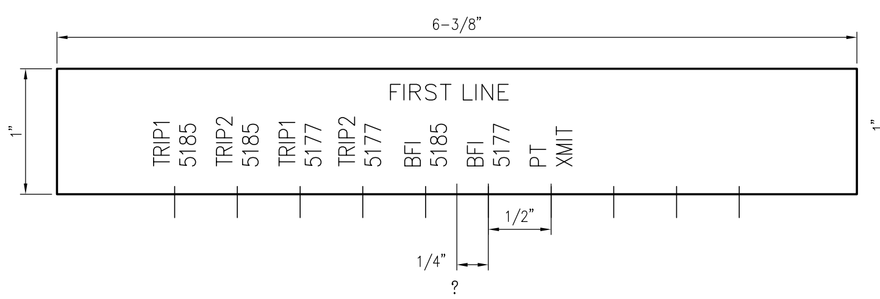
DETAIL TS2



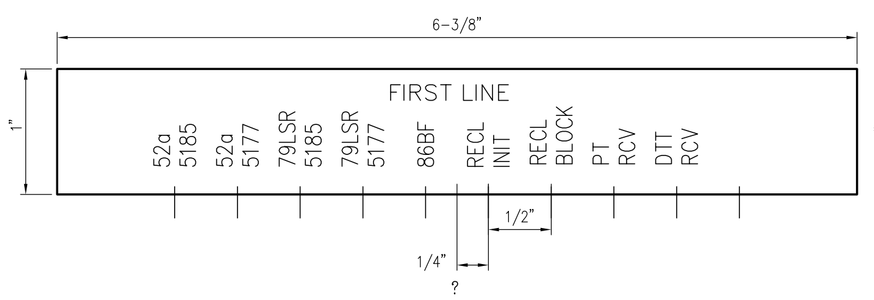
DETAIL TS3



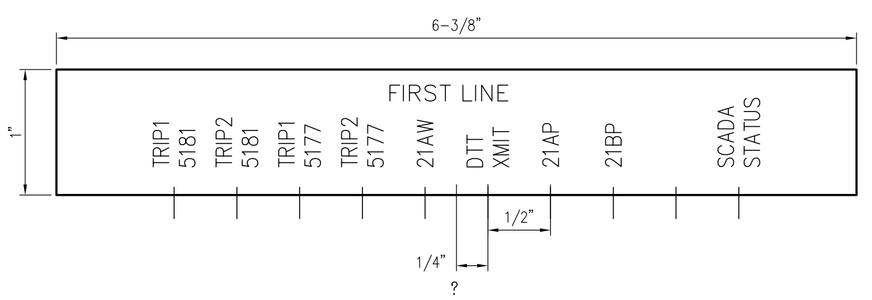
DETAIL TS4



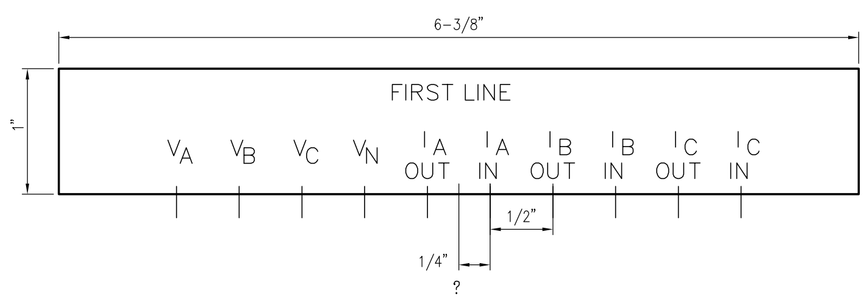
DETAIL TS5



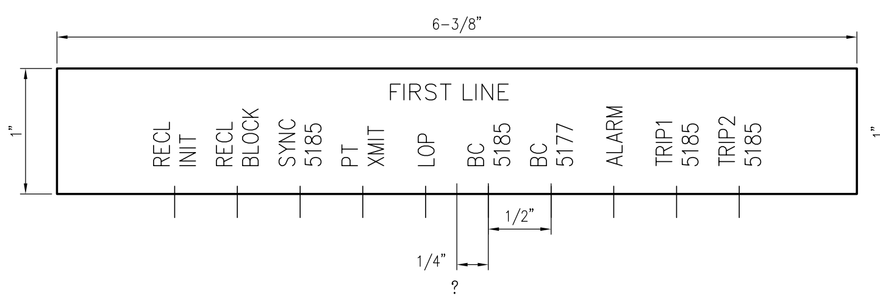
DETAIL TS6



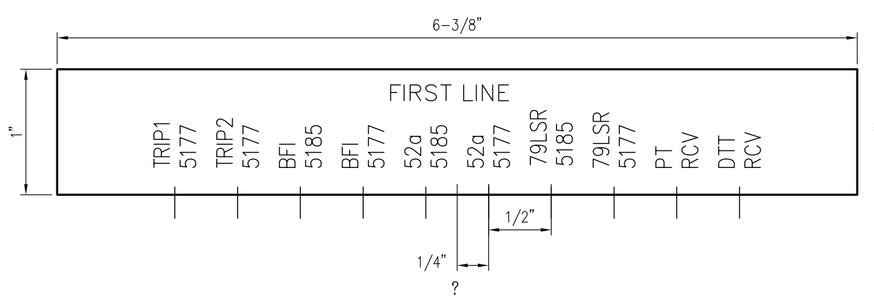
DETAIL TS10



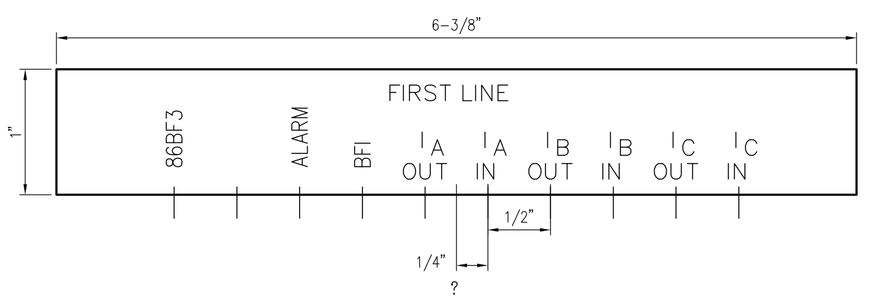
DETAIL TS7



DETAIL TS8



DETAIL TS9



DETAIL TS11

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
PANEL 3F LAYOUT,
MATERIAL LIST & NAMEPLATE SCHEDULE

0 1" 2"

FILENAME	TWEND-PL-03.DWG
SCALE	NONE

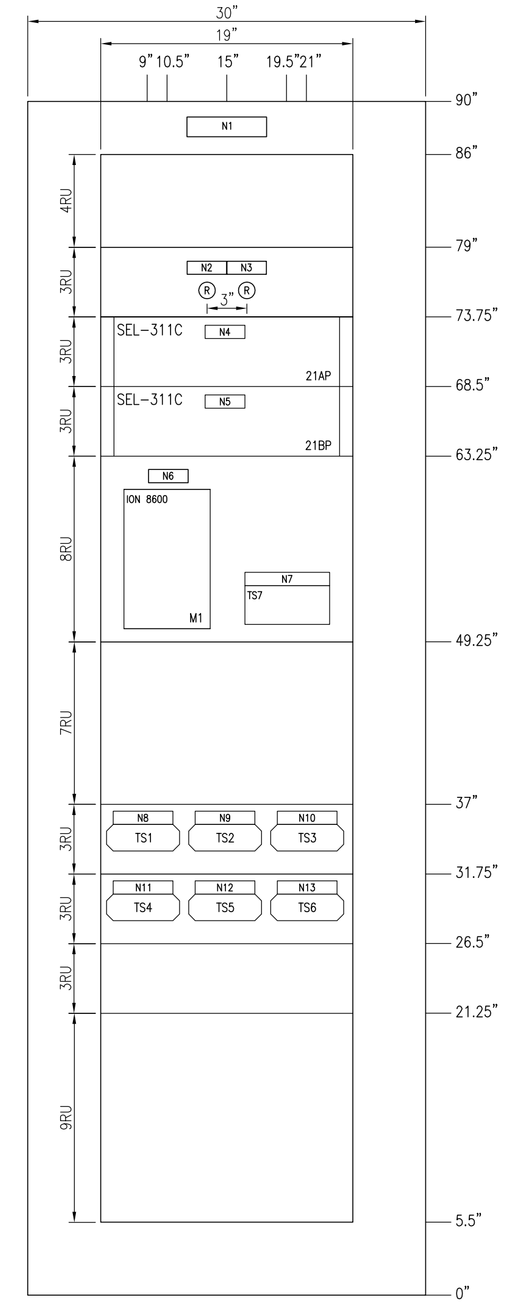
SHEET **PL-03**

BILL OF MATERIALS

ITEM NO.	QTY	DESCRIPTION	MANUFACTURER	STYLE/TYPE	CATALOG NO.
21AP	1	RELAY, LINE PROTECTION, 125VDC, 5A, 60HZ, 19" RACK MOUNT	SCHWEITZER	SEL-311C	0311C01H232545X
21BP	1	RELAY, LINE PROTECTION, 125VDC, 5A, 60HZ, 19" RACK MOUNT	SCHWEITZER	SEL-311C	0311C01H232545X
M1	1	METER, PML ION 8600 ADVANCED REVENUE METER, FORM 9 FT21 SWITCHBOARD METER, 125VDC, 1A, 60HZ	POWER MEASUREMENT	ION 8600	S8600A4E0H6E0B0B
TS1,TS2,TS3	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, TS1 (4P,6C), TS2, TS3 (10P)	ABB	FT-19R	FR3G119001001
TS4,TS5,TS6	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, TS4 (4P,6C), TS5, TS6 (10P)	ABB	FT-19R	FR3G119001001
TS7	1	FT-1 TEST SWITCH, 10 POLE, (4P,6C)	ABB	FT-1	1586C42G05
R	2	CIRCUIT MONITOR DEVICE, 125VDC	E-MAX	RAW-1D	632A304

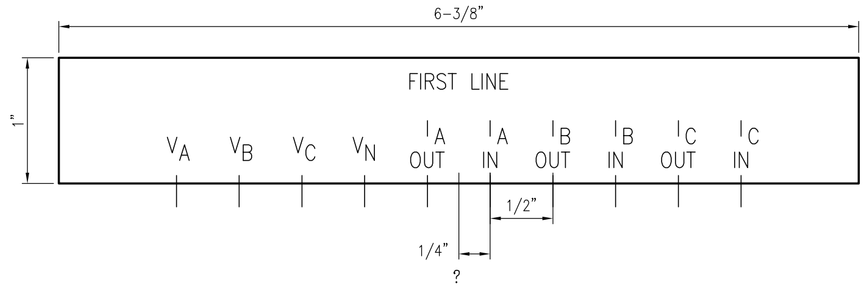
NAME-PLATE NO.	NAMEPLATE SIZE W x L	LETTER SIZE	FIRST LINE	SECOND LINE	THIRD LINE
1	1-1/2" x 6"	3/16"	PROJECT 230KV LINE		PANEL 4F
2	1" x 3"	1/8"	74DC-21AP		
3	1" x 3"	1/8"	74DC-21BP		
4	1" x 3"	1/8"	21AP-PROJECT	PRIMARY RELAYING	
5	1" x 3"	1/8"	21BP-PROJECT	SECONDARY RELAYING	
6	1" x 3"	1/8"	PROJECT 230KV	REVENUE METER	
7	1" x 6-3/8"	1/8"	M1-VOLTAGE & CURRENT TS7	(SEE DETAIL TS7)	
8	1" x 6-3/8"	1/8"	21AP-VOLTAGE & CURRENT TS1	(SEE DETAIL TS1)	
9	1" x 6-3/8"	1/8"	21AP-CONTROL TS2	(SEE DETAIL TS2)	
10	1" x 6-3/8"	1/8"	21AP-CONTROL TS3	(SEE DETAIL TS3)	
11	1" x 6-3/8"	1/8"	21BP-VOLTAGE & CURRENT TS4	(SEE DETAIL TS4)	
12	1" x 6-3/8"	1/8"	21BP-CONTROL TS5	(SEE DETAIL TS5)	
13	1" x 6-3/8"	1/8"	21BP-CONTROL TS6	(SEE DETAIL TS6)	

PANEL 4F

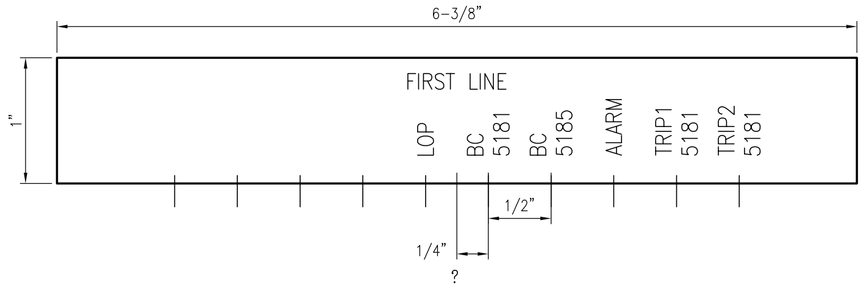


FRONT VIEW

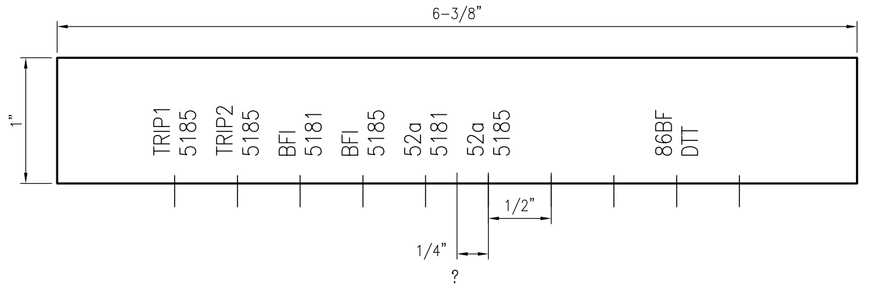
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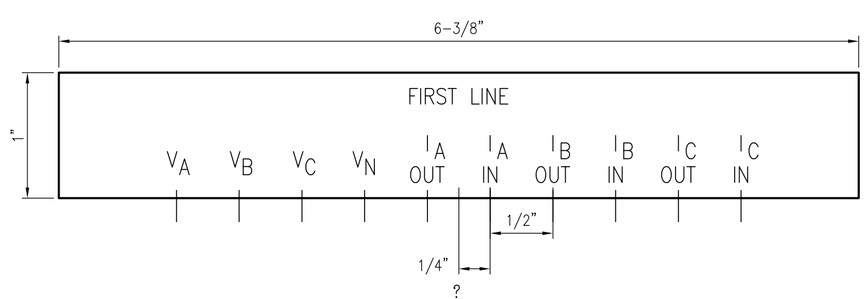
DETAIL TS1



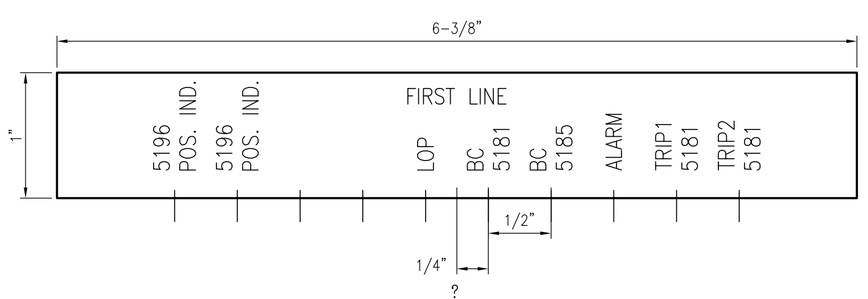
DETAIL TS2



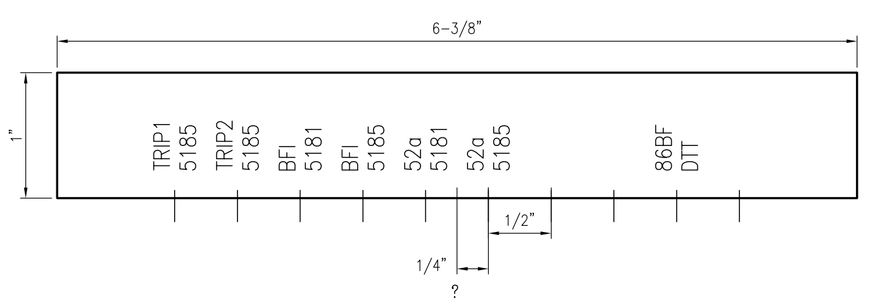
DETAIL TS3



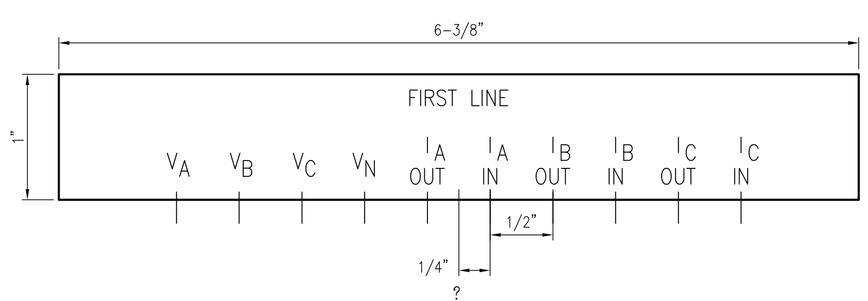
DETAIL TS4



DETAIL TS5



DETAIL TS6



DETAIL TS7

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48069

acciona

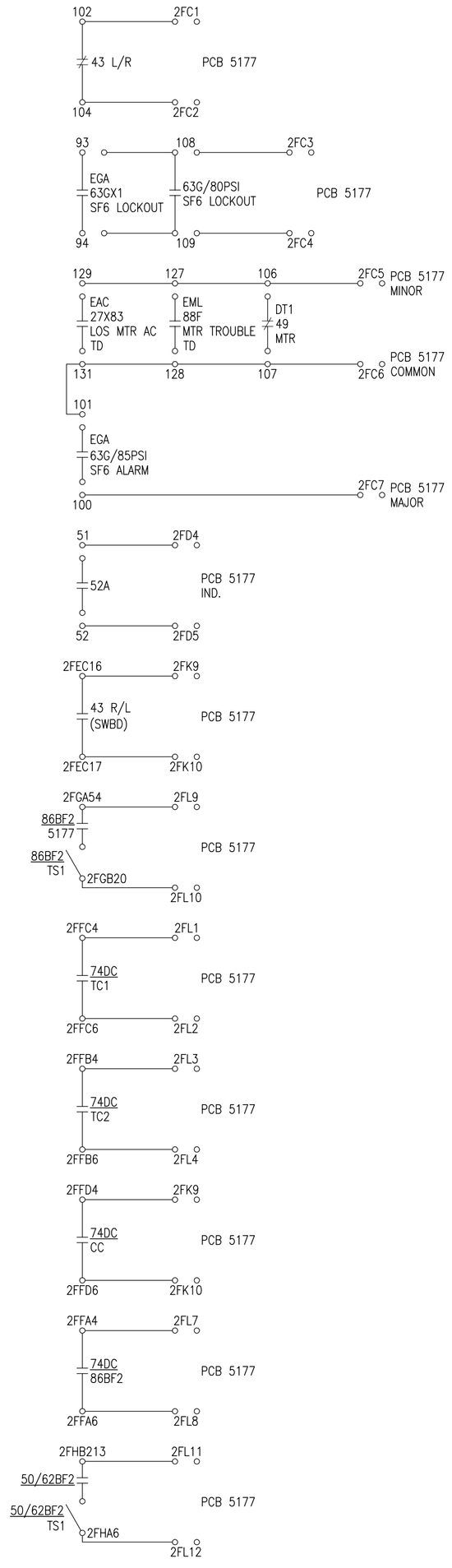
TATANKA WIND ENERGY

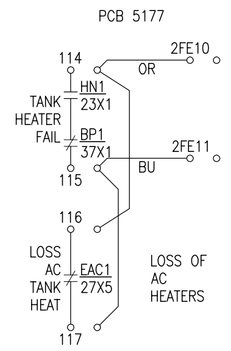
230kV INTERCONNECT SUBSTATION
PANEL 4F LAYOUT,
MATERIAL LIST & NAMEPLATE SCHEDULE

0 1" 2"

FILENAME	TWEND-PL-04.DWG
SCALE	NONE

SHEET **PL-04**





	07-07-08	AS BUILT
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

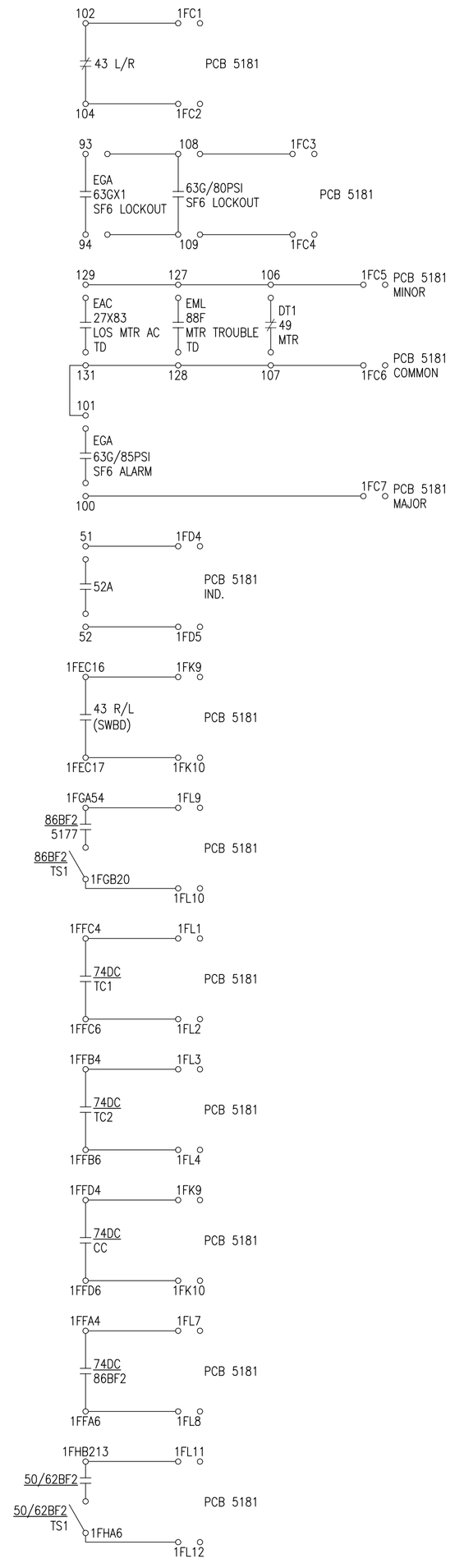
230kV INTERCONNECT SUBSTATION SCADA ALARM

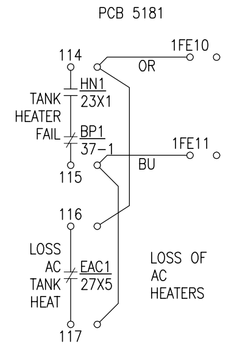
0 1" 2"

FILENAME	TWEND-SA-01
SCALE	NONE

SHEET

SA-01





PROJECT MANAGER	WEB	
PROJECT NUMBER	48069	

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT

MORTENSON

HDR Engineering, Inc.

acciona

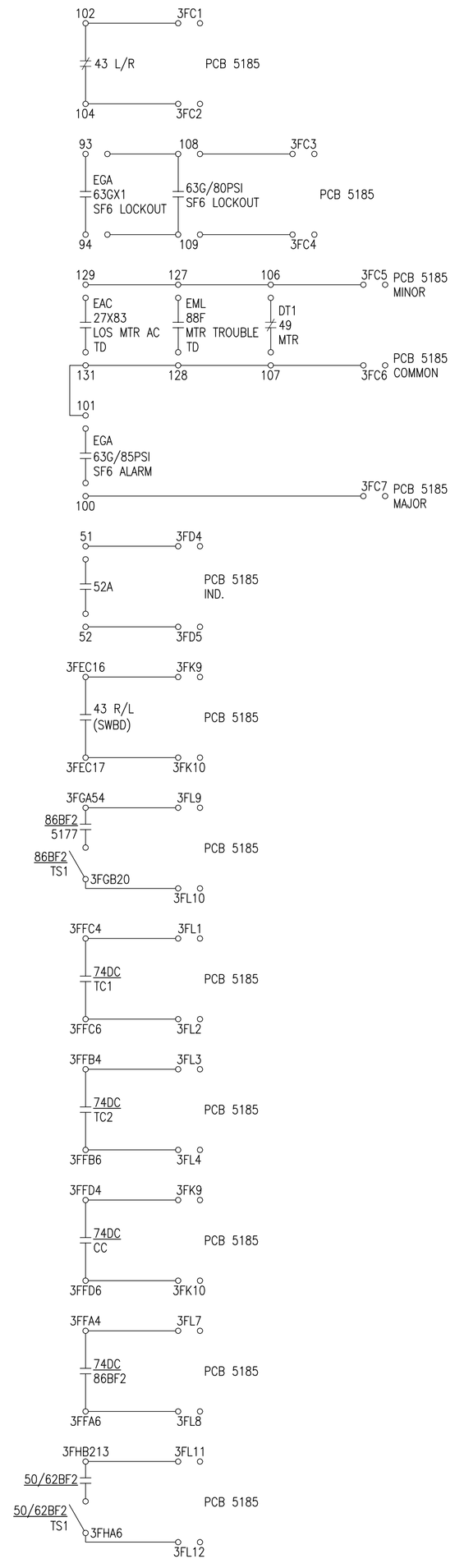
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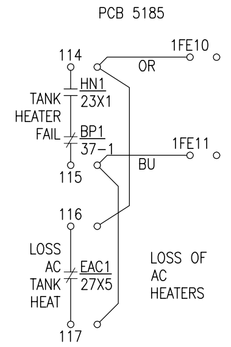
230kV INTERCONNECT SUBSTATION SCADA ALARM

0 1" 2"

FILENAME	TWEND-SA-02
SCALE	NONE

SHEET SA-02





	07-07-08	AS BUILT
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

acciona

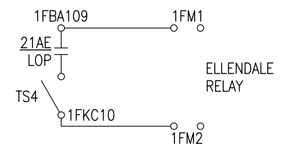
TATANKA WIND ENERGY

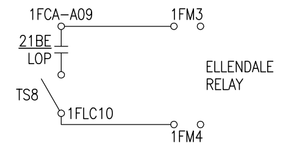
230kV INTERCONNECT SUBSTATION SCADA ALARM

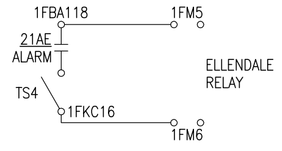
0 1" 2"

FILENAME	TWEND-SA-03
SCALE	NONE

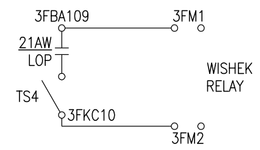
SHEET
SA-03

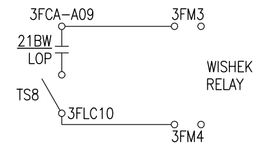


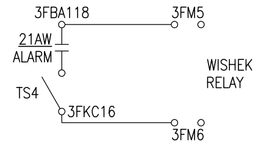


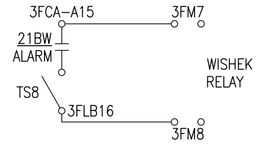




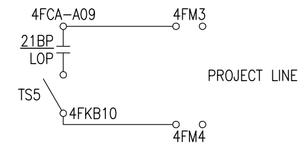




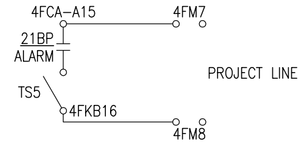


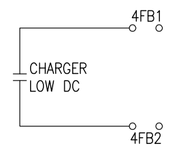


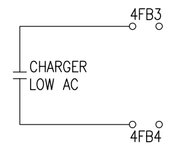


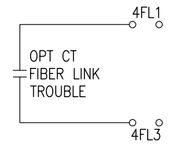


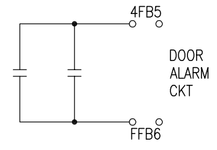


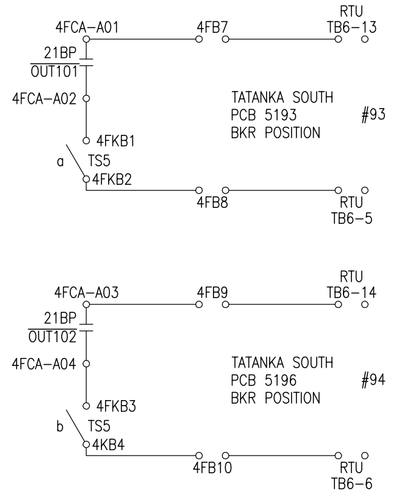












MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

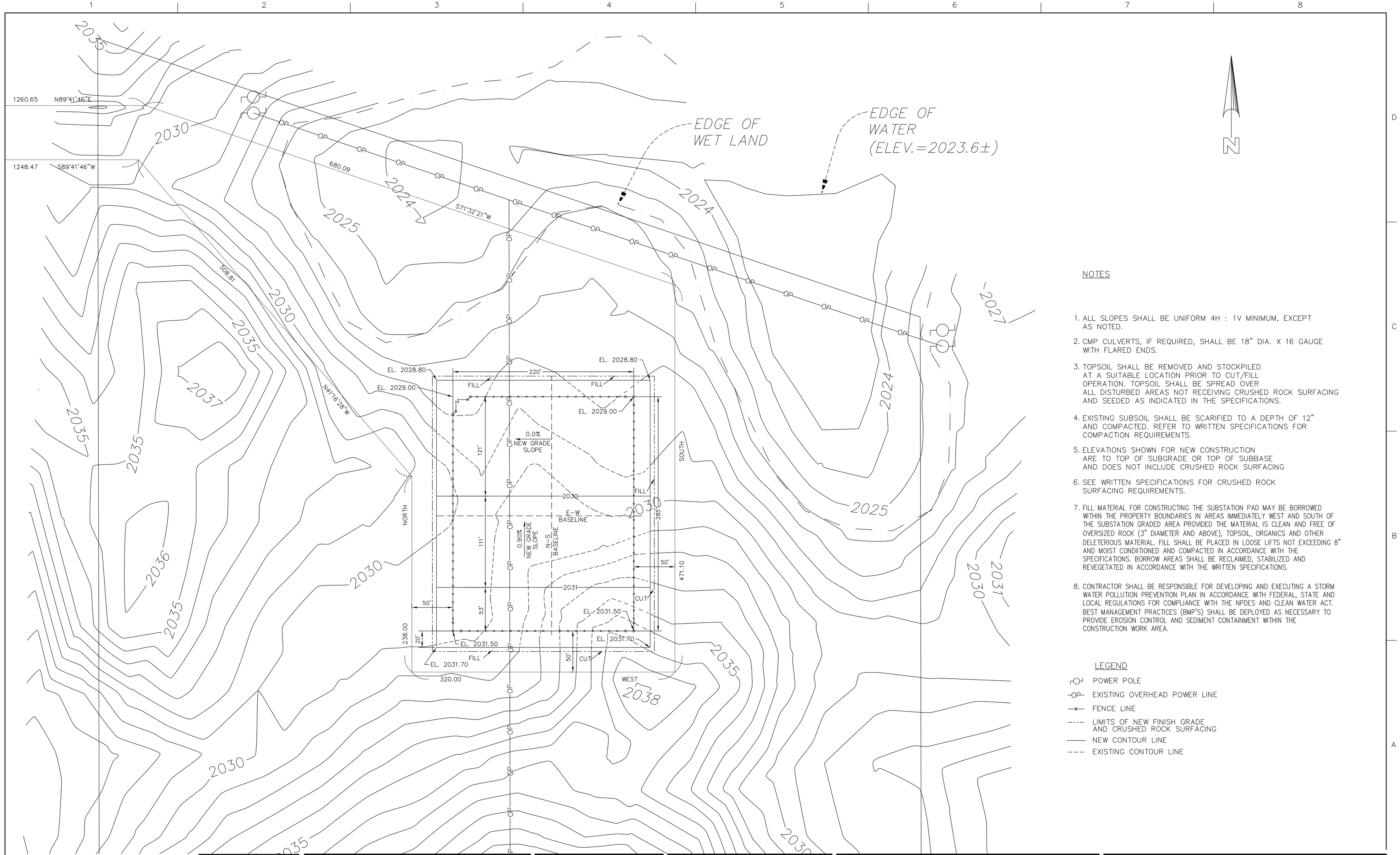
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
SCADA ALARM

0 1" 2"

FILENAME	TWEND–SA–04
SCALE	NONE

SHEET **SA-04**



NOTES

1. ALL SLOPES SHALL BE UNIFORM 4H : 1V MINIMUM, EXCEPT AS NOTED.
2. CMP CULVERTS, IF REQUIRED, SHALL BE 18" DIA. X 16 GAUGE WITH FLARED ENDS.
3. TOPSOIL SHALL BE REMOVED AND STOCKPILED AT A SUITABLE LOCATION PRIOR TO CUT/FILL OPERATION. TOPSOIL SHALL BE SPREAD OVER ALL DISTURBED AREAS NOT RECEIVING CRUSHED ROCK SURFACING AND SEEDED AS INDICATED IN THE SPECIFICATIONS.
4. EXISTING SUBSOIL SHALL BE SCARIFIED TO A DEPTH OF 12" AND COMPACTED. REFER TO WRITTEN SPECIFICATIONS FOR COMPACTION REQUIREMENTS.
5. ELEVATIONS SHOWN FOR NEW CONSTRUCTION ARE TO TOP OF SUBGRADE OR TOP OF SUBBASE AND DOES NOT INCLUDE CRUSHED ROCK SURFACING
6. SEE WRITTEN SPECIFICATIONS FOR CRUSHED ROCK SURFACING REQUIREMENTS.
7. FILL MATERIAL FOR CONSTRUCTING THE SUBSTATION PAD MAY BE BORROWED WITHIN THE PROPERTY BOUNDARIES IN AREAS IMMEDIATELY WEST AND SOUTH OF THE SUBSTATION GRADED AREA PROVIDED THE MATERIAL IS CLEAN AND FREE OF OVERSIZED ROCK (3" DIAMETER AND ABOVE), TOPSOIL, ORGANICS AND OTHER DELETERIOUS MATERIAL. FILL SHALL BE PLACED IN LOOSE LIFTS NOT EXCEEDING 8" AND MOIST CONDIITIONED AND COMPACTED IN ACCORDANCE WITH THE SPECIFICATIONS. BORROW AREAS SHALL BE RECLAIMED, STABILIZED AND REVEGETATED IN ACCORDANCE WITH THE WRITTEN SPECIFICATIONS.
8. CONTRACTOR SHALL BE RESPONSIBLE FOR DEVELOPING AND EXECUTING A STORM WATER POLLUTION PREVENTION PLAN IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS FOR COMPLIANCE WITH THE NPDES AND CLEAN WATER ACT. BEST MANAGEMENT PRACTICES (BMP'S) SHALL BE DEPLOYED AS NECESSARY TO PROVIDE EROSION CONTROL AND SEDIMENT CONTAINMENT WITHIN THE CONSTRUCTION WORK AREA.

LEGEND

- POWER POLE
- EXISTING OVERHEAD POWER LINE
- FENCE LINE
- LIMITS OF NEW FINISH GRADE AND CRUSHED ROCK SURFACING
- NEW CONTOUR LINE
- EXISTING CONTOUR LINE

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
1	05-21-07	ADDED SITE SURVEY
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RLB
PROJECT NUMBER	48069

acciona

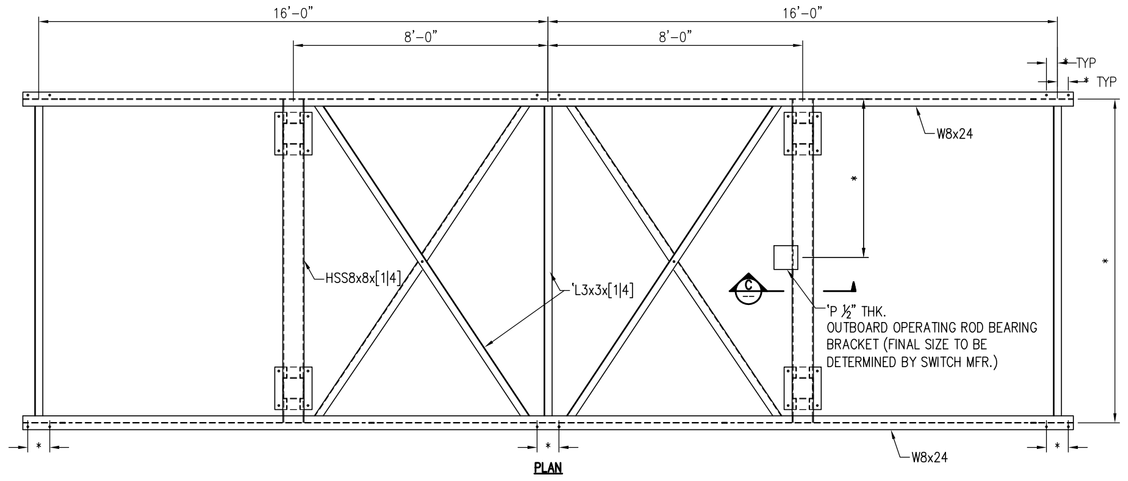
TATANKA WIND ENERGY

230KV INTERCONNECT SUBSTATION SITE - GRADING PLAN

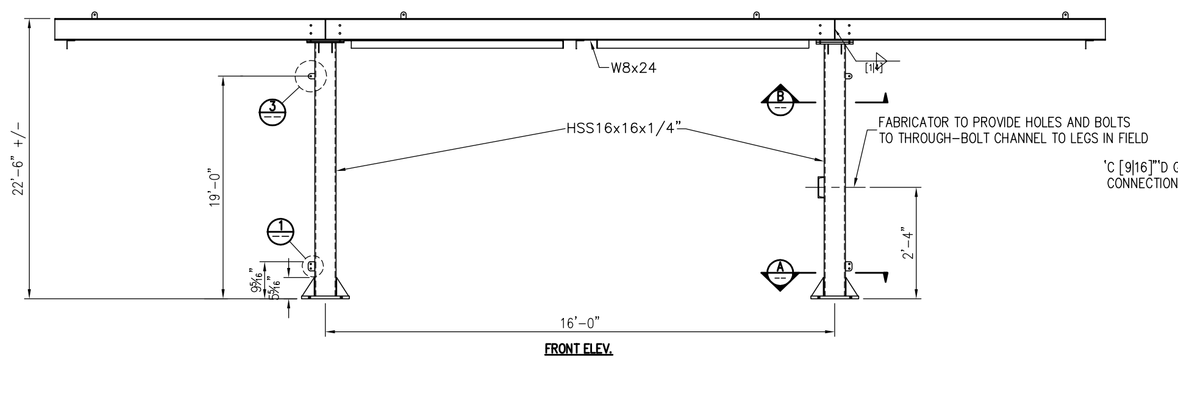
0 1" 2"

FILENAME	TWEND-SG-01
SCALE	1:50

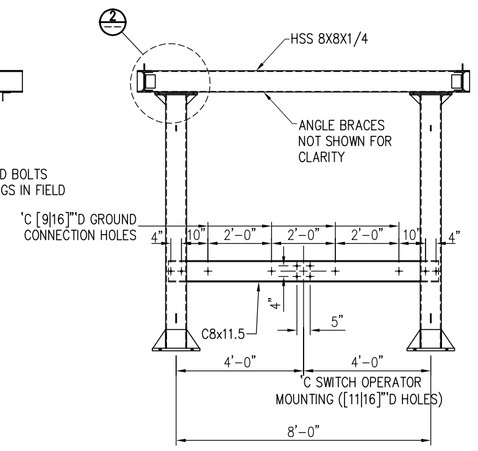
SHEET SG-01



PLAN



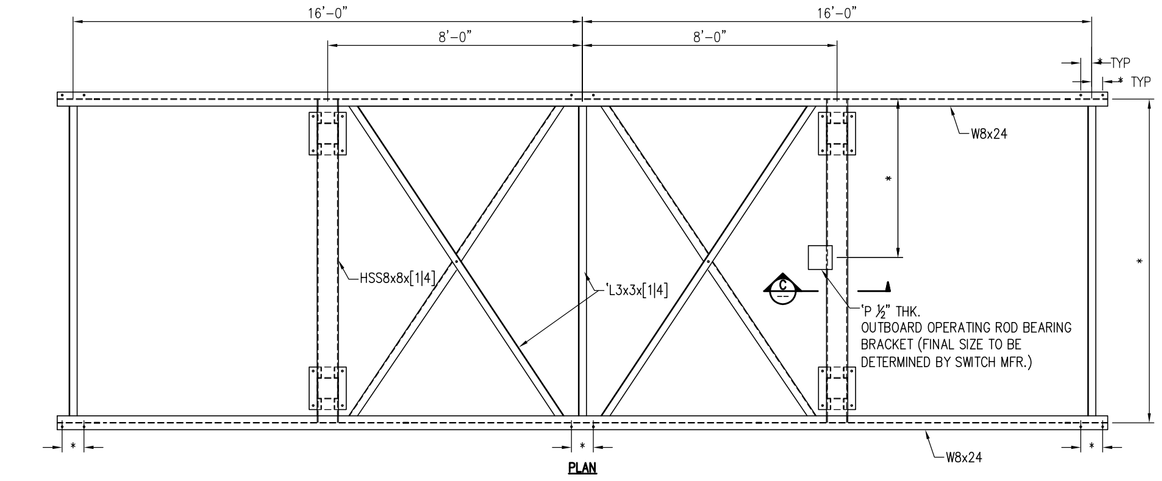
FRONT ELEV.



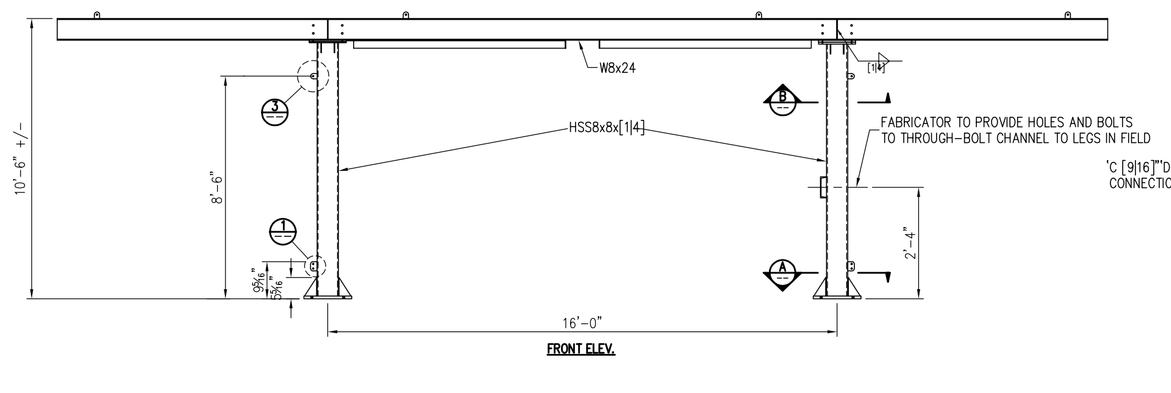
SIDE ELEV.

230kV SWITCH STAND – 230SS1 (4 REQ'D) GA01

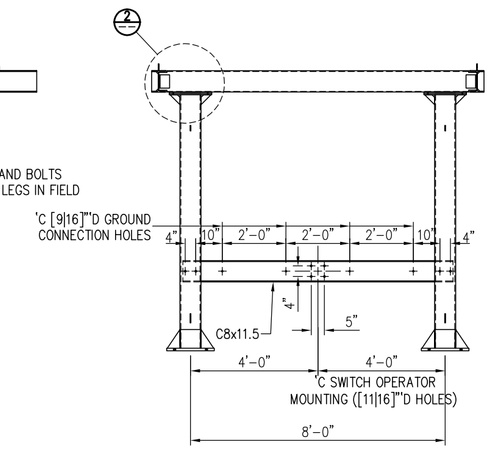
N.T.S.



PLAN



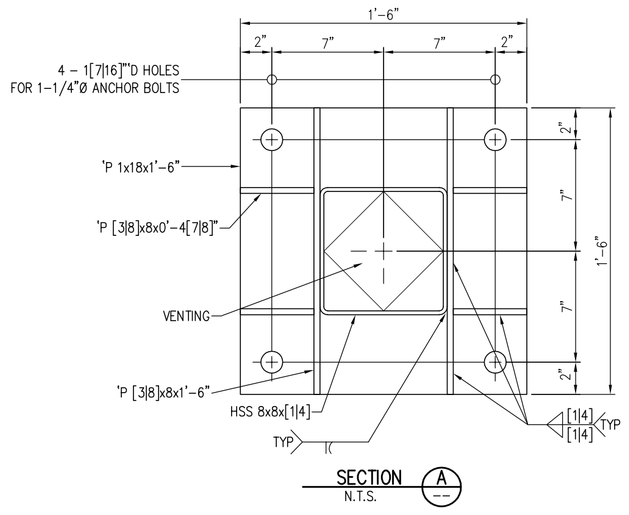
FRONT ELEV.



SIDE ELEV.

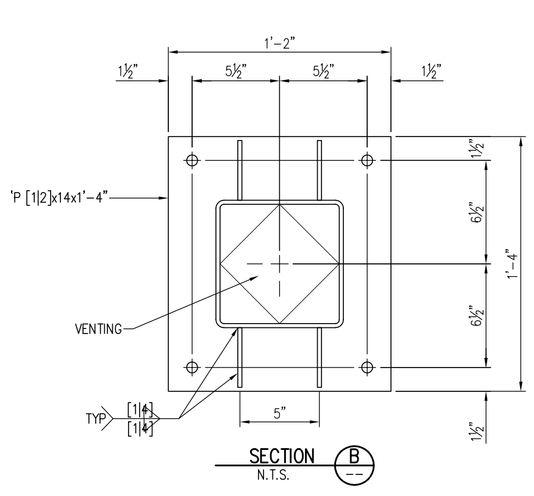
230kV SWITCH STAND – 230SS2 (3 REQ'D) GA01

N.T.S.



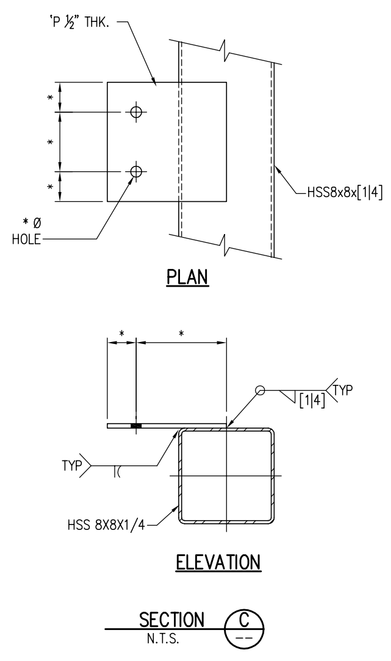
SECTION A

N.T.S.



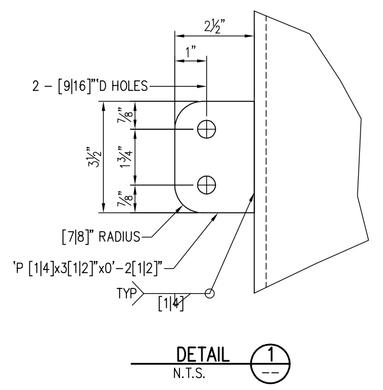
SECTION B

N.T.S.



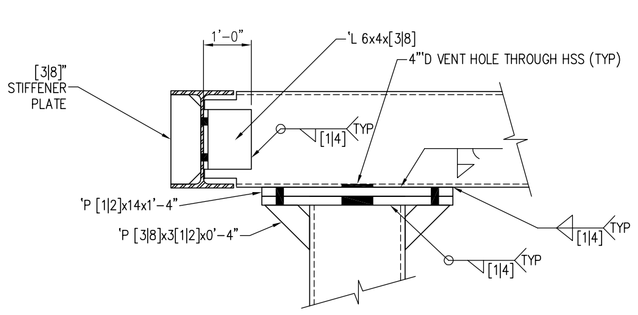
SECTION C

N.T.S.



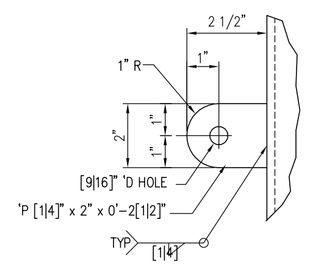
DETAIL 1

N.T.S.



DETAIL 2

N.T.S.



DETAIL 3

N.T.S.

NOTES:

1. ALL STRUCTURE MOUNTING HOLES ARE 11/16" DIA. FOR A325 5/8" DIA. BOLTS UNLESS OTHERWISE NOTED.
2. ALL MEMBERS TO BE HOT DIPPED GALVANIZED.
3. PLATES, BARS, AND MISC SHAPES SHALL CONFORM TO ASTM A36 AMENDED TO DATE. WIDE FLANGE SHALL BE ASTM A992 AMENDED TO DATE. HSS SECTIONS SHALL BE ASTM A500 GR.B MINIMUM YIELD STRENGTH 46.0 KSI.

MORTENSON

HDR

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

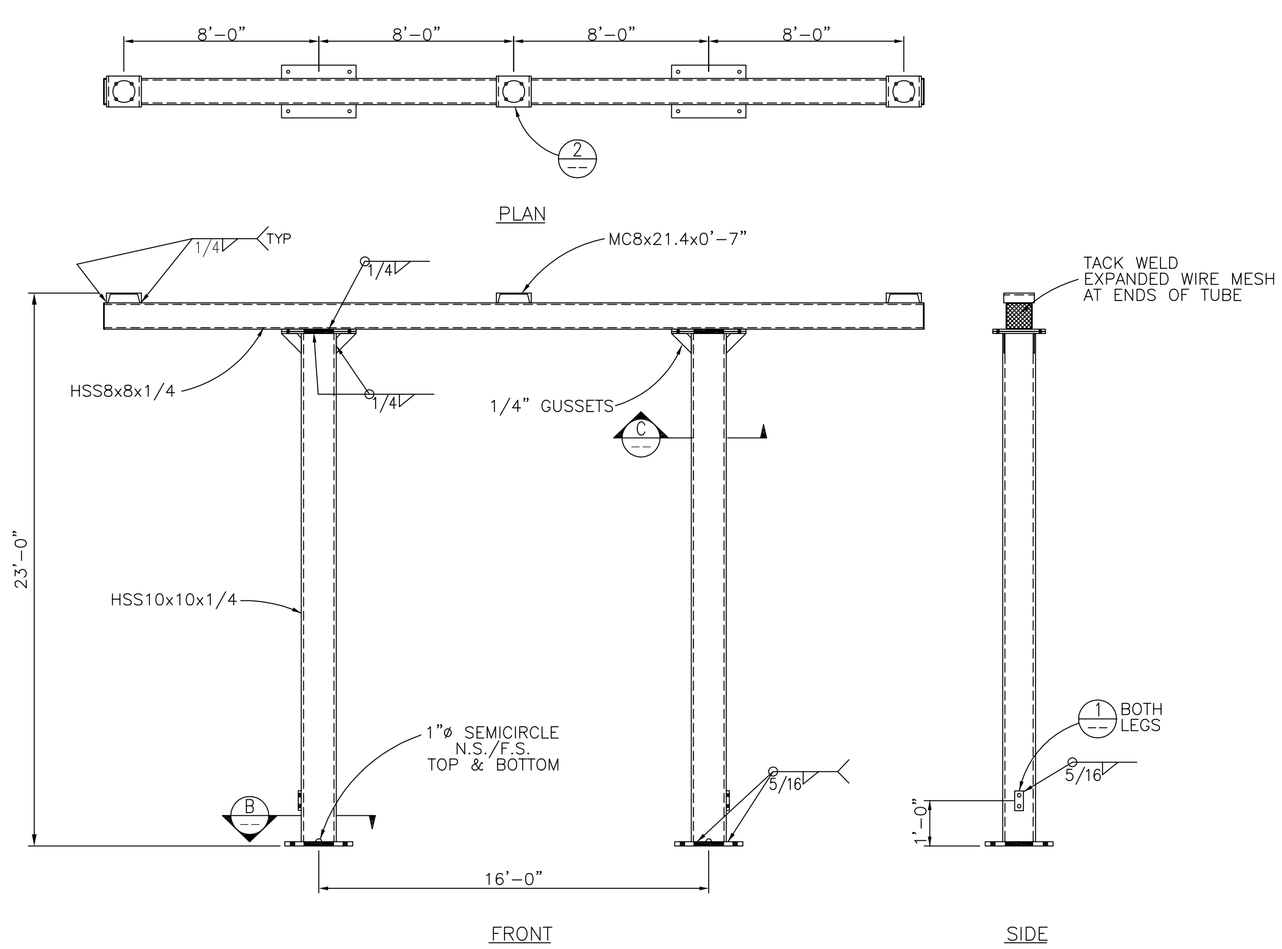
TATANKA WIND ENERGY

TATANKA 230kV INTERCONNECT SUBSTATION STRUCTURAL STEEL - SWITCH STANDS

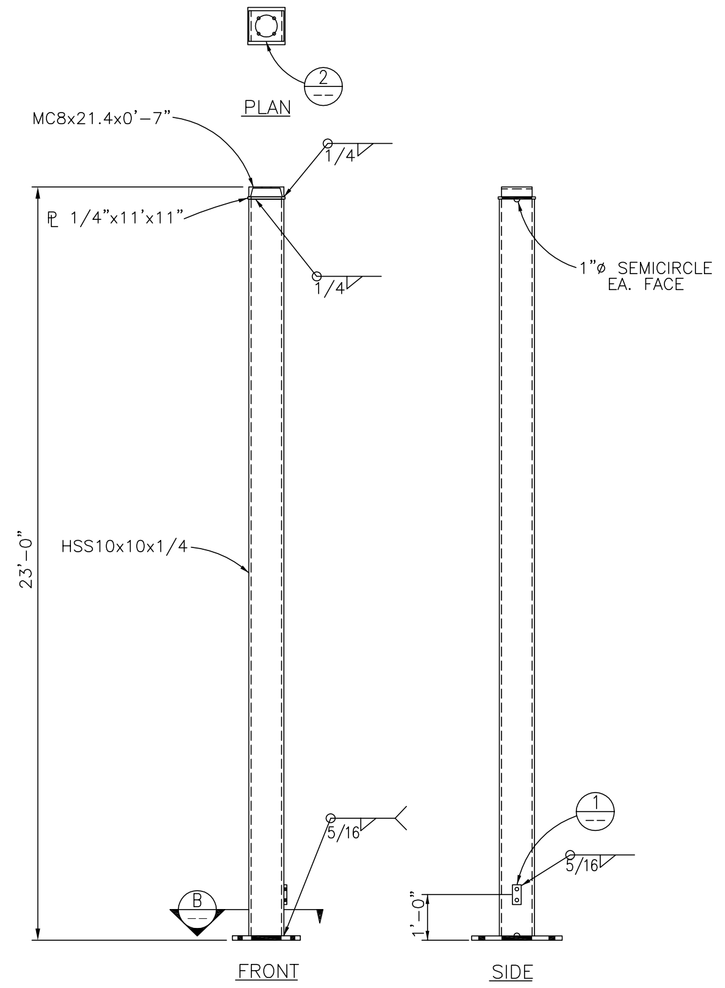
0 1" 2"

FILENAME	TWEND-SS-01
SCALE	NONE

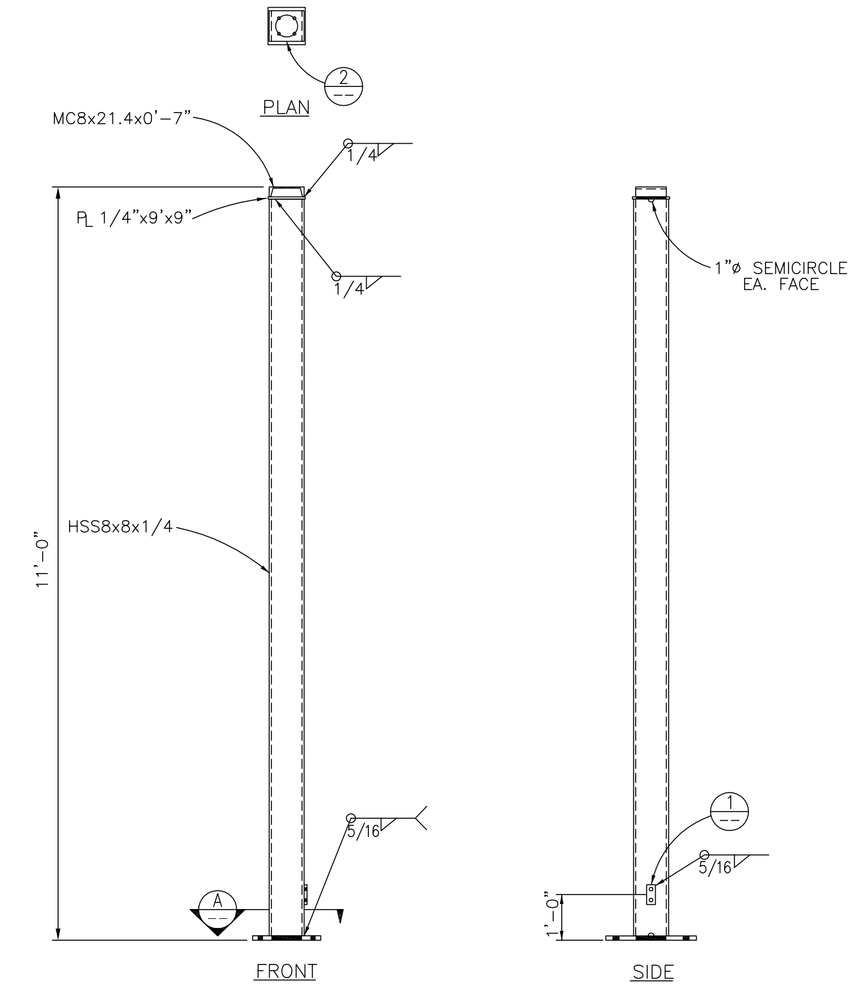
SHEET SS-01



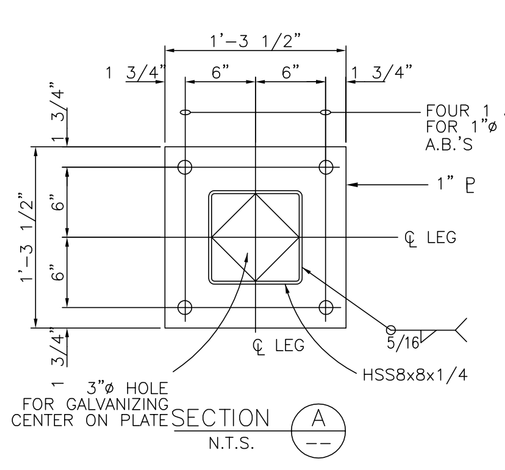
230kV BUS SUPPORT – 230BS1 (6 REQ'D) GA01
N.T.S.



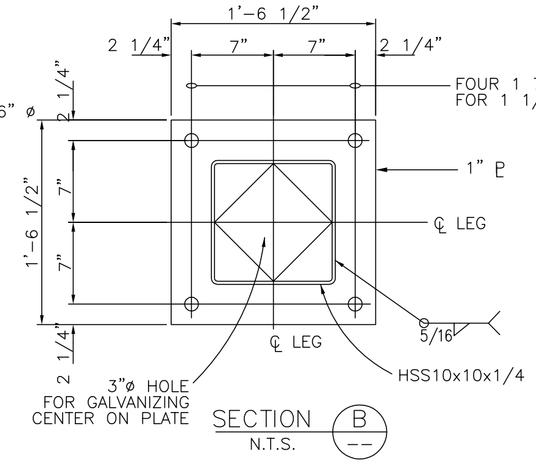
230kV BUS SUPPORT PEDESTAL – 230BS2 (3 REQ'D) GA01
N.T.S.



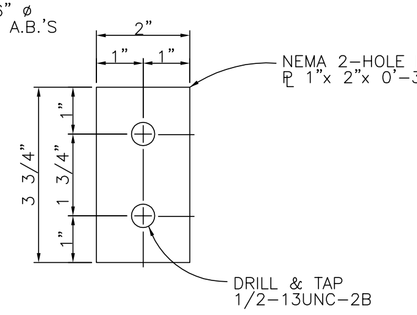
230kV BUS SUPPORT PEDESTAL – 230BS3 (20 REQ'D) GA01
N.T.S.



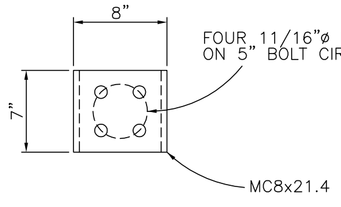
SECTION A
N.T.S.



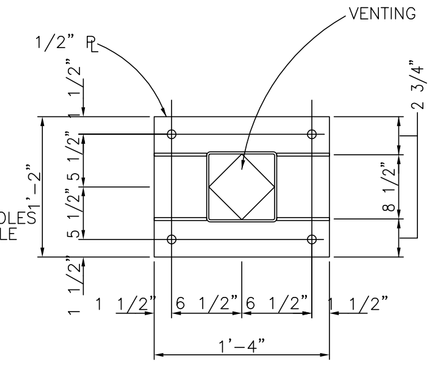
SECTION B
N.T.S.



DETAIL 1
N.T.S.



DETAIL 2
N.T.S.



SECTION C
N.T.S.

NOTES:

1. ALL STRUCTURE MOUNTING HOLES ARE 3/4" DIA. FOR A325 5/8" DIA. BOLTS UNLESS OTHERWISE NOTED.
2. ALL MEMBERS TO BE HOT DIPPED GALVANIZED.
3. PLATES, BARS, AND MISC SHAPES SHALL CONFORM TO ASTM A36 AMENDED TO DATE. WIDE FLANGE SHALL BE ASTM A992 AMENDED TO DATE. HSS SECTIONS SHALL BE ASTM A500 GR.B MINIMUM YIELD STRENGTH 46.0 KSI.

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

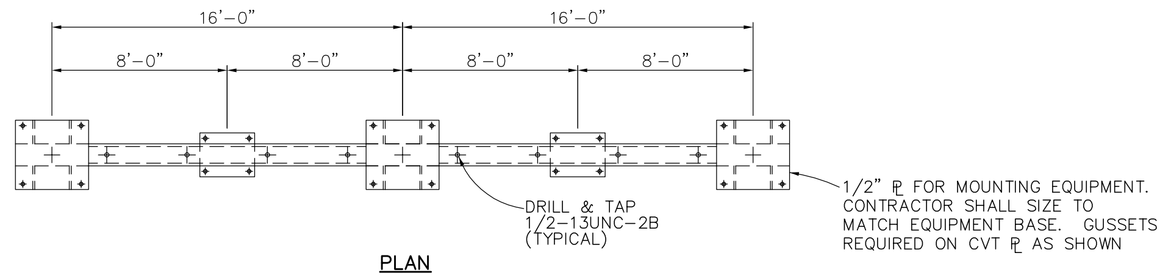
TATANKA WIND ENERGY

TATANKA 230kV INTERCONNECT SUBSTATION STRUCTURAL STEEL - BUS SUPPORTS

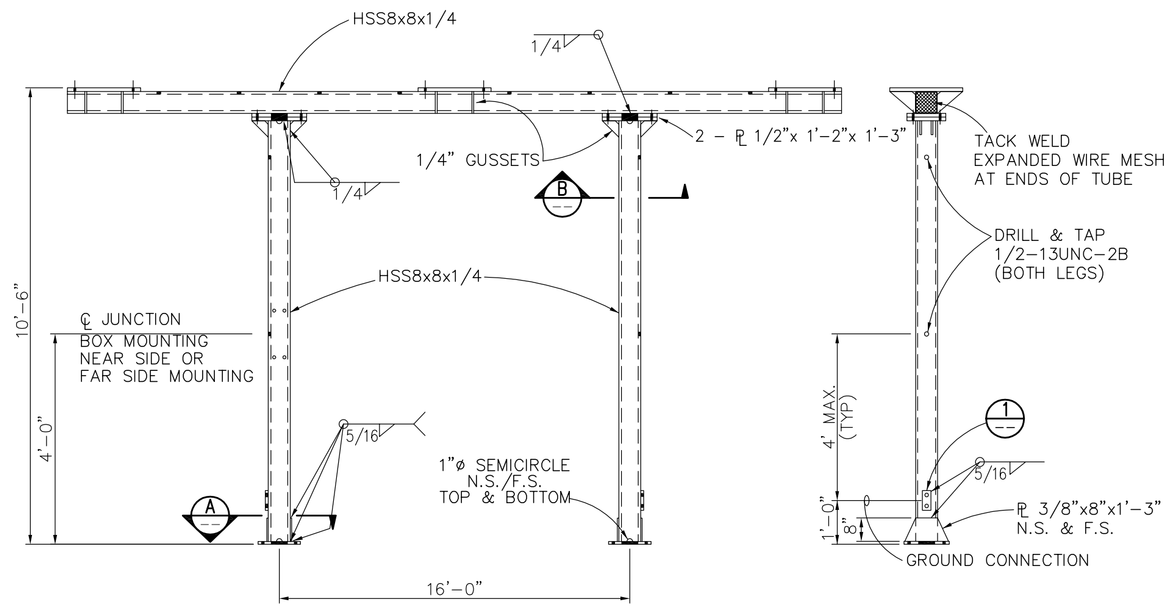
0 1" 2"

FILENAME	TWEND-SS-02
SCALE	NONE

SHEET SS-02

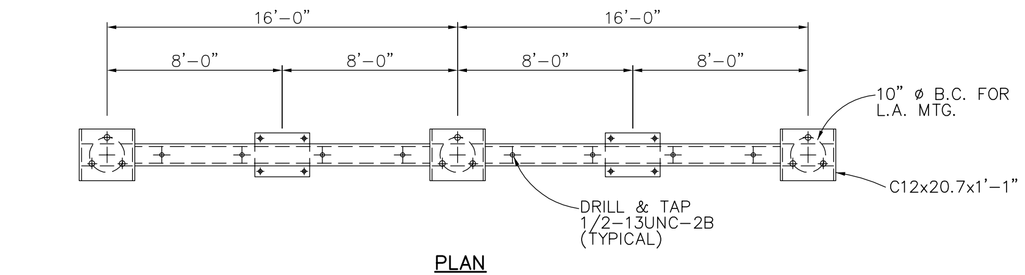


PLAN

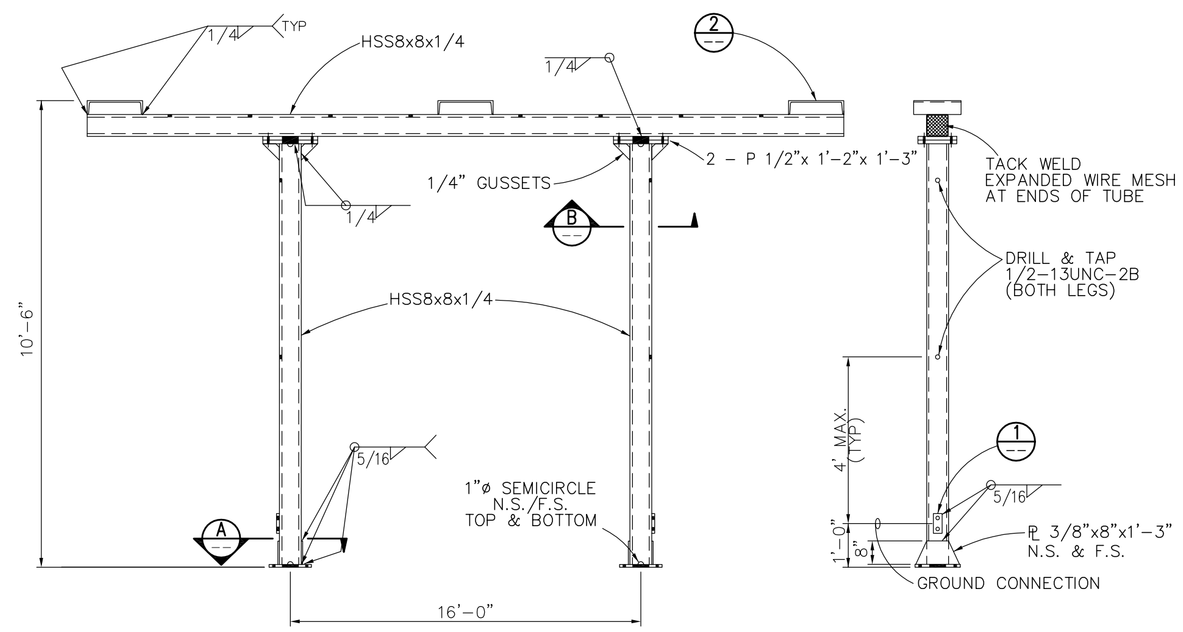


FRONT SIDE

230kV CVT/CT STAND – 230CVT (4 REQ'D)
N.T.S.

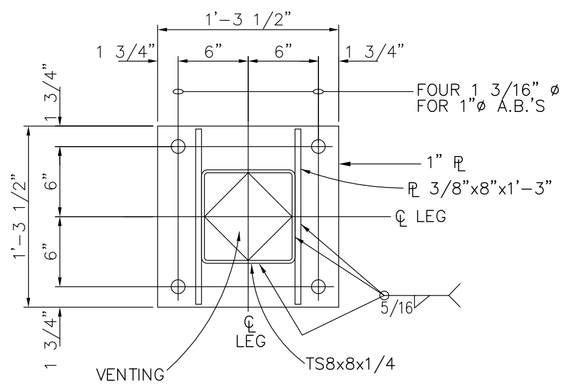


PLAN

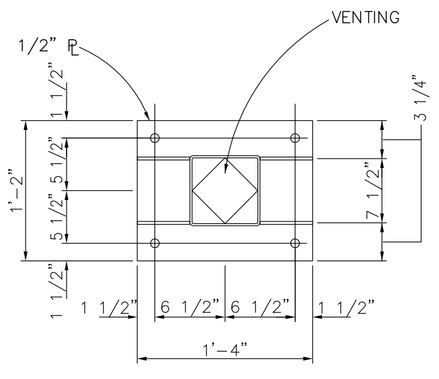


FRONT SIDE

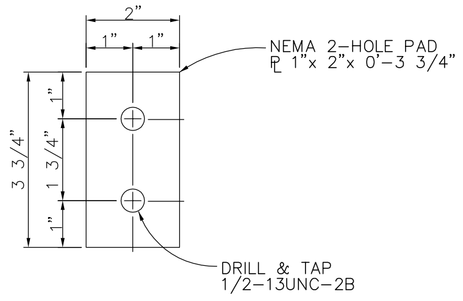
230kV LIGHTNING ARRESTER STAND – 230LA (3 REQ'D)
N.T.S.



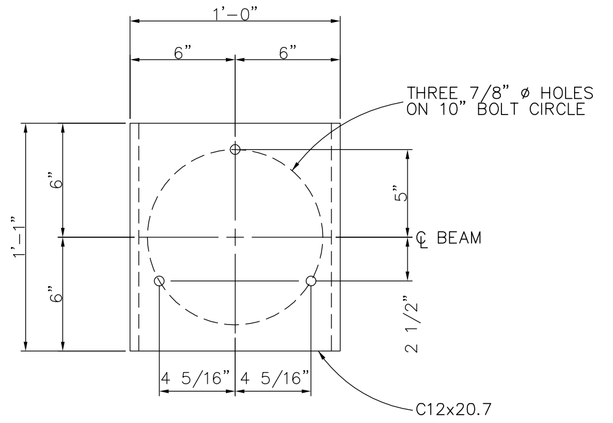
SECTION A
N.T.S.



SECTION B
N.T.S.



DETAIL 1
N.T.S.



DETAIL 2
N.T.S.

NOTES:

1. ALL STRUCTURE MOUNTING HOLES ARE 3/4" DIA. FOR A325 5/8" DIA. BOLTS UNLESS OTHERWISE NOTED.
2. ALL MEMBERS TO BE HOT DIPPED GALVANIZED.
3. PLATES, BARS, AND MISC SHAPES SHALL CONFORM TO ASTM A36 AMENDED TO DATE. WIDE FLANGE SHALL BE ASTM A992 AMENDED TO DATE. HSS SECTIONS SHALL BE ASTM A500 GR.B MINIMUM YIELD STRENGTH 46.0 KSI.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

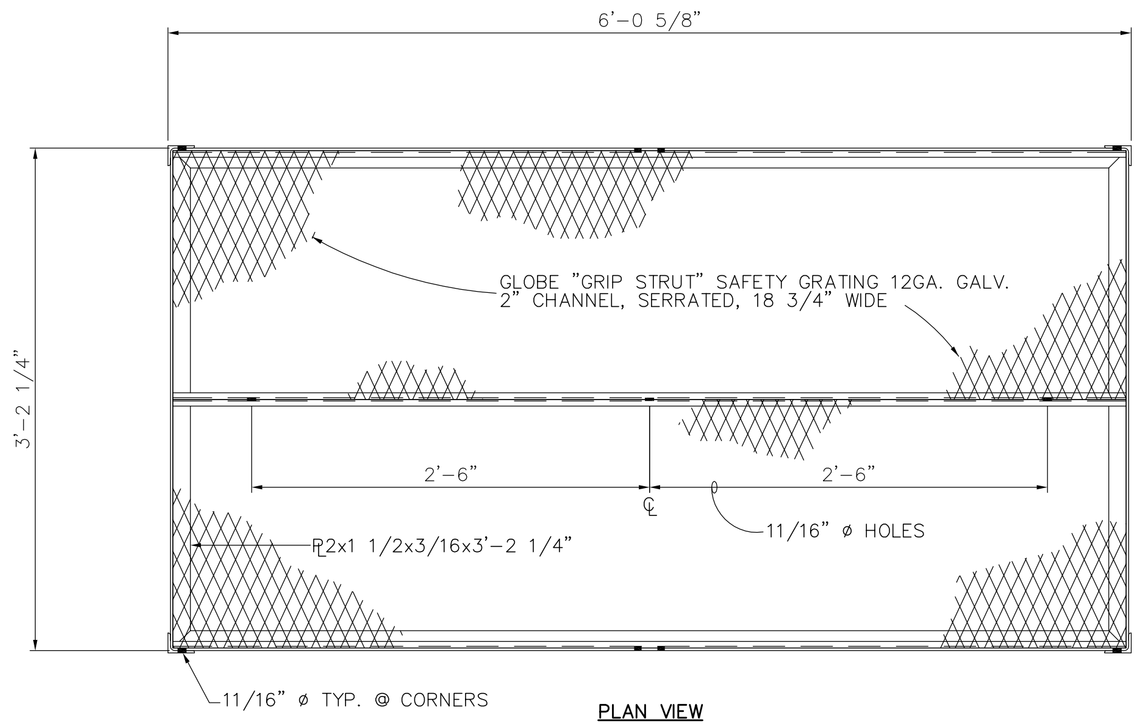
TATANKA WIND ENERGY

TATANKA 230kV INTERCONNECT SUBSTATION STRUCTURAL STEEL - EQUIPMENT SUPPORTS

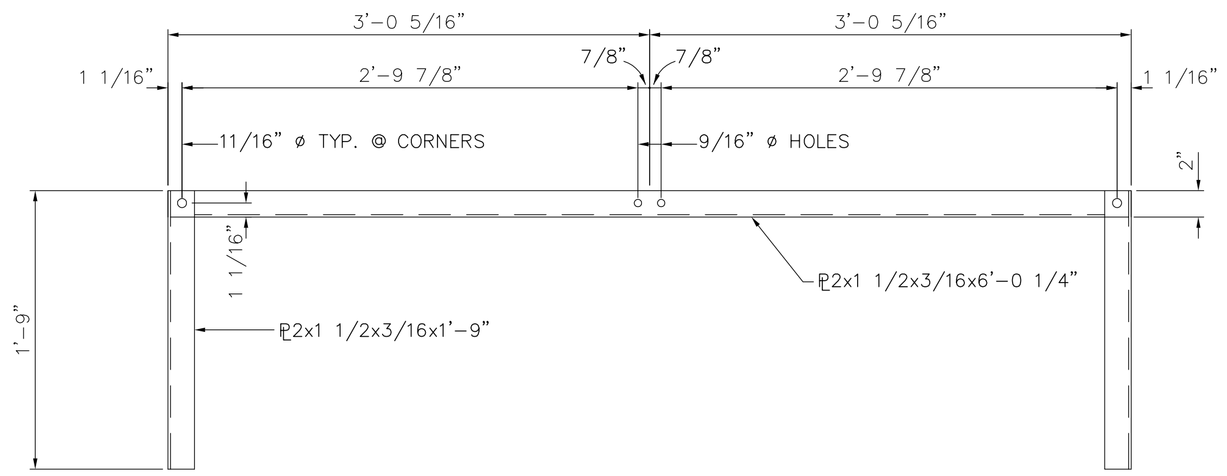
0 1" 2"

FILENAME	TWEND-SS-03
SCALE	NONE

SHEET SS-03



PLAN VIEW



ELEVATION

GROUND PLATFORM – GP–1 (7 REQ'D)
N.T.S.

GA01

NOTES:

1. ALL MEMBERS TO BE HOT DIPPED GALVANIZED.
2. PLATES, BARS, AND MISC SHAPES SHALL CONFORM TO ASTM A36 AMENDED TO DATE. WIDE FLANGE SHALL BE ASTM A992 AMENDED TO DATE. HSS SECTIONS SHALL BE ASTM A500 GR.B MINIMUM YIELD STRENGTH 46.0 KSI.

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HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

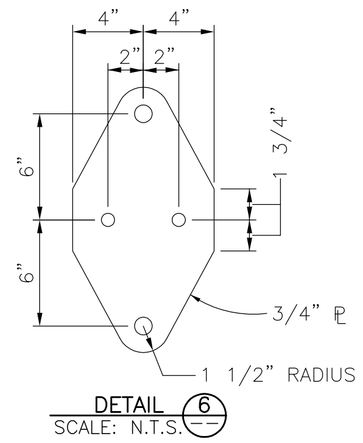
TATANKA WIND ENERGY

TATANKA 230kV INTERCONNECT SUBSTATION STRUCTURAL STEEL - MISC.

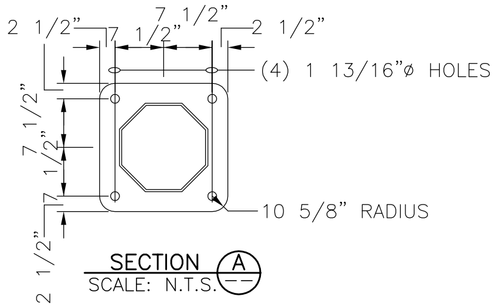
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FILENAME	TWEND-SS-04
SCALE	NONE

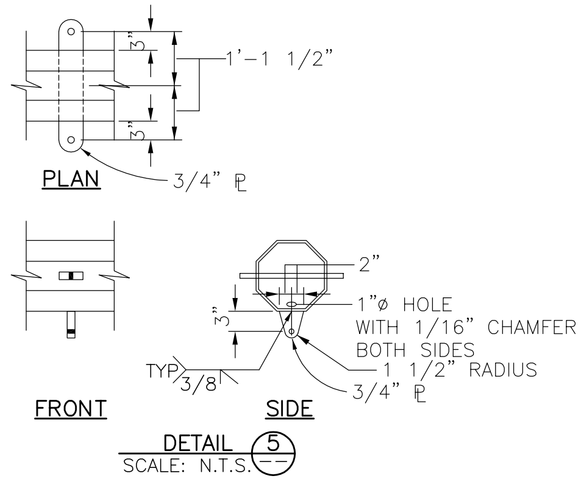
SHEET **SS-04**



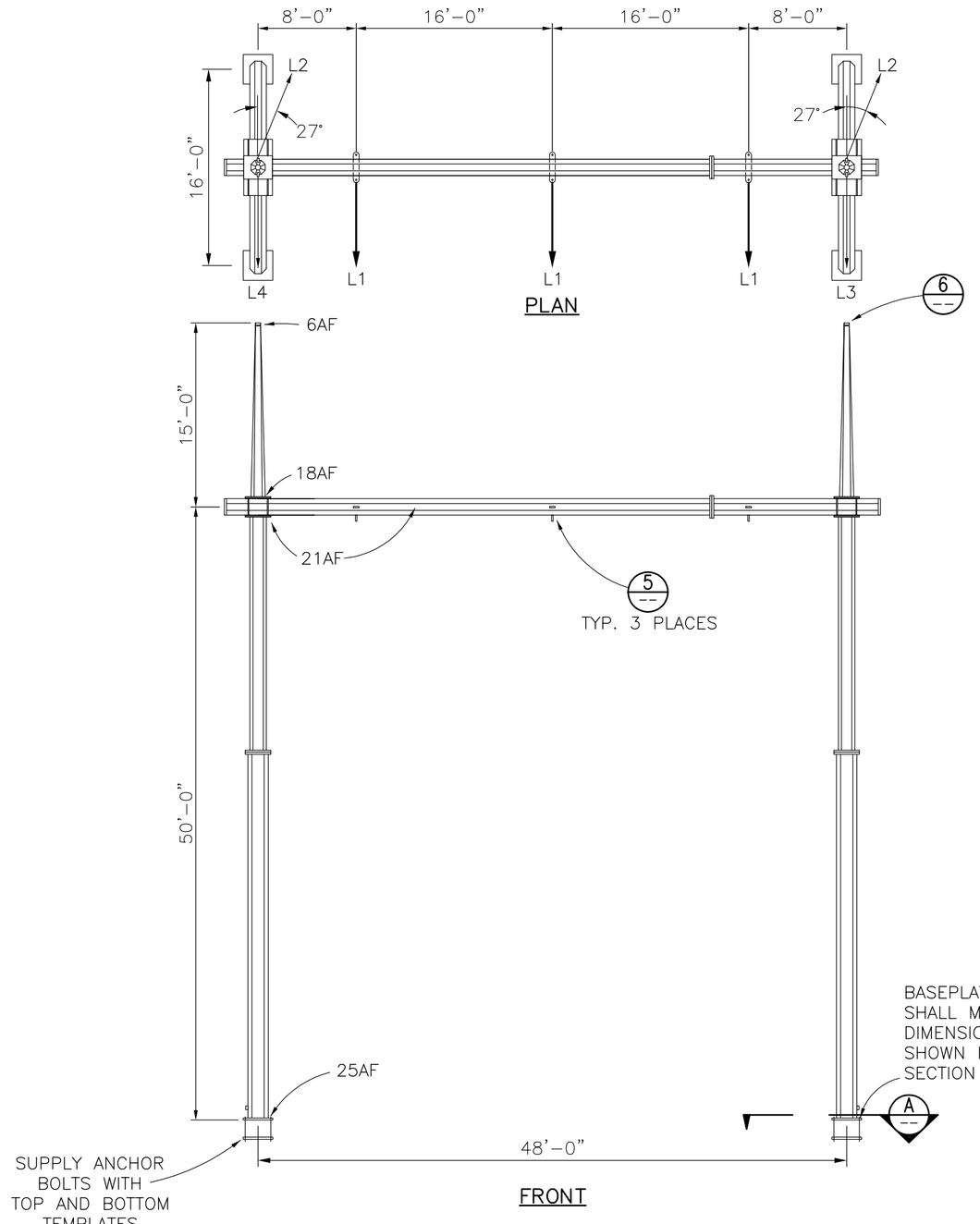
DETAIL 6
SCALE: N.T.S.



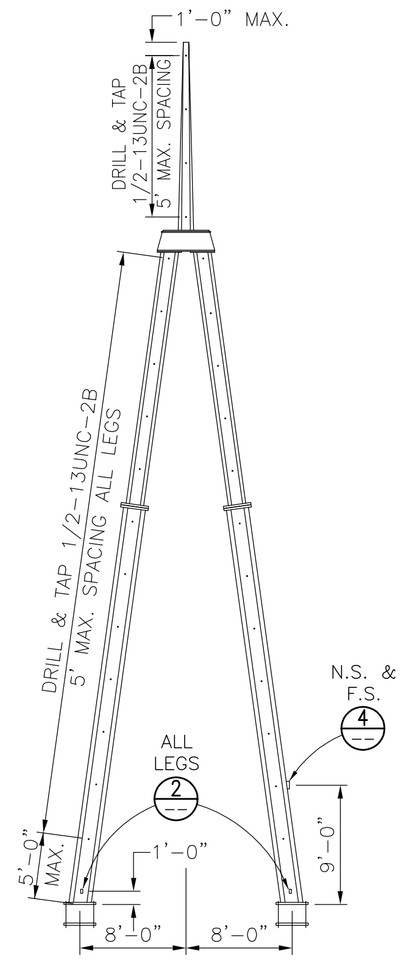
SECTION A
SCALE: N.T.S.



DETAIL 5
SCALE: N.T.S.



230kV DEADEND TOWER – 230DE (3 REQ'D)
SCALE: 1/8"=1'-0"



NOTES

1. THE DEADEND TOWER SHALL BE 8 SIDED GALVANIZED STEEL TUBE.

STRUCTURE DESIGN CRITERIA

CASE 1 – EXTREME WIND

LONGITUDINAL – ALL WIRES INTACT; UTILIZE HIGH WIND LOADS ON WIRES AND STRUCTURE, OLF=1.1

TRANSVERSE – WIND ON BARE WIRES AND ANGLE COMPONENT, OLF=1.1

VERTICAL – WEIGHT OF BARE WIRES, OLF=1.1

CASE 2 – NESC HEAVY

LONGITUDINAL – ANY OR ALL WIRES DEAD ENDED UTILIZING NESC TENSIONS, OLF=1.65

TRANSVERSE – WIND ON ATTACHED ICE WIRES, OLF=2.5 AND ANGLE COMPONENT OF DEADEND, OLF=1.65

VERTICAL – WEIGHT OF ATTACHED ICED WIRES, OLF=1.5

DEFLECTION LIMITATIONS

1. HORIZONTAL DEFLECTION OF VERTICAL MEMBERS <1/50 VERTICAL HEIGHT (STATIC MAST)
   HORIZONTAL DEFLECTION OF VERTICAL MEMBERS <1/50 VERTICAL HEIGHT (DEADEND STRUCTURES)
2. VERTICAL DEFLECTION OF HORIZONTAL MEMBERS <1/200 OF SPAN
3. HORIZONTAL DEFLECTION OF HORIZONTAL MEMBERS <1/100 OF SPAN

NOTES

1. STRUCTURES SHALL BE DESIGNED FOR THE FOLLOWING DESIGN CONDITIONS:
   A. L1, L3 AND L4 INTACT WITH L2 DOWN
   B. L1 AND L2 INTACT WITH L3 AND L4 DOWN
   C. DEFLECTION CRITERIA SHALL APPLY TO CONDITIONS A AND B ABOVE WITHOUT OVERLOAD FACTORS.
2. ANCHOR BOLTS SHALL BE DESIGNED ACCORDING TO AISC AND ACI FOR F'c=4000psi.
3. REFER TO WRITTEN SPECIFICATIONS FOR DESIGN AND MATERIAL REQUIREMENTS.

LOAD	DESCRIPTION	NESC HEAVY (W/O OLF) 1/2" ICE, 4lb. WIND, 0° F	HIGH WIND (W/O OLF) 0 ICE, 100 MPH WIND, 60° F
L1	1272 KCMIL 45/7 ACSR, BITTERN,	4000 lb	3383 lb
	400' MAX. SPAN, 15° MAX. LINE ANGLE		
L2	3/8 DIA. 7 STRAND EHS, 400' MAX. SPAN,	2000 lb	1131 lb
	27° MAX. LINE ANGLE		
L3	OPGW		
L4	3/8 DIA. 7 STRAND EHS, 400' MAX. SPAN,	2000 lb	1131 lb
	15° MAX. LINE ANGLE		

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
1	07-16-07	REVISED BASE PLATE DETAILS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48069

acciona

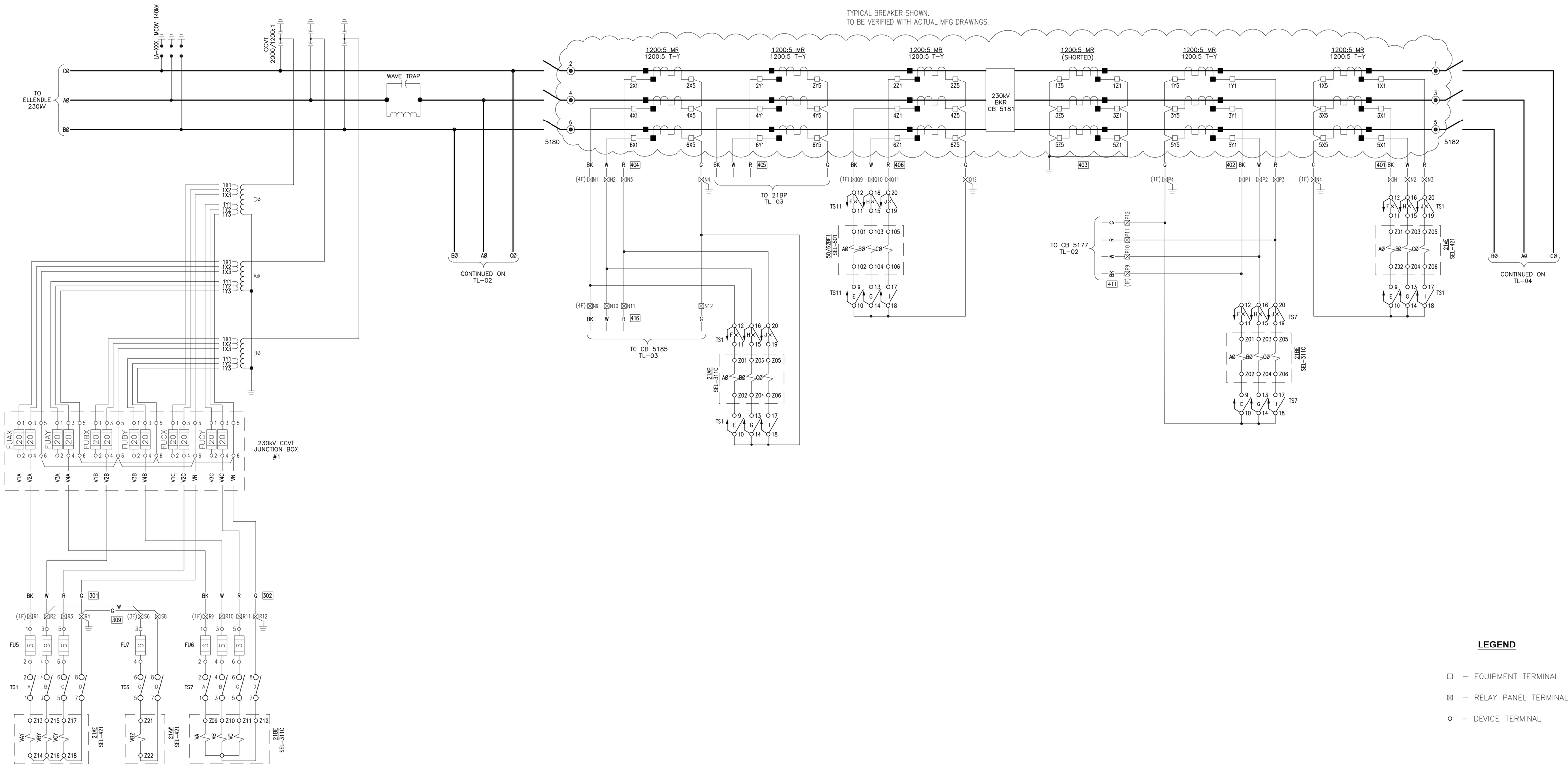
TATANKA WIND ENERGY

TATANKA 230kV INTERCONNECT SUBSTATION
STRUCTURAL STEEL - DEADEND TOWER

0 1" 2"

FILENAME	TWEND-SS-05
SCALE	1/8" = 1'-0"

SHEET
SS-05



MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-06	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

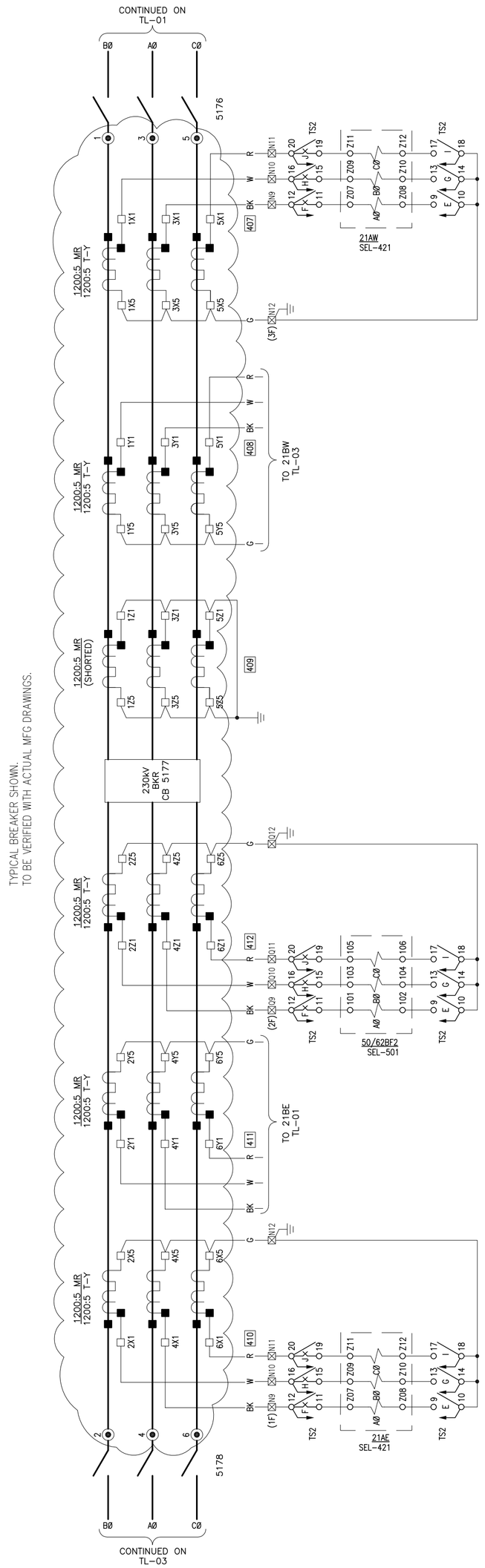
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
CB 5181
THREE LINE DIAGRAM

0 1" 2"

FILENAME	TWEND-TL-01.DWG
SCALE	NONE

SHEET TL-01



LEGEND

□ – EQUIPMENT TERMINAL

⊠ – RELAY PANEL TERMINAL

○ – DEVICE TERMINAL

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

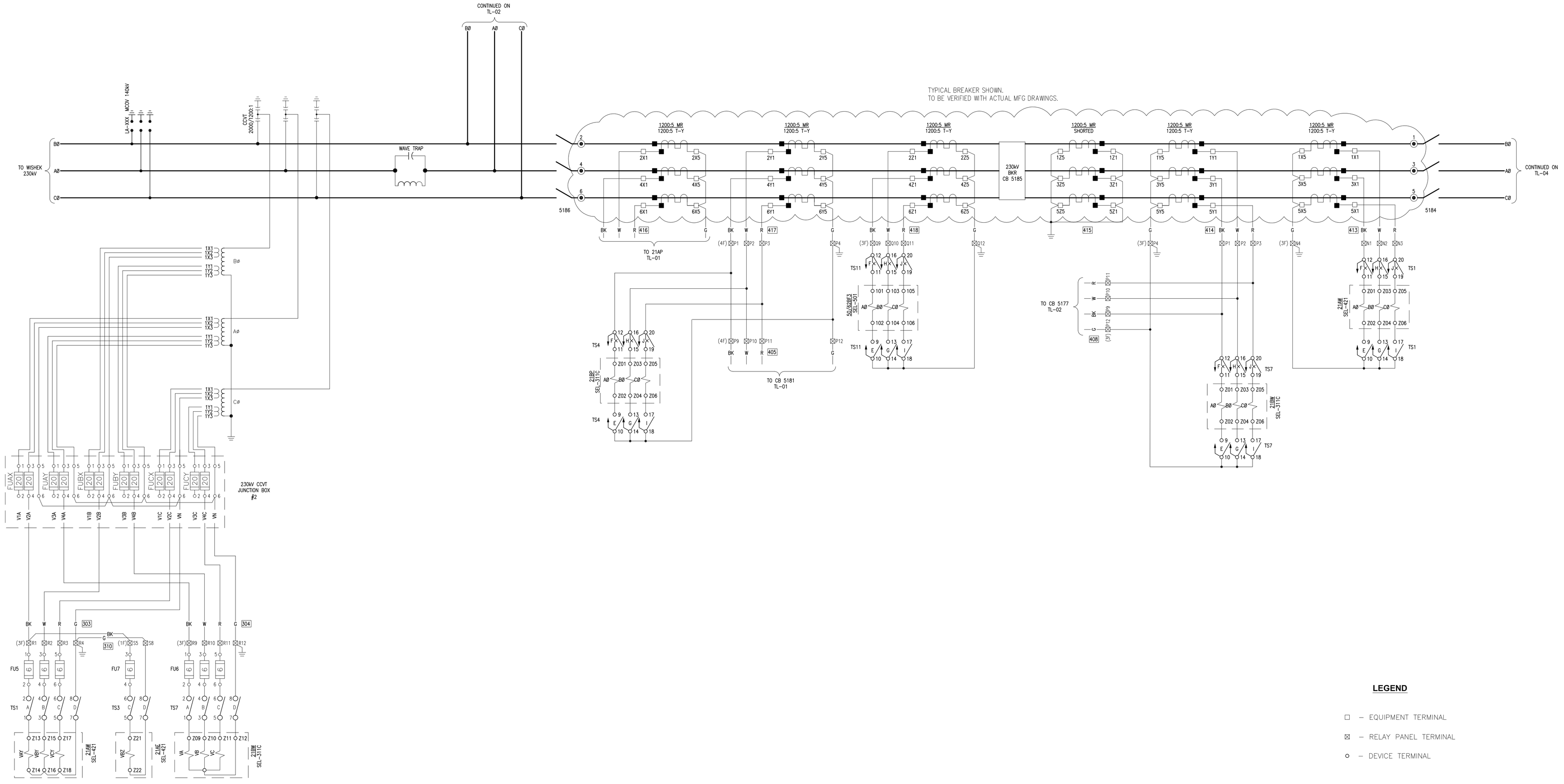
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
CB 5177
THREE LINE DIAGRAM

0 1" 2"

FILENAME	TWEND-TL-02.DWG
SCALE	NONE

SHEET TL-02



LEGEND

- □ – EQUIPMENT TERMINAL
- ⊠ – RELAY PANEL TERMINAL
- ○ – DEVICE TERMINAL

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

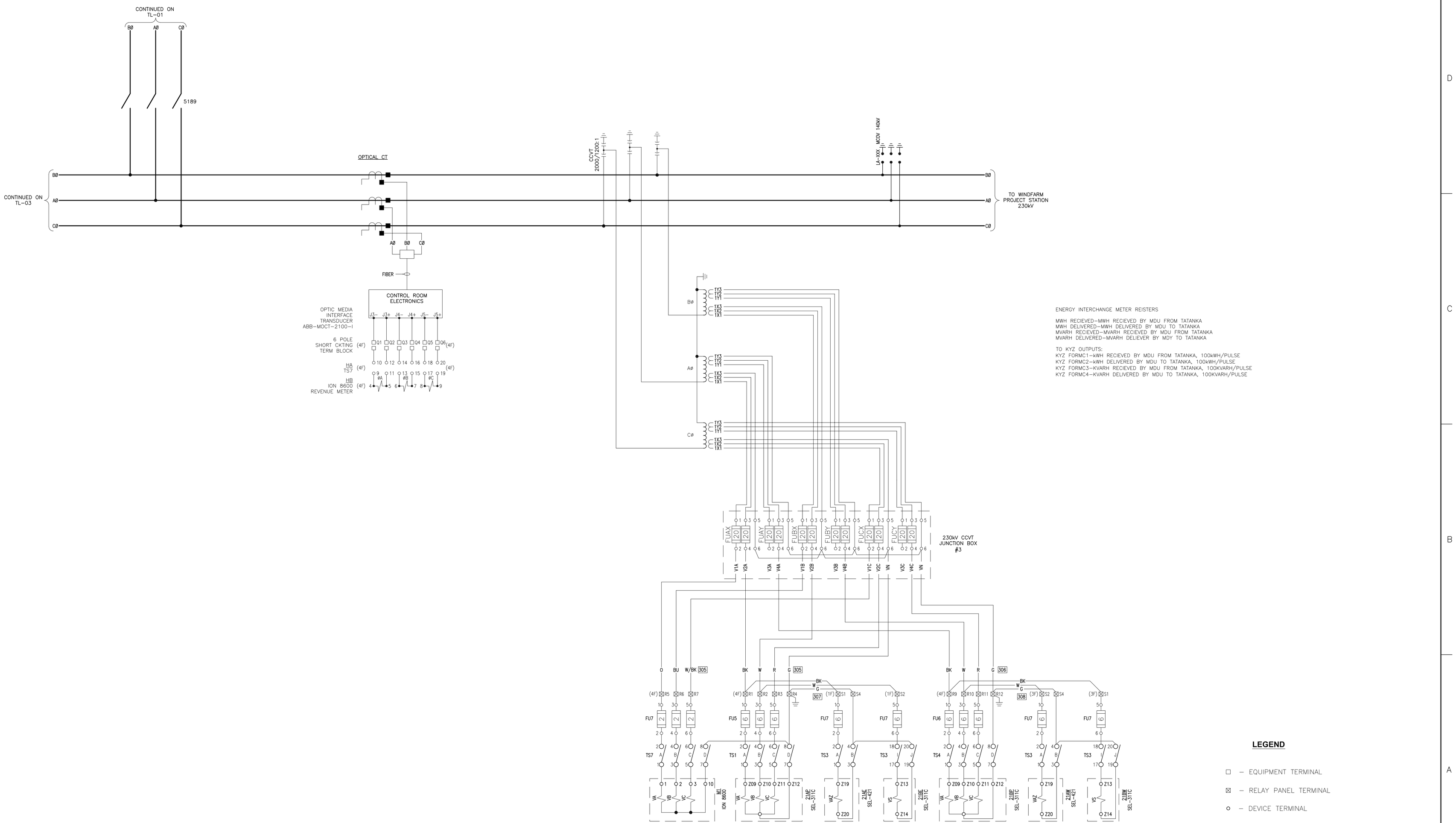
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
CB 5185
THREE LINE DIAGRAM

0 1" 2"

FILENAME	TWEND-TL-03.DWG
SCALE	NONE

SHEET
TL-03



MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION PROJECT LINE OCT & CCVT THREE LINE DIAGRAM

0 1" 2"

FILENAME	TWEND-TL-04.DWG
SCALE	NONE

SHEET **TL-04**

ACCIONA, LLC
DICKEY COUNTY, NORTH DAKOTA

TATANKA WIND ENERGY
NORTH DAKOTA INTERCONNECT SUBSTATION

DRAWING LIST

DRAWING DESCRIPTION	SHEET NUMBER	REVISION
TITLE SHEET	TS-01	AS-BUILT
SITE - GRADING PLAN	SG-01	AS-BUILT
GENERAL ARRANGEMENT	GA-01	AS-BUILT
GENERAL ARRANGEMENT SECTIONS A&B	GA-02	AS-BUILT
GENERAL ARRANGEMENT SECTIONS C&D	GA-03	AS-BUILT
GENERAL ARRANGEMENT SECTIONS E, F, G, H & I	GA-04	AS-BUILT
BUS ASSEMBLY DETAILS B1 THROUGH B12	GA-05	AS-BUILT
BUS DETAILS B13 THROUGH B17	GA-06	AS-BUILT
MATERIAL LIST	ML-01	AS-BUILT
MATERIAL LIST	ML-02	AS-BUILT
FOUNDATION PLAN	FD-01	AS-BUILT
FOUNDATION DETAILS - A, B, CB & DE1	FD-02	AS-BUILT
FOUNDATION DETAILS - CH	FD-03	AS-BUILT
GROUNDING PLAN	GD-01	AS-BUILT
GROUNDING DETAILS 01 THROUGH 013	GD-02	AS-BUILT
CONDUIT PLAN	CC-01	AS-BUILT
CONDUIT DETAILS K1 THROUGH K4	CC-02	AS-BUILT
CONDUIT DETAILS K5	CC-03	AS-BUILT
STRUCTURAL STEEL-230kV SWITCH STANDS	SS-01	AS-BUILT
STRUCTURAL STEEL-230kV BUS SUPPORTS	SS-02	AS-BUILT
STRUCTURAL STEEL-230kV EQUIPMENT SUPPORTS	SS-03	AS-BUILT
STRUCTURAL STEEL-230kV STEEL MISC.	SS-04	AS-BUILT
STRUCTURAL STEEL - DEADEND TOWER	SS-05	AS-BUILT
RELAY ONE LINE DIAGRAM	OL-01	AS-BUILT
THREE LINE DIAGRAM - CB 5181	TL-01	AS-BUILT
THREE LINE DIAGRAM - CB 5177	TL-02	AS-BUILT
THREE LINE DIAGRAM - CB 5185	TL-03	AS-BUILT
THREE LINE DIAGRAM - PROJECT LINE OCT & CCVT	TL-04	AS-BUILT
DC SCHEMATIC DIAGRAM - PCB 5181 TRIP & CLOSE	CS-01	AS-BUILT
DC SCHEMATIC DIAGRAM - 230KV PCB 5181	CS-02	AS-BUILT
DC SCHEMATIC DIAGRAM - ELLENDALE PRIMARY LINE RELAY	CS-03	AS-BUILT
DC SCHEMATIC DIAGRAM - ELLENDALE SECONDARY LINE RELAY	CS-04	AS-BUILT
DC SCHEMATIC DIAGRAM - PCB 5181 BREAKER FAILURE	CS-05	AS-BUILT
DC SCHEMATIC DIAGRAM - PCB 5177 TRIP & CLOSE	CS-06	AS-BUILT
DC SCHEMATIC DIAGRAM - PCB 5177	CS-07	AS-BUILT
DC SCHEMATIC DIAGRAM - PCB 5177 BREAKER FAILURE	CS-08	AS-BUILT
DC SCHEMATIC DIAGRAM - PCB 5185 TRIP & CLOSE	CS-09	AS-BUILT
DC SCHEMATIC DIAGRAM - PCB 5185	CS-10	AS-BUILT
DC SCHEMATIC DIAGRAM - WISHEK PRIMARY LINE RELAY	CS-11	AS-BUILT
DC SCHEMATIC DIAGRAM - WISHEK SECONDARY LINE RELAY	CS-12	AS-BUILT
DC SCHEMATIC DIAGRAM - PCB 5185 BREAKER FAILURE	CS-13	AS-BUILT
DC SCHEMATIC DIAGRAM - PROJECT PRIMARY LINE RELAY	CS-14	AS-BUILT
DC SCHEMATIC DIAGRAM - PROJECT SECONDARY LINE RELAY	CS-15	AS-BUILT
DC SCHEMATIC DIAGRAM - RELAY COMMUNICATIONS EQUIPMENT	CS-16	AS-BUILT
DC SCHEMATIC DIAGRAM - REVENUE METER	CS-17	AS-BUILT
DC SCHEMATIC DIAGRAM - MDU TONE EQUIPMENT	CS-18	AS-BUILT
SPS LOGIC DESCRIPTION	CS-19	AS-BUILT
SPS LOGIC DIAGRAM	CS-20	AS-BUILT
PANEL 1F LAYOUT	PL-01	AS-BUILT
PANEL 2F LAYOUT	PL-02	AS-BUILT
PANEL 3F LAYOUT	PL-03	AS-BUILT
PANEL 4F LAYOUT	PL-04	AS-BUILT

PANEL 1F WIRING DIAGRAM SH. 1	WD-01	AS-BUILT
PANEL 1F WIRING DIAGRAM SH. 2	WD-02	AS-BUILT
PANEL 2F WIRING DIAGRAM	WD-03	AS-BUILT
PANEL 3F WIRING DIAGRAM SH. 1	WD-04	AS-BUILT
PANEL 3F WIRING DIAGRAM SH. 2	WD-05	AS-BUILT
PANEL 4F WIRING DIAGRAM	WD-06	AS-BUILT
CABLE LIST	CL-01	AS-BUILT
AC PANEL BOARD	LC-01	AS-BUILT
DC PANEL BOARDS	LC-02	AS-BUILT
CONTROL HOUSE	CH-01	AS-BUILT
CONTROL HOUSE	CH-02	AS-BUILT
CONTROL HOUSE	CH-03	AS-BUILT
CONTROL HOUSE	CH-04	AS-BUILT
CONTROL HOUSE	CH-05	AS-BUILT
CONNECTION DIAGRAM - CB 5181	CD-01	AS-BUILT
CONNECTION DIAGRAM - CB 5177	CD-02	AS-BUILT
CONNECTION DIAGRAM - CB 5185	CD-03	AS-BUILT
CONNECTION DIAGRAM - ELLENDALE LINE CCVT J-BOX #1	CD-04	AS-BUILT
CONNECTION DIAGRAM - WISHEK LINE CCVT J-BOX #2	CD-05	AS-BUILT
CONNECTION DIAGRAM - PROJECT LINE CCVT J-BOX #3	CD-06	AS-BUILT
230kV PCB 5177, 5181, 5185 LEGEND	MD-01	AS-BUILT
230kV PCB 5177, 5181, 5185 CONTROL SCHEMATIC	MD-02	AS-BUILT
230kV PCB 5177, 5181, 5185 CONTROL SCHEMATIC	MD-03	AS-BUILT
230kV PCB 5177, 5181, 5185 ALARMS & AUX SWITCHES	MD-04	AS-BUILT
230kV PCB 5177, 5181, 5185 CABINET HEATING	MD-05	AS-BUILT
230kV PCB 5177, 5181, 5185 WIRING DIAGRAM	MD-06	AS-BUILT
230kV PCB 5177, 5181, 5185 WIRING DIAGRAM	MD-07	AS-BUILT
230kV PCB 5177, 5181, 5185 WIRING DIAGRAM	MD-08	AS-BUILT
230kV PCB 5177, 5181, 5185 WIRING DIAGRAM	MD-09	AS-BUILT
230kV PCB 5177, 5181, 5185 PANEL LAYOUT	MD-10	AS-BUILT
230kV PCB 5177, 5181, 5185 BILL OF MATERIALS	MD-11	AS-BUILT
230kV PCB 5177, 5181, 5185 BILL OF MATERIALS	MD-12	AS-BUILT
230kV PCB 5177, 5181, 5185 BCT WIRING/NAMEPLATE	MD-13	AS-BUILT
230kV PCB 5177, 5181, 5185 SF6 GAS PIPING/RATING NAMEPLATE	MD-14	AS-BUILT
230kV PCB 5177, 5181, 5185 TERMINAL MARKER STRIPS	MD-15	AS-BUILT
230kV PCB 5177, 5181, 5185 OUTLINE DRAWING	MD-16	AS-BUILT

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
1	09-04-07	ADD NEW METERED FDR&PANEL FOR O+M BUILDING
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48069

acciona

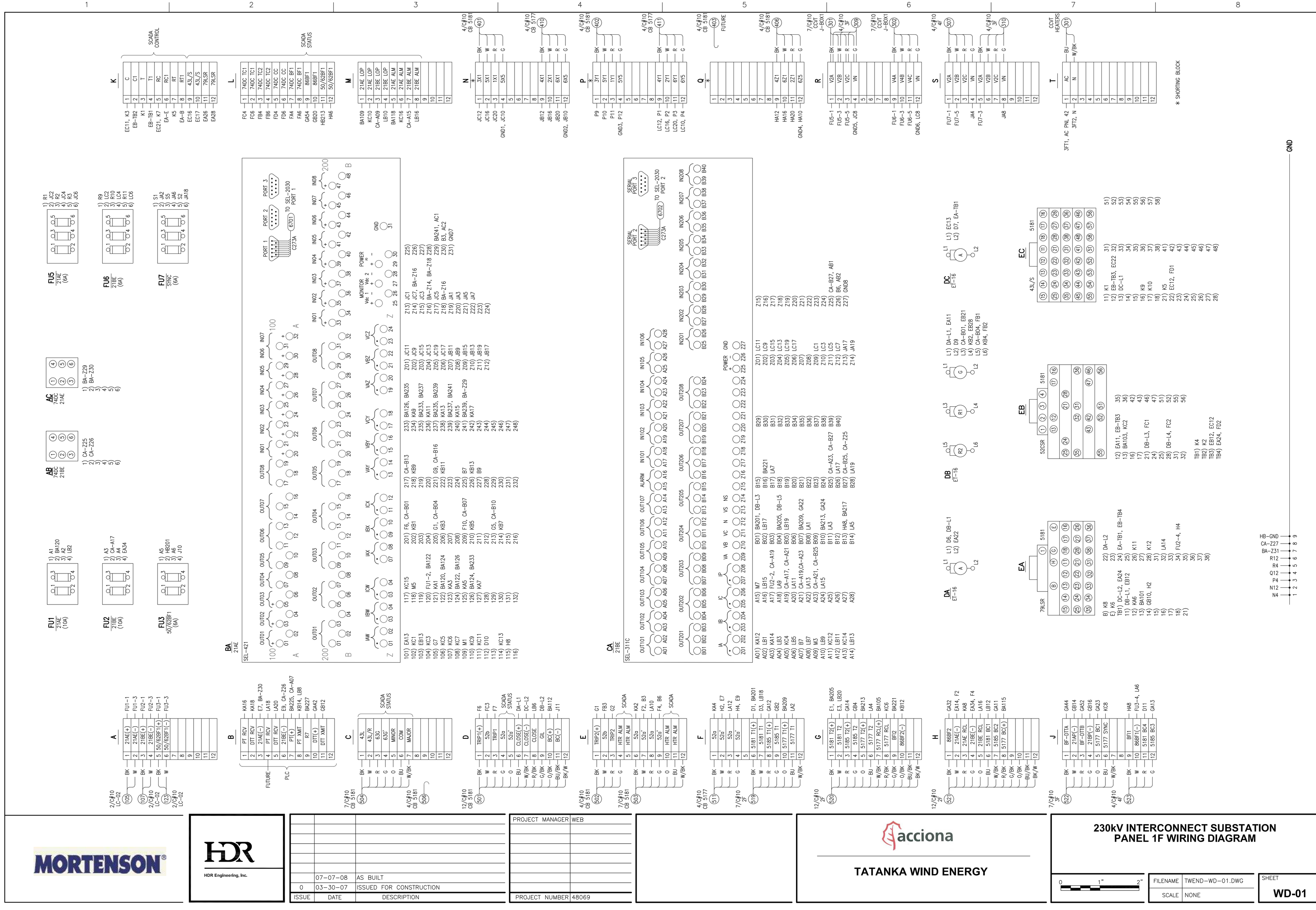
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION
TITLE SHEET

0 1" 2"

FILENAME	TWEND-TS-01.dwg
SCALE	NONE

SHEET **TS-01**



	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

acciona

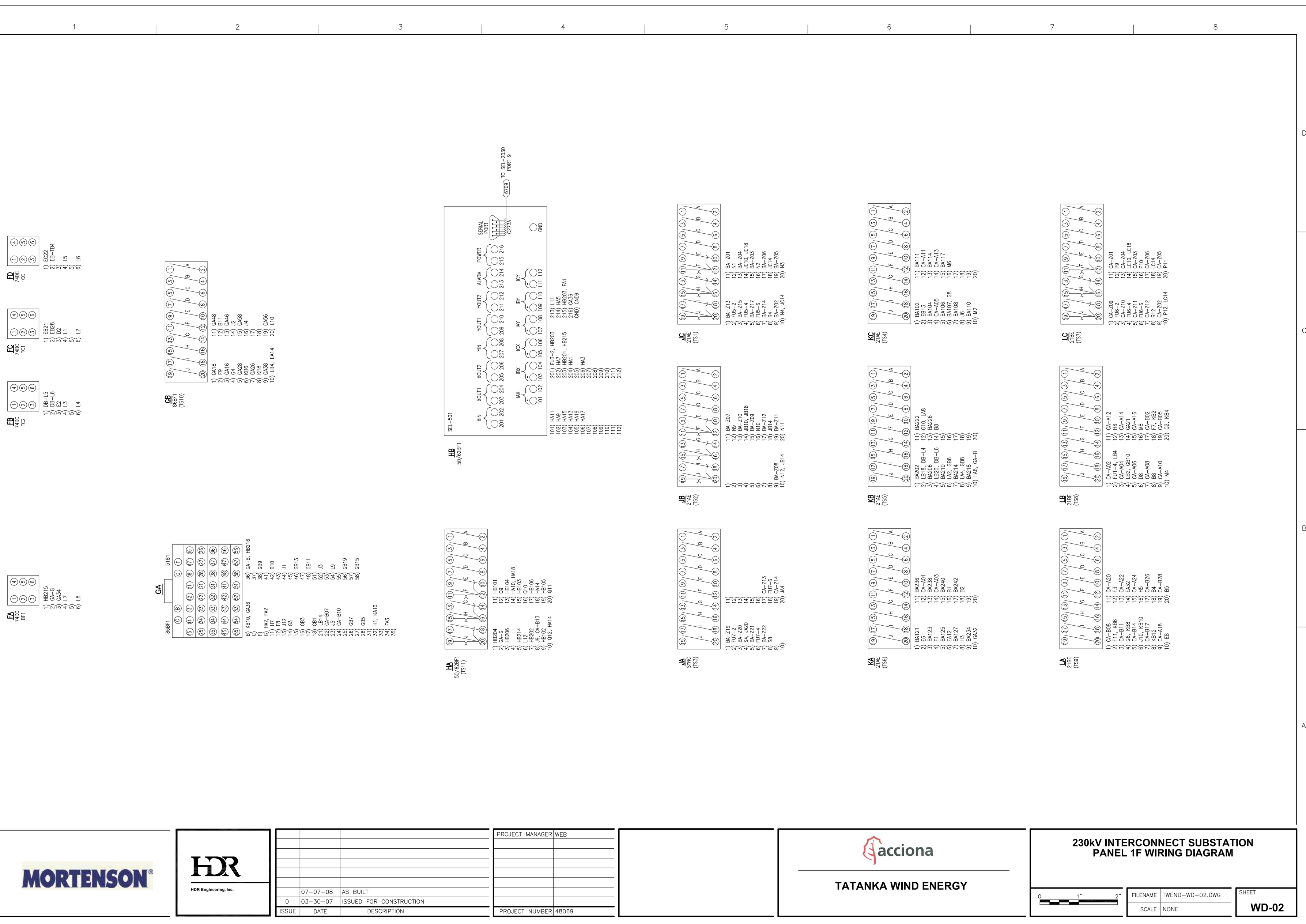
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION PANEL 1F WIRING DIAGRAM

0 1" 2"

FILENAME	TWEND-WD-01.DWG
SCALE	NONE

SHEET WD-01



MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

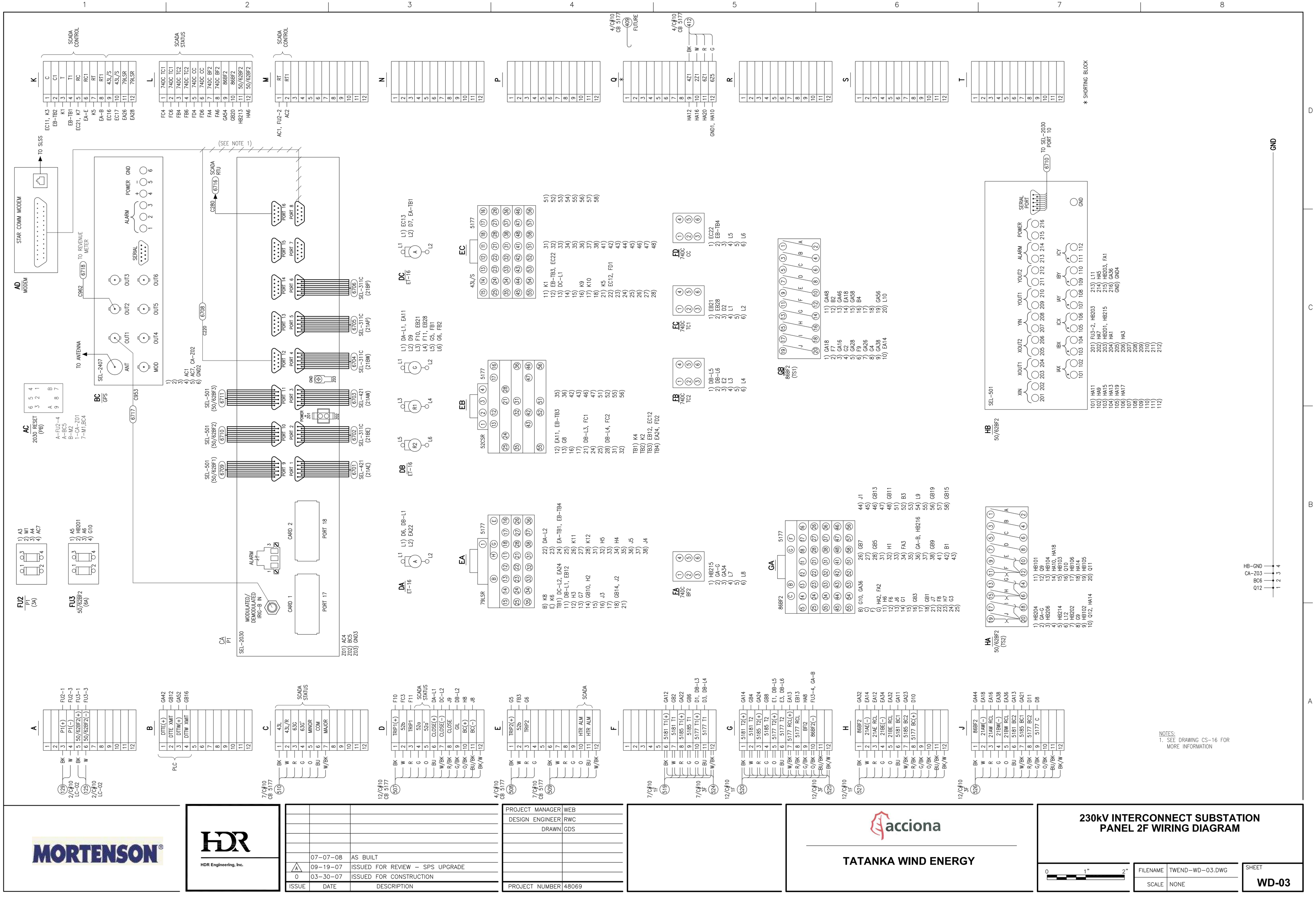
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION PANEL 1F WIRING DIAGRAM

0 1" 2"

FILENAME	TWEND-WD-02.DWG
SCALE	NONE

SHEET **WD-02**



	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

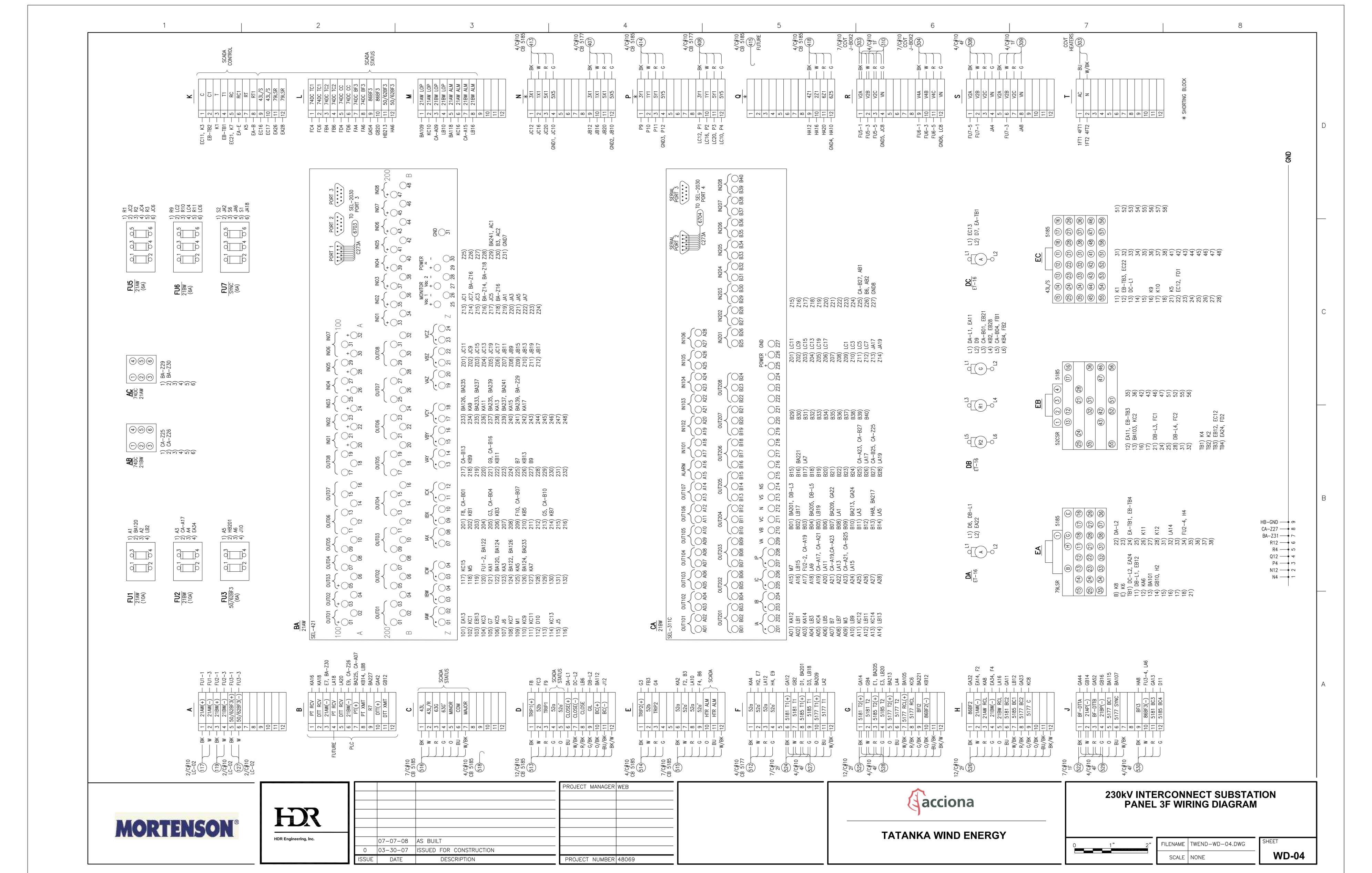
acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION PANEL 2F WIRING DIAGRAM

FILENAME	TWEND-WD-03.DWG
SCALE	NONE

SHEET WD-03



	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

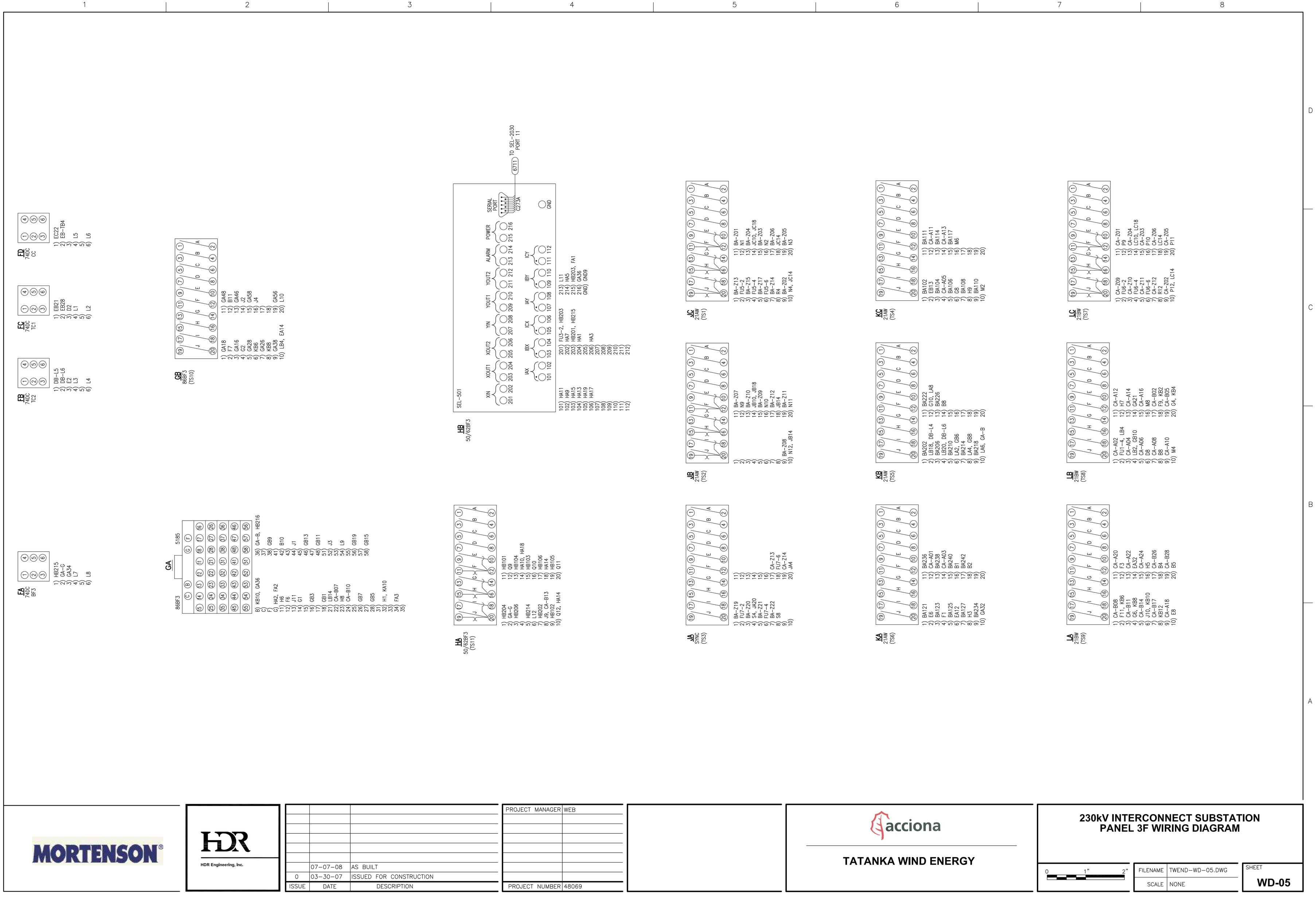
acciona

TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION PANEL 3F WIRING DIAGRAM

FILENAME	TWEND-WD-04.DWG
SCALE	NONE

SHEET WD-04



	07-07-08	AS BUILT	
0	03-30-07	ISSUED FOR CONSTRUCTION	
ISSUE	DATE	DESCRIPTION	

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON®

HDR Engineering, Inc.

acciona

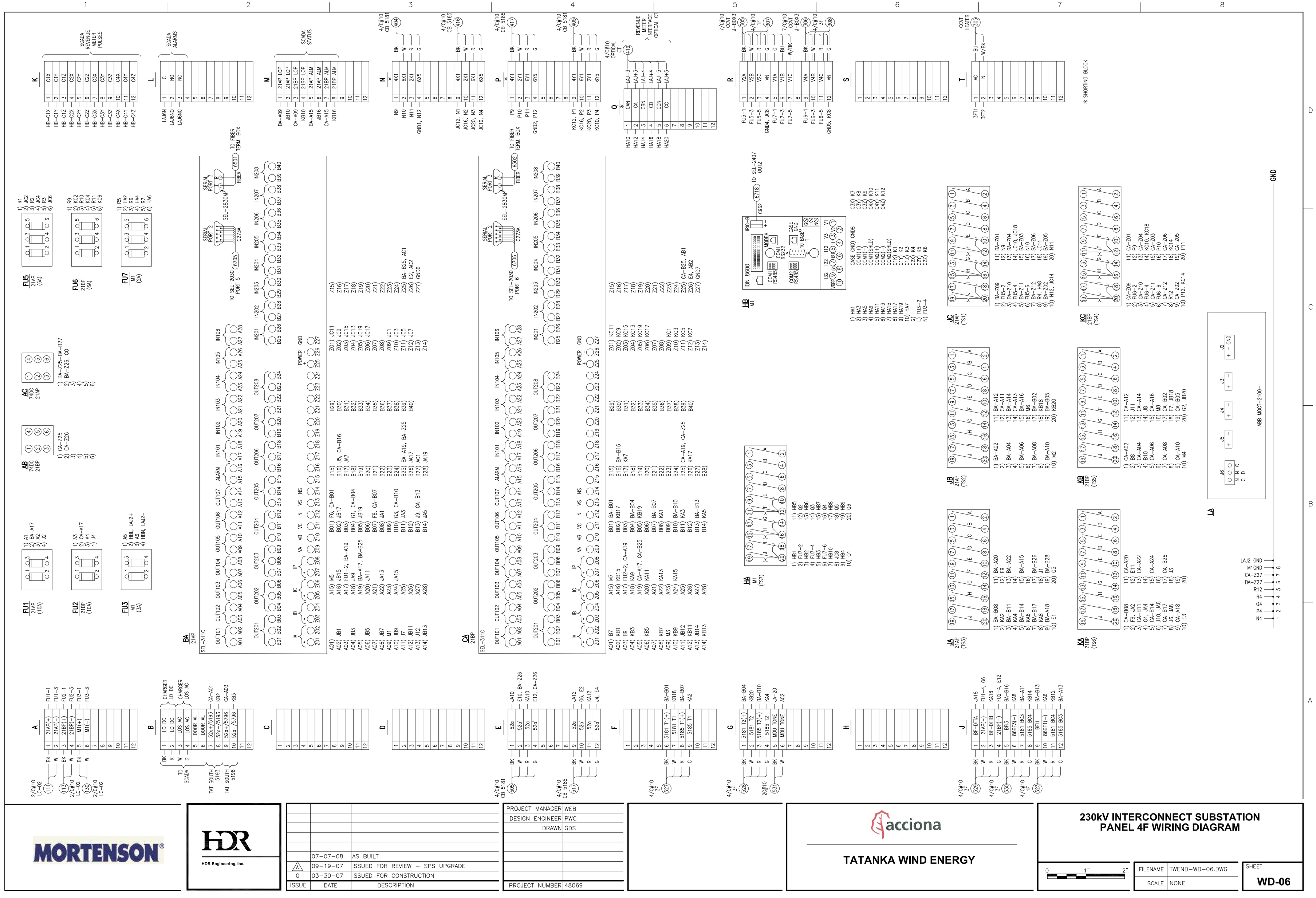
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION PANEL 3F WIRING DIAGRAM

0 1" 2"

FILENAME	TWEND-WD-05.DWG
SCALE	NONE

SHEET WD-05



ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	PWC
DRAWN	GDS
PROJECT NUMBER	48069

MORTENSON

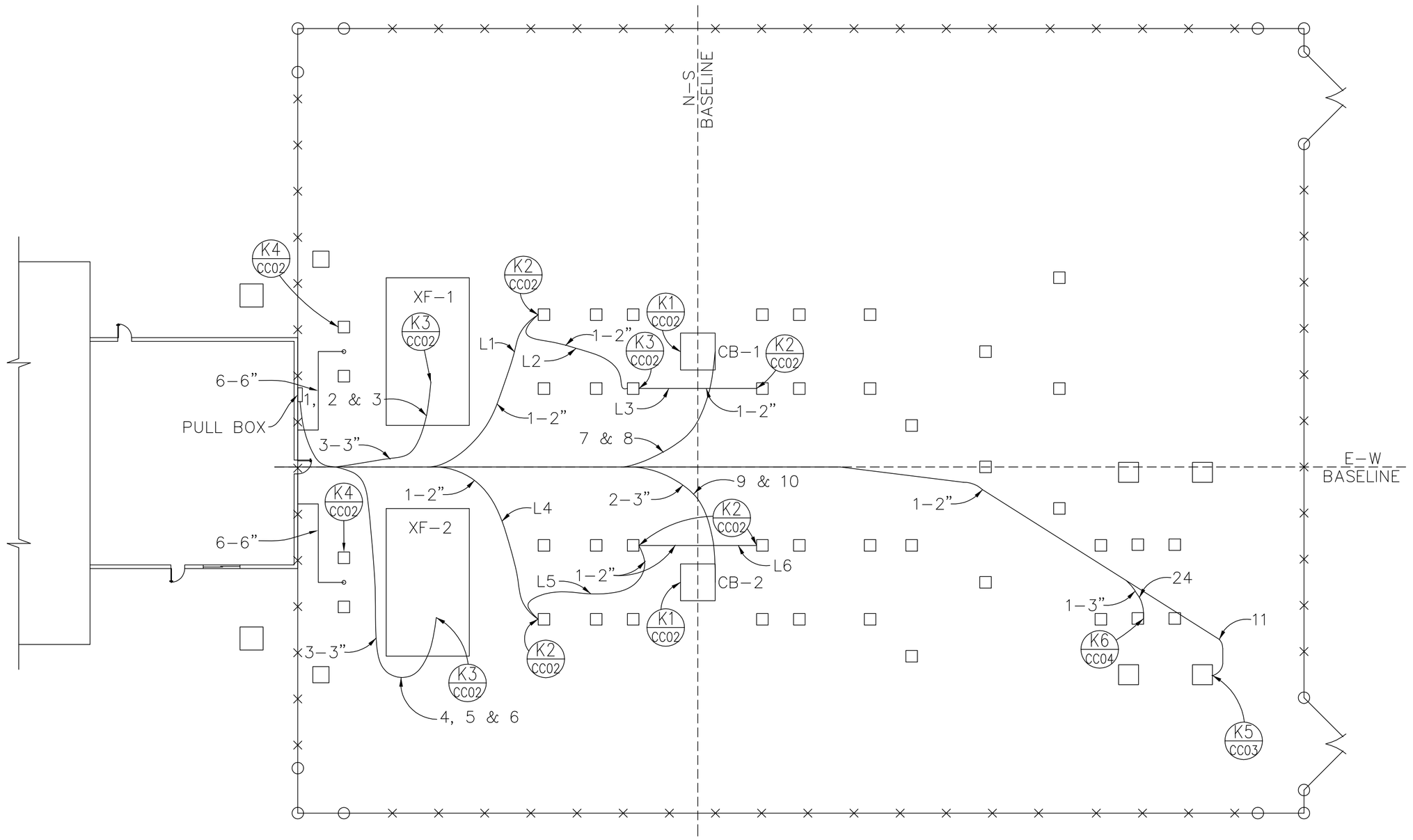
HDR Engineering, Inc.

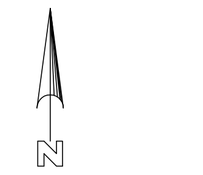
acciona

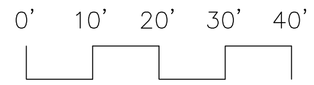
TATANKA WIND ENERGY

230kV INTERCONNECT SUBSTATION PANEL 4F WIRING DIAGRAM

FILENAME	TWEND-WD-06.DWG
SCALE	NONE
SHEET	WD-06







CONDUIT SCHEDULE

CONDUIT ID	CONDUIT SIZE	CONDUIT LENGTH	TO	FROM
L1	2"	APPROX 90'	SW GR ROOM	L1 JB
L2	2"	APPROX 40'	L1 JB	L2 JB
L3	2"	APPROX 30'	L2 JB	L3 JB
L4	2"	APPROX 110'	SW GR ROOM	L4 JB
L5	2"	APPROX 40'	L4 JB	L5 JB
L6	2"	APPROX 30'	L5 JB	L6 JB
1	3"	APPROX 90'	SW GR ROOM	TRANSFORMER XF-1
2	3"	APPROX 90'	SW GR ROOM	TRANSFORMER XF-1
3	3"	APPROX 90'	SW GR ROOM	TRANSFORMER XF-1
4	3"	APPROX 120'	SW GR ROOM	TRANSFORMER XF-2
5	3"	APPROX 120'	SW GR ROOM	TRANSFORMER XF-2
6	3"	APPROX 120'	SW GR ROOM	TRANSFORMER XF-2
7	3"	APPROX 130'	SW GR ROOM	PCB CB-1
8	3"	APPROX 130'	SW GR ROOM	PCB CB-1
9	3"	APPROX 130'	SW GR ROOM	PCB CB-2
10	3"	APPROX 130'	SW GR ROOM	PCB CB-2
11	2"	APPROX 260'	SW GR ROOM	WINDFARM 230kV OPGW
12	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF-1 RISER
13	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF-1 RISER
14	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF-1 RISER
15	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF-1 RISER
16	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF-1 RISER
17	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF-1 RISER
18	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF2-RISER
19	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF2-RISER
20	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF2-RISER
21	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF2-RISER
22	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF2-RISER
23	6"	APPROX 30'	SW GR ROOM	TRANSFORMER XF2-RISER
24	3"	APPROX 240'	SW GR ROOM	WINDFARM 230kV CCVT'S

NOTES:

1. CONDUITS 7, 8, 9, & 10 SHALL HAVE RISER LOCATION AT 230KV BREAKERS VERIFIED WITH BREAKER MFG. DRAWINGS FOR ACTUAL CONTROL CABINET LOCATION.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
1	09-28-07	CONTROL ROOM CHANGES
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

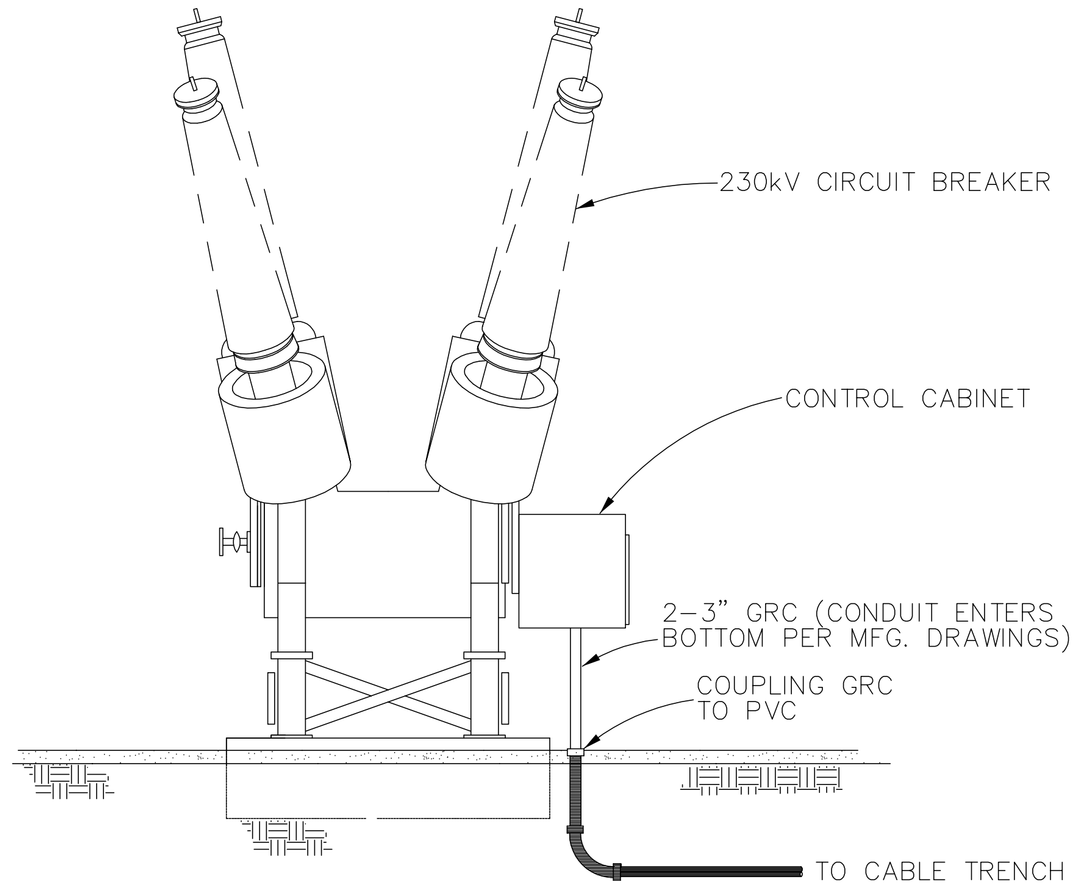
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION CONDUIT PLAN

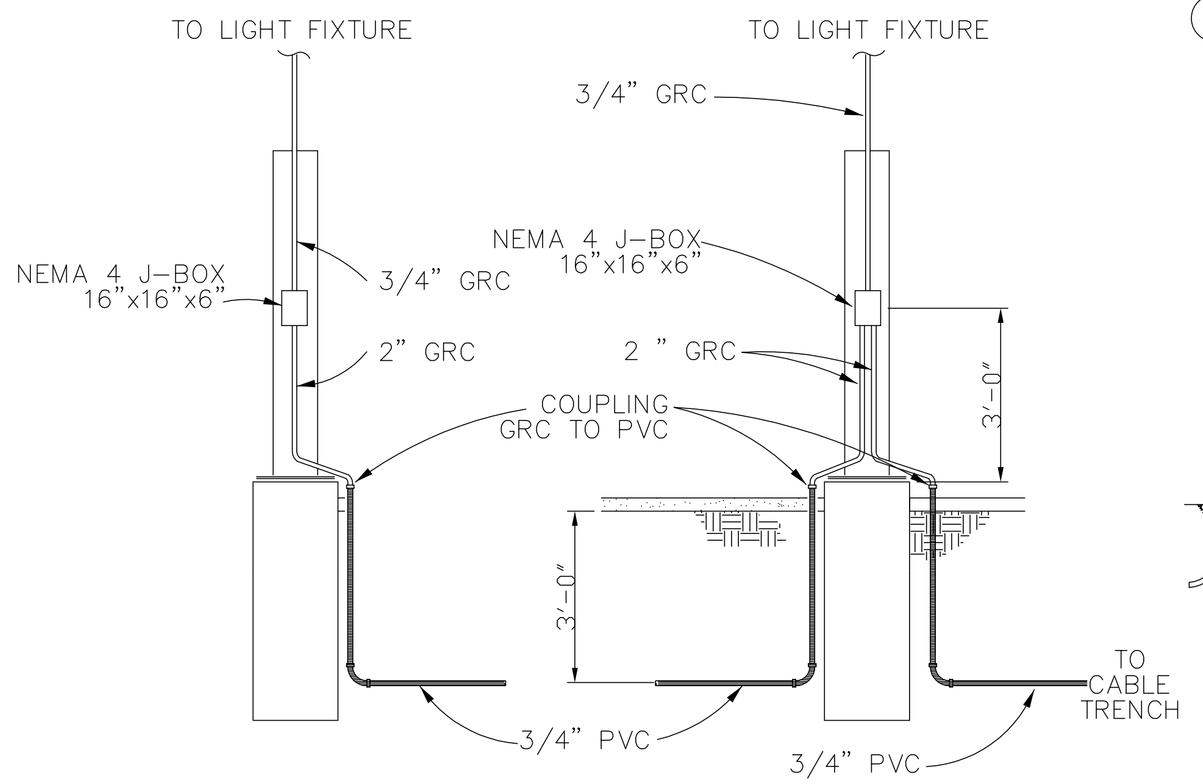
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FILENAME	TWESD-CC-01
SCALE	NONE

SHEET **CC-01**

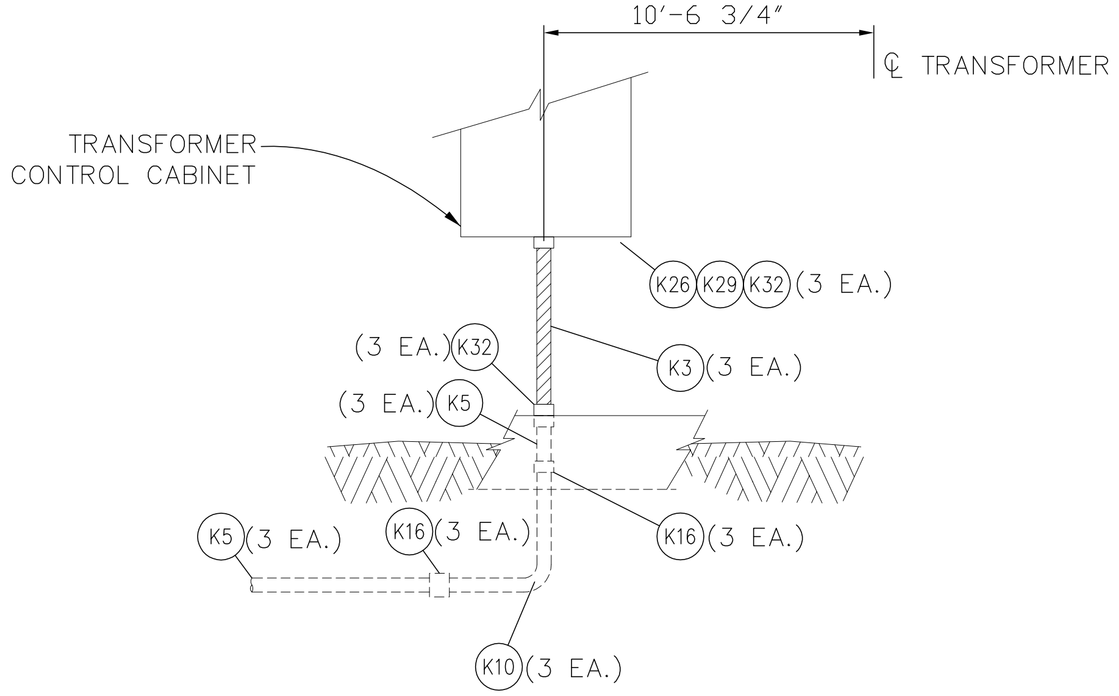


230kV CIRCUIT BREAKER CONDUIT DETAIL (K1 / CC01)
N.T.S.
(TYPICAL)

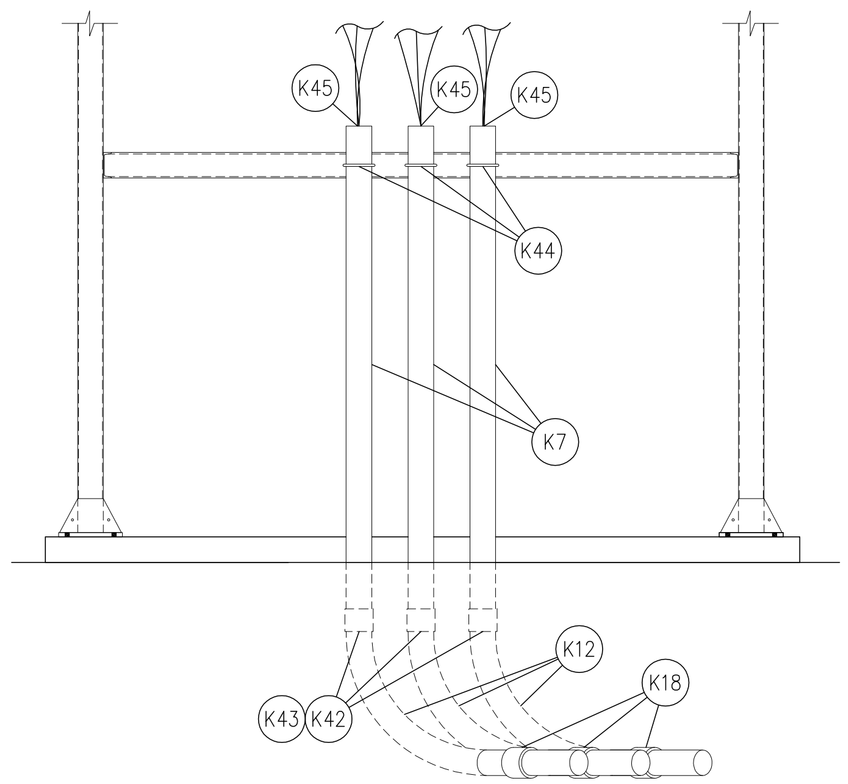


NOTE:
CONTRACTOR RESPONSIBLE FOR DRIILING AND TAPPING STRUCTURE AND FOR ALL NECESSARY MOUNTING HARDWARE. MOUNTING HEIGHT 10'–0"

LIGHT FIXTURE CONDUIT DETAIL (K2 / CC01)
N.T.S.



230/34.5kV TRANSFORMER CONDUIT DETAIL (K3 / CC01)
N.T.S.



34.5kV RISER CONDUIT DETAIL (K4 / CC01)
N.T.S.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
1	07–16–07	REVISED TRANSFORMER DETAILS
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	JI
PROJECT NUMBER	48049

acciona

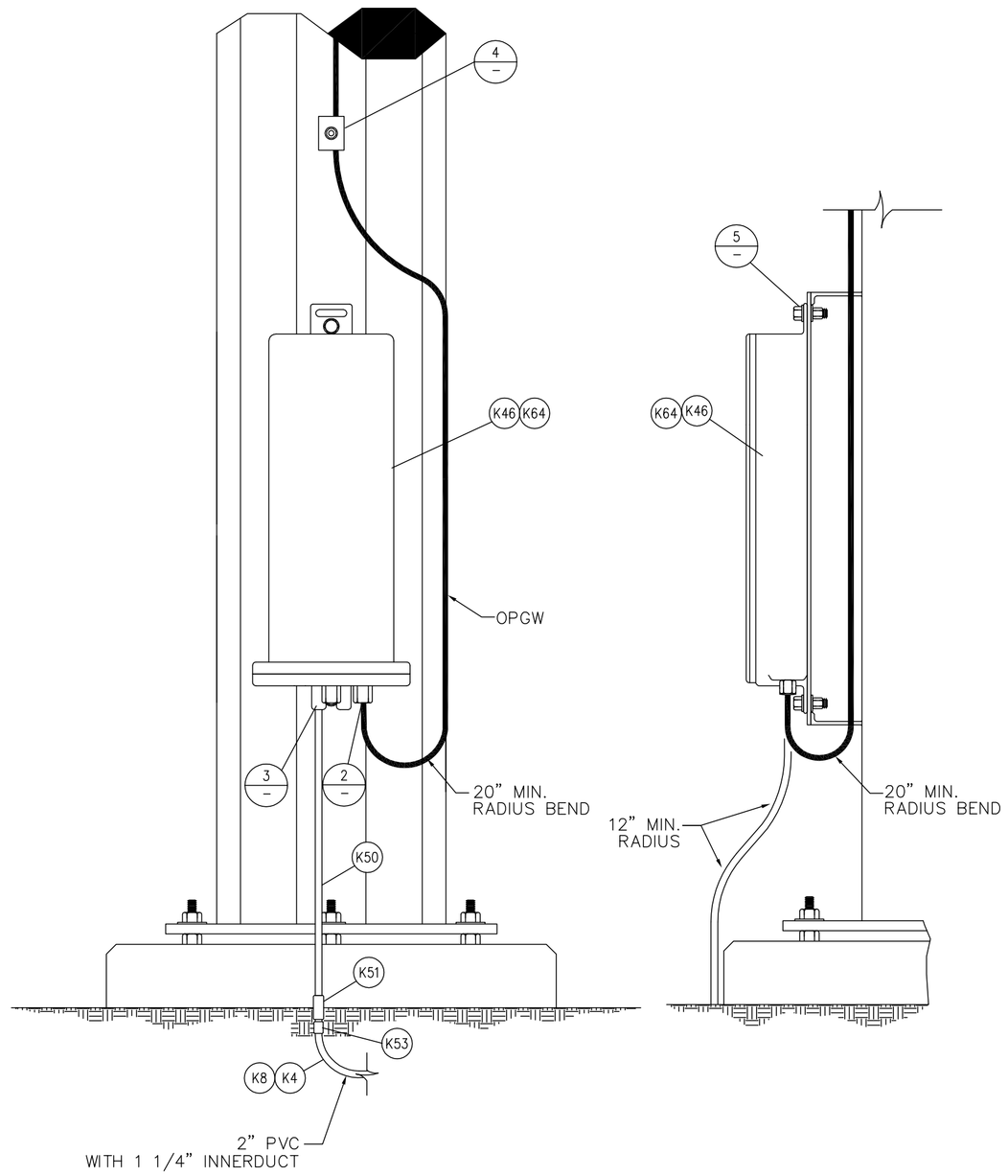
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
CONDUIT DETAILS K1 THROUGH K4

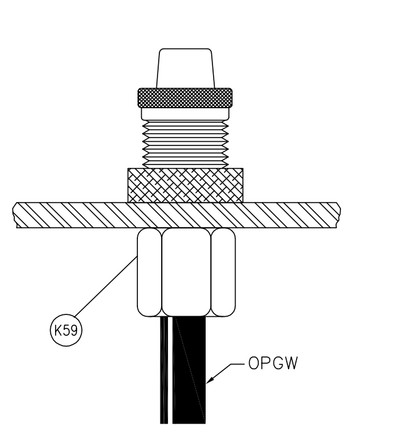
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FILENAME	TWESD–CC–02
SCALE	NONE

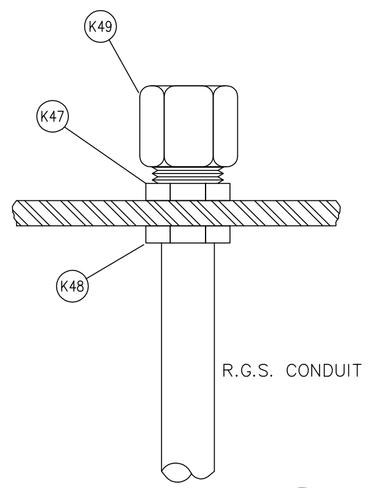
SHEET
CC-02



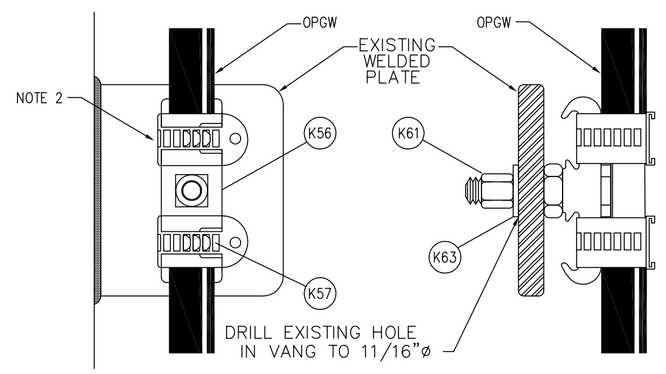
OPGW SPLICE BOX DETAIL K5 (CC01)
N.T.S.



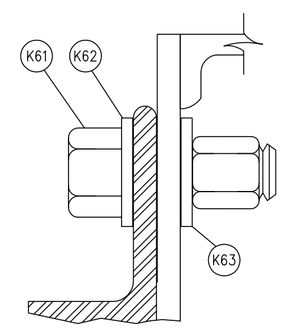
DETAIL 2 — OPGW ENTRY CONNECTOR ASSEMBLY



DETAIL 3 — CONDUIT ATTACHMENT



DETAIL 4 — OPGW – POST CONNECTOR



DETAIL 5 — SPLICE BOX ATTACHMENT

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

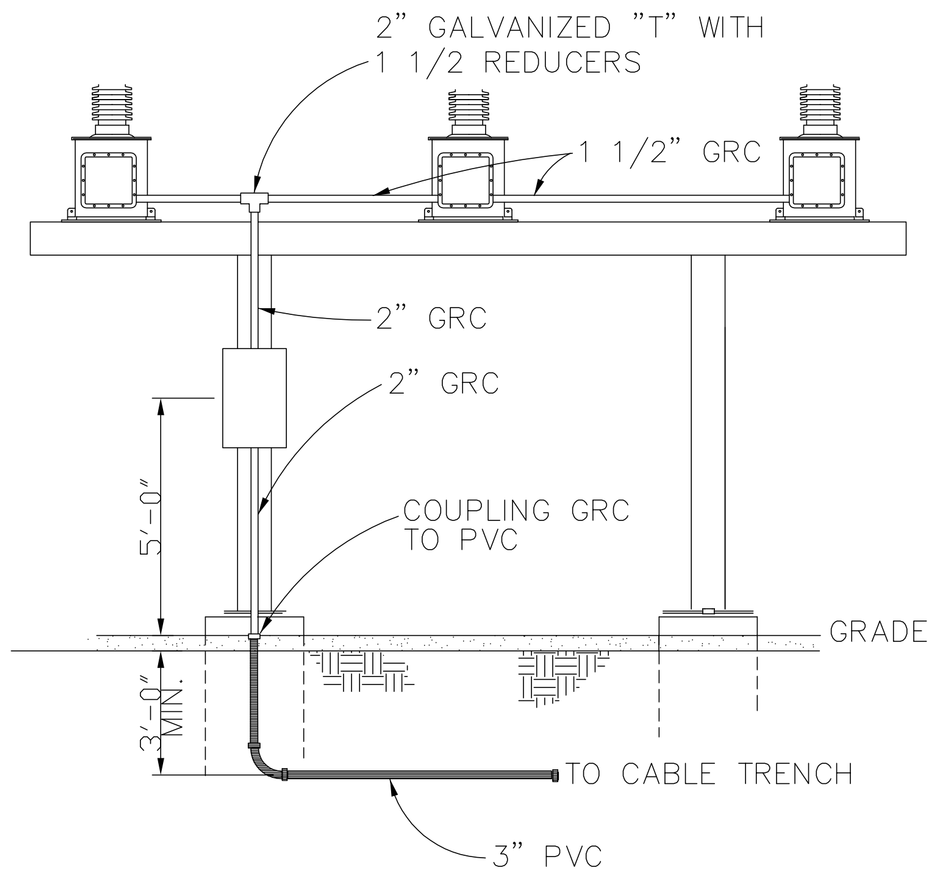
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
CONDUIT DETAIL K5

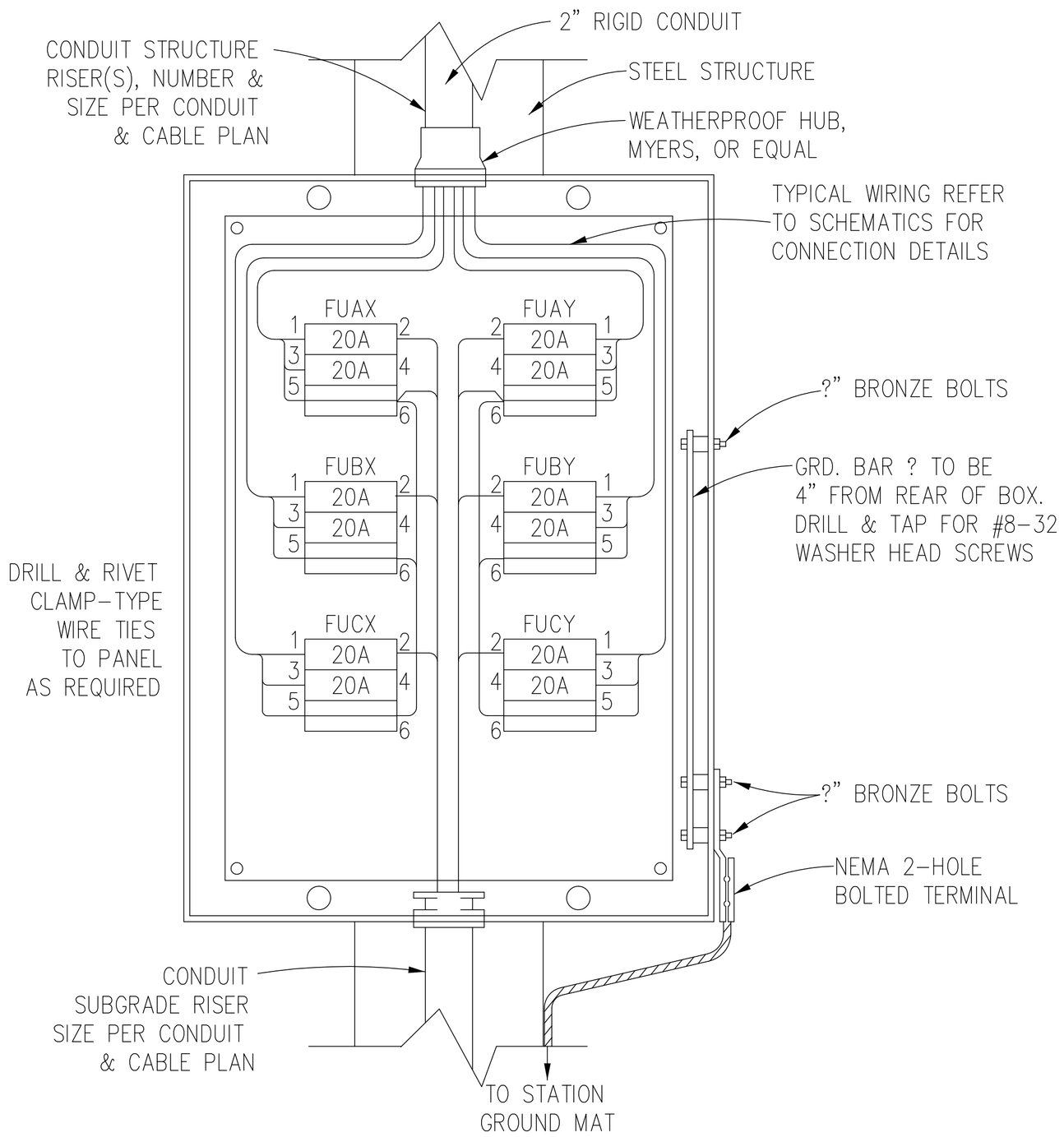
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FILENAME	TWESD-CC-03
SCALE	NONE

SHEET
CC-03

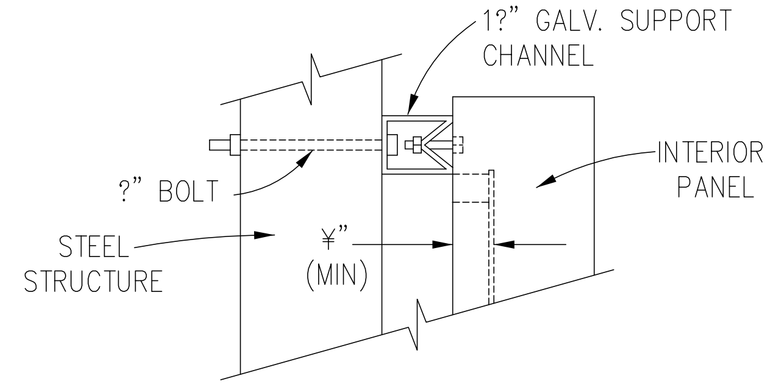


CCVT CONDUIT DETAIL K6 / CC01
N.T.S.



MATERIAL LIST

QUANITY	DESCRIPTION
1	NEMA 3R JUNCTION BOX. 20 X 20 X 8 W/HINGED DOOR, AND ANSI #61 GRAY FINISH. HOFFMAN A20R208HCR, WITH A20P20 INTERIOR PANEL.
6	3P, 30A, 250V REJECTION FUSE BLOCK, WITH SCREW TERMINALS & SPRING REINFORCED CLIPS, FOR RK5 FUSES TAYLOR 20318R
12	FUSES, 250V, 20A, x2", BUSSMAN TYPE NON
1	GROUND BAR, ?" x 1?" x 10" CU. BAR.
AS REQ'D	1?" GALV. SUPPORT CHANEL WITH HARDWARE; POWER-STRUT, OR EQUAL.
AS REQ'D	WIRE TIES, CONDUIT DEVICES AND MTG. HARDWARE.



230KV BUS CCVT JUNCTION BOX MOUNTING DETAIL

MATERIAL ITEM X

REFERENCE DRAWINGS

CONDUIT PLAN CC-01
MATERIAL LIST GA-06

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

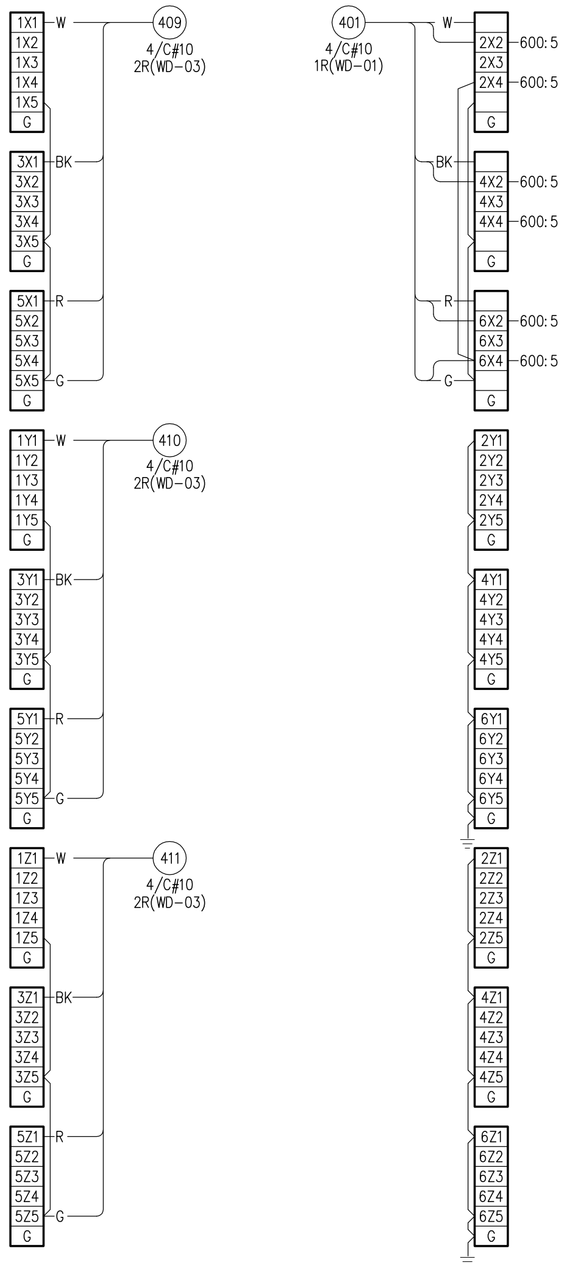
TATANKA WIND ENERGY

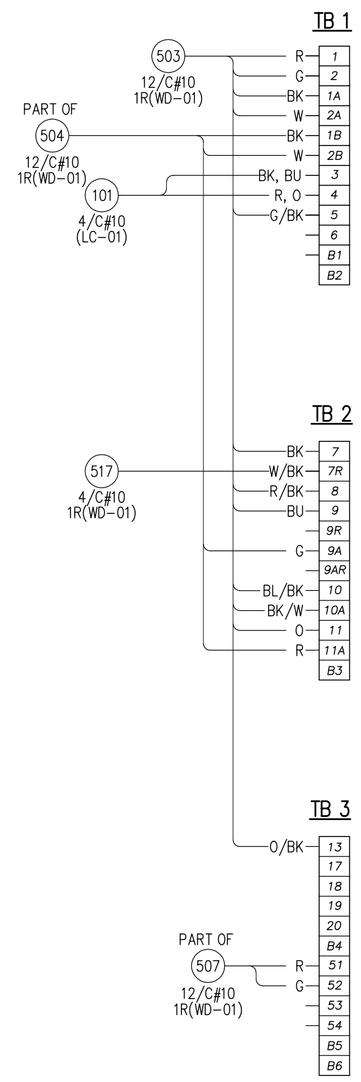
230/34.5kV PROJECT SUBSTATION
CONDUIT DETAIL K6

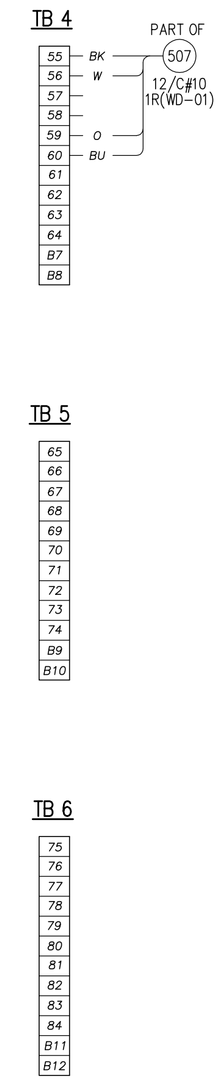
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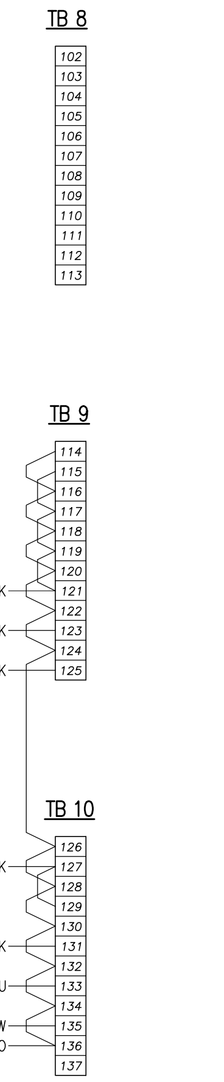
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SCALE	NONE

SHEET **CC-04**

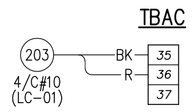


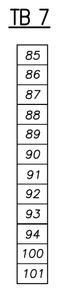


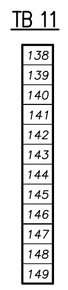












1200 AMP MULTI-RATIO CT'S		
CURRENT RATIO	TURNS RATIO	SECONDARY TAPS
100-5	20-1	X2-X3
200-5	40-1	X1-X2
300-5	60-1	X1-X3
400-5	80-1	X4-X5
500-5	100-1	X3-X4
600-5	120-1	X2-X4
800-5	160-1	X1-X4
900-5	180-1	X3-X5
1000-5	200-1	X2-X5
1200-5	240-1	X1-X5

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
B	11-19-07	REVISED WIRING
A	10-10-07	REVISED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

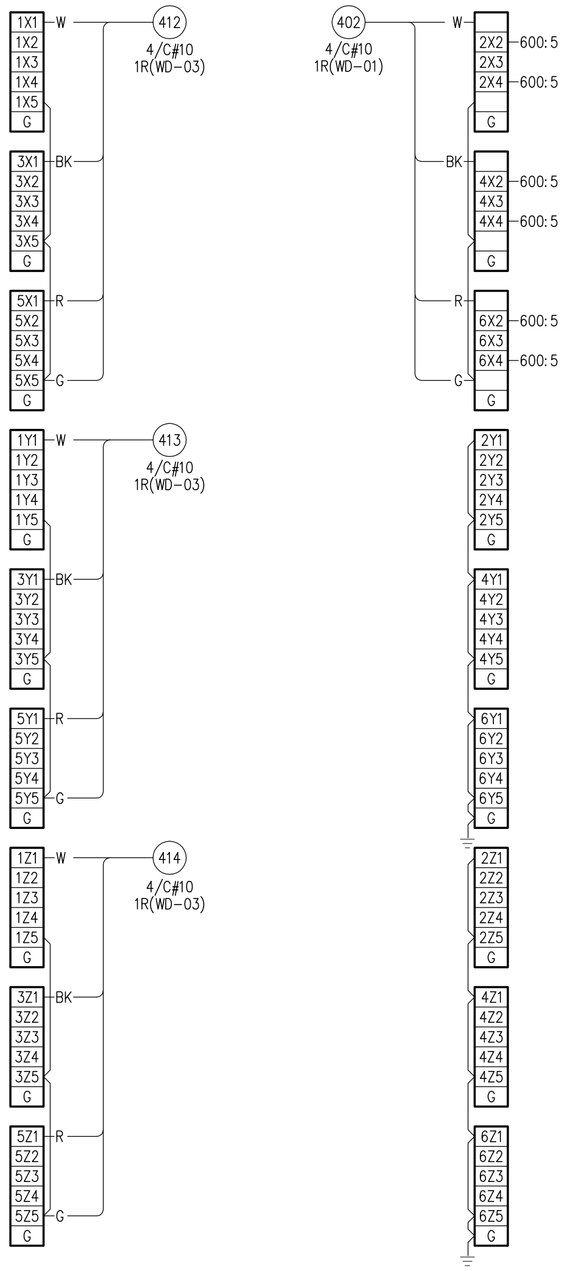
TATANKA WIND ENERGY

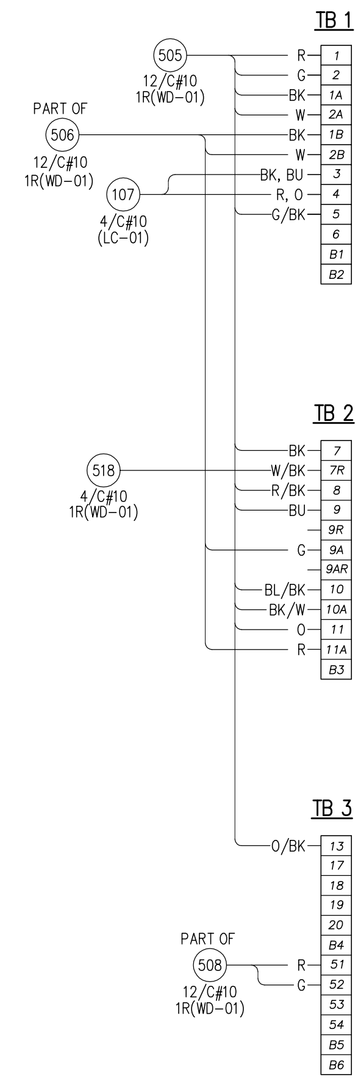
230/34.5kV PROJECT SUBSTATION CB(1) CONNECTION DIAGRAM

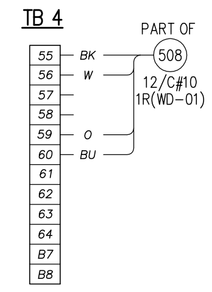
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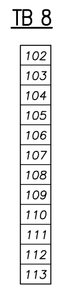
FILENAME	TWESD-CD-01
SCALE	NONE

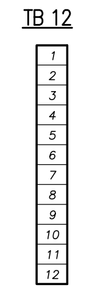
SHEET CD-01

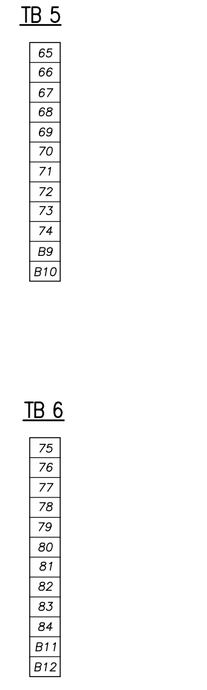


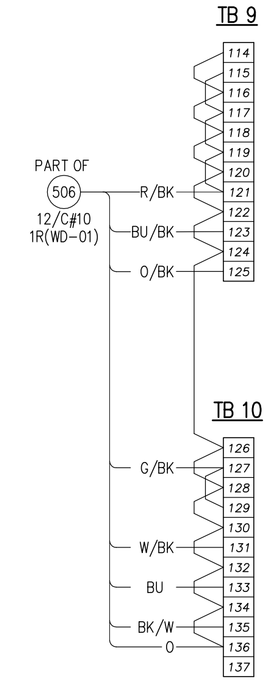


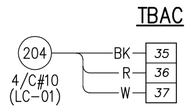


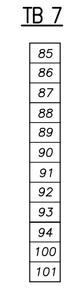


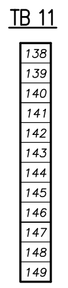












1200 AMP MULTI-RATIO CT'S		
CURRENT RATIO	TURNS RATIO	SECONDARY TAPS
100-5	20-1	X2-X3
200-5	40-1	X1-X2
300-5	60-1	X1-X3
400-5	80-1	X4-X5
500-5	100-1	X3-X4
600-5	120-1	X2-X4
800-5	160-1	X1-X4
900-5	180-1	X3-X5
1000-5	200-1	X2-X5
1200-5	240-1	X1-X5

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
B	11-19-07	REVISED WIRING
A		REVISED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION (CB2) CONNECTION DIAGRAM

0 1" 2"

FILENAME	TWESD-CD-02
SCALE	NONE

SHEET CD-02

BACK PANEL

L-1
1.– B(7), L-2(1)
2.– L-2(2) WHT
B(10) WHT

L-2
1.– L-1(1), L-3(1)
2.– L-1(2) WHT,
L-3(2) WHT

L-3
1.– L-2(1)
2.– L-2(2) WHT

4-1A
A1-4-1B(A1), 43-1(2)
A2-4-1B(A2) WHT
1-8-2A(2)
2-JBF-1(1)
3-8-2A(4)
4-4-1A(5)
5-4-1A(4)
6-JBF-1(2)

4-1B
A1-4-1A(A1), 49-1(2)
A2-4-1A(A2) WHT
4-2A(A2) WHT
1-8-2B(2)
2-JBF-3(1)
3-8-2B(4)
4-4-1B(5)
5-4-1B(4)
6-JBF-3(2)

4-2A
A1-4-2B(A1), 49-1(5)
A2-4-1B(A2) WHT,
4-2B(A2) WHT
1-8-3A(2)
2-JBF-2(1)
3-8-3A(4)
4-4-2A(5)
5-4-2A(4)
6-JBF-2(2)

4-2B
A1-4-2A(A1), 43-2(2)
A2-4-2A(A2) WHT,
B(10) WHT
1-8-3B(2)
2-JBF-4(1)
3-8-3B(4)
4-4-2B(5)
5-4-2B(4)
6-JBF-4(2)

63FP-1X
FU-SR(2), 63FP-1B(K)
FU-SR(4)
SR-T(2)
SR-A(2)
SR-A(4)
SR-T(4)
63FP-1B(BLU)
63FP-1B(RED)

63B-1X
FU-SR1(2), 63B(61)
FU-SR1(4)
SR-T(3)
SR-A(3)
SR-A(5)
SR-T(5)
63B(60)
63B(62)

FU-SR
1– D(1), FU-SR1(1)
2– 63FP–1X(12)
3– D(2), FU-SR1(3)
4– 63FP–1X(11)

FU-SR1
1– FU-SR(1)
2– 63B–1X(12)
3– FU-SR(3)
4– 63B–1X(11)

PROLEC
APPROVAL DRAWING
MAY/18/07
DEAR CUSTOMER :
WE WANT TO SERVE YOU BETTER.
PLEASE REVIEW THIS DRAWING
AND SEND BACK WITH YOUR
COMMENTS OR APPROVAL. THE
TIMETABLE OF PROJECT AFTER
THE DATE MARKED IN THIS STAMP.

Acciona Energía North America
700 Meadow Lane North
Minneapolis, MN 55422
TATANKA WIND FARM SUBSTATION
P.O. # I–001/07
GE Req. # TD600224
GE Prolec Serial: G2049–01 / 02

TRANSFORMER
ONAN/ONAF/ONAF
60/80/100 MVA, 65°C, 60 HZ
THREE PHASE, 3300 FASL
230/132.79 KV–< 34.5/19.918 KV
TERTIARY (BURIED):
21/28/35 MVA, 9.95 KV △

NOTES:

1.– CONDUCTOR TYPE MTW/TEW/AWM, 105°C, 600 V, #14 AWG FOR INSTRUMENTS.
EXCEPT MARKED WITH △ # 12 AWG.
□ # 10 AWG.
* # 8 AWG.
○ # 6 AWG.

2.– TERMINAL BLOCKS FOR INSTRUMENTS ARE DESIGNED FOR 600 V, 30 A MAX.

3.– CONDUCTOR TYPE ETFE 150°C, 600 V, #10 AWG. FOR INTERNAL CT'S & HEATER'S WIRING

4.– CONDUCTOR TYPE MTW/TEW/AWM, 105°C, 600 V, #12 AWG. FOR EXTERNAL CT'S WIRING

49-1
49T-1(BLK) 43-1(4) → 1
49T-1(RED) 4-1B(A1) → 2
49T-1(BLU) → 3
49T-1(ORG) 43-2(4) → 4
49T-1(YEL) 4-2A(A1) → 5
49T-1(BRN) → 6
49T-1(RED/BLK) → 7 BK → (513)
49T-1(BLU/BLK) → 8 W
49T-1(ORG/BLK) → 9
49T-1(YEL/BLK) → 10 BR-T(1), LG-1(2)
49T-1(BRN/BLK) → 11 BR-T(2), LG-1(3)
49T-1(BLK/RED) → 12

26-1
26Q-1(BLK) → 1 R → (513)
26Q-1(RED) → 2 G
26Q-1(BLU) → 3
26Q-1(ORG) → 4 LG-1(2)
26Q-1(YEL) → 5 LG-1(3)
26Q-1(BRN) → 6

26-2
BB(1) → 1
BB(2) → 2
BB(3) → 3
BB(4) → 4 SR-T(3), BR-T(1)
BB(5) → 5 SR-T(4), BR-T(2)
BB(6) → 6

SR-A
63FP-1X(6) → 1 W/BK → (513)
63FP-1X(7) → 2 R/BK
63FP-1X(8) → 3
63B-1X(6) → 4 BU/BK → (513)
63B-1X(7) → 5 BK/W
63B-1X(8) → 6

SR-T
63FP-1X(9) → 1 BK → (501)
63FP-1X(10) → 2 W
63B-1X(9) → 3 26-2(4)
63B-1X(10) → 4 26-2(5)
5
6

PR-1
1 → DA(1)
2 → DA(2)
3 → DA(3)

PR-2
1 → DB(1)
2 → DB(2)
3 → DB(3)

PR-4
1 → DD(1)
2 → DD(2)
3 → DD(3)
4
5
6

LG-1
1 → CA(1)
26-1(4), 49-1(10) → 2 CA(2)
26-1(5), 49-1(11) → 3 CA(3)

LG-2
(513) G/BK → 1 CB(1)
O/BK → 2 CB(2)
3 CB(3)

BR-A
(513) O → 1 63BH-1(13)
BU → 2 63BH-1(14)
3

BR-T
1 63BH-1(23)
26-2(4), 49-1(10) → 2 63BH-1(24)
26-2(5), 49-1(11) → 3

B
SEE NOTE # 4
SEE DRAWING G204901B902
5 → 43-1(1)
6 → 8–CC(2)
7 → 8L–1(1), L–1(1)
△ 23-1(2) → 8 H–1(1) ETFE, H–2(1) ETFE
△B(10) WHT → 9 H–1(2) WHT ETFE, H–2(2) WHT ETFE
△ B(9) WHT, L–1(2) WHT → 10 4–2B(A2) WHT, B(4) WHT △
11
12
13
14
15
16

A
X5(12) → 1
X5(8) → 2
X5(9) → 3
X5(10) → 4
X5(11) → 5
96Z(2) → 6
96Z(1) → 7
8
9
10
11
12

C
X3(4) → 1
90(8) → 2
90(9), X3(5) → 3
90(7), X3(6) → 4
90(2), ACT(3) → 5
90(4), ACT(4) → 6
8–6(1) → 7
90(3) → 8
8–6(2) → 9
90(1) → 10
11
12

D
FU-SR(1) → 1 BK → (501)
FU-SR(3) → 2 R
3
GRDP → 4 G → (201)

B
○ 8–1(1), X1(1) → 1 L1 BK
○ 8–1(3) → 2 L2 R
□ B(4) WHT, X1(2) WHT → 3 LN W
□ B(3) WHT, △B(10) WHT → 4 95–1(2) WHT

405
H1-1
R → X1 1A(1), X2 1A(2), X3 1A(3), X4 1A(4), X5 1A(5), GRD H1–5(GRD) GRN

H0-4
2A(1) → X1
2A(2) → X2
2A(3) → X3
2A(4) → X4
2A(5) → X5
X0–24(GRD) GRN, H2–2(GRD) GRN → GRD

X0-24
X1 2A(6)
X2 2A(7)
X3 2A(8)
X4 2A(9)
X5 2A(10)
GRD H0–4(GRD) GRN, H3–3(GRD) GRN

H1-5
X1 1A(6)
X2 1A(7)
X3 1A(8)
X4 1A(9)
X5 1A(10)
GRD H1–1(GRD) GRN, X1–21(GRD) GRN

H2-2
1A(11) → X1
1A(12) → X2
1A(13) → X3
1A(14) → X4
1A(15) → X5 G
H0–4(GRD) GRN, H2–6(GRD) GRN → GRD
BK → 405

H3-3
W → X1 1A(21)
X2 1A(22)
X3 1A(23)
X4 1A(24)
G → X5 1A(25)
GRD X0–24(GRD) GRN, H3–7(GRD) GRN

403
X1-21
R → X1 2A(11), X2 2A(12), X3 2A(13), X4 2A(14), X5 2A(15), G, GRD H1–5(GRD) GRN, X1–25(GRD) GRN

H2-6
1A(16) → X1
1A(17) → X2
1A(18) → X3
1A(19) → X4
1A(20) → X5
H2–2(GRD) GRN, X2–22(GRD) GRN → GRD

H3-7
X1 1A(26)
X2 1A(27)
X3 1A(28)
X4 1A(29)
X5 1A(30)
GRD H3–3(GRD) GRN, X3–23(GRD) GRN

X1-25
X1 2A(16)
X2 2A(17)
X3 2A(18)
X4 2A(19)
X5 2A(20)
GRD X1–21(GRD) GRN, X2–26(GRD) GRN

X2-22
3A(1) → X1
3A(2) → X2
3A(3) → X3
3A(4) → X4
3A(5) → X5 G
H2–6(GRD) GRN, X2–26(GRD) GRN → GRD
BK → 403

X3-23
W → X1 3A(16)
X2 3A(17)
X3 3A(18)
X4 3A(19)
G → X5 3A(20)
GRD H3–7(GRD) GRN, X3–27(GRD) GRN

X2-26
3A(6) → X1
3A(7) → X2
3A(8) → X3
3A(9) → X4
3A(10) → X5
X2–22(GRD) GRN, X1–25(GRD) GRN → GRD

X3-27
X1 3A(21)
X2 3A(22)
X3 3A(23)
X4 3A(24)
X5 3A(25)
GRD X3–23(GRD) GRN, GRDP GRN

23-1
2○ 1△ 3○
1.– 8–4(2)△
2.– B(8) △

H-1
1.– B(8) ETFE
2.– B(9) WHT ETFE

H-2
1.– B(8) ETFE
2.– B(9) WHT ETFE

GRDP
95–1(3) GRN, TB6(GRD) GRN → TB2(GRD) GRN, TB3(GRD) GRN, TB4(GRD) GRN, TB5(GRD) GRN

GRDP
96Z(3) GRN, X2–AX(GRD) GRN, X3–27(GRD) GRN, TB1(GRD) GRN → JBF–1(GRD) GRN, JBF–2(GRD) GRN, JBF–3(GRD) GRN, JBF–4(GRD) GRN

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
A	11–06–07	REVISED PER VENDOR DRAWINGS
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION TRANSFORMER (1) CABINET CONNECTION DIAGRAM

0 1" 2"

FILENAME	TWESD–CD–03
SCALE	NONE

SHEET CD-03

BACK PANEL

L-1
1.– B(7), L-2(1)
2.– L-2(2) WHT
B(10) WHT

L-2
1.– L-1(1), L-3(1)
2.– L-1(2) WHT,
L-3(2) WHT

L-3
1.– L-2(1)
2.– L-2(2) WHT

4-1A
A1 A2 13 14 23 24
2 4 6 14
A1-4-1B(A1), 43-1(2)
A2-4-1B(A2) WHT
1-8-2A(2)
2-JBF-1(1)
3-8-2A(4)
4-4-1A(5)
5-4-1A(4)
6-JBF-1(2)

4-1B
A1 A2 13 14 23 24
2 4 6 14
A1-4-1A(A1), 49-1(2)
A2-4-1A(A2) WHT
4-2A(A2) WHT
1-8-2B(2)
2-JBF-3(1)
3-8-2B(4)
4-4-1B(5)
5-4-1B(4)
6-JBF-3(2)

4-2A
A1 A2 13 14 23 24
2 4 6 14
A1-4-2B(A1), 49-1(5)
A2-4-1B(A2) WHT,
4-2B(A2) WHT
1-8-3A(2)
2-JBF-2(1)
3-8-3A(4)
4-4-2A(5)
5-4-2A(4)
6-JBF-2(2)

4-2B
A1 A2 13 14 23 24
2 4 6 14
A1-4-2A(A1), 43-2(2)
A2-4-2A(A2) WHT,
B(10) WHT
1-8-3B(2)
2-JBF-4(1)
3-8-3B(4)
4-4-2B(5)
5-4-2B(4)
6-JBF-4(2)

63FP-1X
FU-SR(2), 63FP-1(BLK), FU-SR(4), SR-T(2), SR-A(2), SR-T(1), SR-A(1), 63FP-1(BLU), 63FP-1(RED)

63B-1X
FU-SR1(2), 63B(61), FU-SR1(4), SR-T(5), SR-A(5), SR-T(4), SR-A(4), 63B(60), 63B(62)

FU-SR
1– D(1), FU-SR1(1)
2– 63FP–1X(12)
3– D(2), FU-SR1(3)
4– 63FP–1X(11)

FU-SR1
1– FU-SR(1)
2– 63B–1X(12)
3– FU-SR(3)
4– 63B–1X(11)

PROLEC
APPROVAL DRAWING
MAY/18/07
DEAR CUSTOMER :
WE WANT TO SERVE YOU BETTER. PLEASE REVIEW THIS DRAWING AND SEND BACK WITH YOUR COMMENTS OR APPROVAL BEFORE THE TIMETABLE OF PROJECT IS DUE THE DATE MARKED IN THIS STAMP.

Acciona Energía North America
700 Meadow Lane North
Minneapolis, MN 55422
TATANKA WIND FARM SUBSTATION
P.O. # I–001/07
GE Req. # TD600224
GE Prolec Serial: 02049–01 / 02

TRANSFORMER
ONAN/ONAF/ONAF
60/80/100 MVA, 65°C, 60 HZ
THREE PHASE, 3300 FASL
230/132.79 KV–< 34.5/19.918 KV
TERTIARY (BURIED):
21/28/35 MVA, 9.95 KV Δ

NOTES:

1.– CONDUCTOR TYPE MTW/TEW/AWM, 105°C, 600 V, #14 AWG FOR INSTRUMENTS.
EXCEPT MARKED WITH △ # 12 AWG.
□ # 10 AWG.
* # 8 AWG.
○ # 6 AWG.

2.– TERMINAL BLOCKS FOR INSTRUMENTS ARE DESIGNED FOR 600 V, 30 A MAX.

3.– CONDUCTOR TYPE ETFE 150°C, 600 V, #10 AWG. FOR INTERNAL CT'S & HEATER'S WIRING

4.– CONDUCTOR TYPE MTW/TEW/AWM, 105°C, 600 V, #12 AWG. FOR EXTERNAL CT'S WIRING

49-1
49T–1(BLK) 43–1(4) → 1
49T–1(RED) 4–1B(A1) → 2
49T–1(BLU) → 3
49T–1(ORG) 43–2(4) → 4
49T–1(YEL) 4–2A(A1) → 5
49T–1(BRN) → 6
49T–1(RED/BLK) → 7 BK → 514
49T–1(BLU/BLK) → 8 W
49T–1(ORG/BLK) → 9
49T–1(YEL/BLK) → 10 BR–T(1), LG–1(2)
49T–1(BRN/BLK) → 11 BR–T(2), LG–1(3)
49T–1(BLK/RED) → 12

26-1
26Q–1(BLK) → 1 R → 514
26Q–1(RED) → 2 G
26Q–1(BLU) → 3
26Q–1(ORG) → 4 LG–1(2)
26Q–1(YEL) → 5 LG–1(3)
26Q–1(BRN) → 6

26-2
BB(1) → 1
BB(2) → 2
BB(3) → 3
BB(4) → 4 SR–T(3), BR–T(1)
BB(5) → 5 SR–T(4), BR–T(2)
BB(6) → 6

SR-A
63FP–1X(6) → 1 W/BK → 514
63FP–1X(7) → 2 R/BK
63FP–1X(8) → 3
63B–1X(6) → 4 BU/BK → 514
63B–1X(7) → 5 BK/W
63B–1X(8) → 6

SR-T
63FP–1X(9) → 1 BK → 502
63FP–1X(10) → 2 W
63B–1X(9) → 3 26–2(4)
63B–1X(10) → 4 26–2(5)
5 → 6

PR-1
1 → DA(1)
2 → DA(2)
3 → DA(3)

PR-2
1 → DB(1)
2 → DB(2)
3 → DB(3)

PR-4
1 → DD(1)
2 → DD(2)
3 → DD(3)
4 → 5 → 6

LG-1
1 → CA(1)
26–1(4), 49–1(10) → 2 CA(2)
26–1(5), 49–1(11) → 3 CA(3)

LG-2
514 → G/BK → 1 CB(1)
O/BK → 2 CB(2)
3 CB(3)

BR-A
514 → O → 1 63BH–1(13)
BU → 2 63BH–1(14)
3

BR-T
1 63BH–1(23)
26–2(4), 49–1(10) → 2 63BH–1(24)
26–2(5), 49–1(11) → 3

B
SEE NOTE # 4
SEE DRAWING G204901B902
5 → 43–1(1)
6 → 8–CC(2)
7 → 8L–1(1) L–1(1)
△ 23–1(2) → 8 H–1(1) ETFE H–2(1) ETFE
△B(10) WHT → 9 H–1(2) WHT ETFE H–2(2) WHT ETFE
△ B(9) WHT L–1(2) WHT → 10 4–2B(A2) WHT B(4) WHT △
11 → 12 → 13 → 14 → 15 → 16

A
X5(12) → 1
X5(8) → 2
X5(9) → 3
X5(10) → 4
X5(11) → 5
96Z(2) → 6
96Z(1) → 7
8 → 9 → 10 → 11 → 12

C
X3(4) → 1
90(8) → 2
90(9) X3(5) → 3
90(7) X3(6) → 4
90(2) ACT(3) → 5
90(4) ACT(4) → 6
8–6(1) → 7
90(3) → 8
8–6(2) → 9
90(1) → 10
11 → 12

TO TSF ALARMS
514 → 12/C#10 1R(WD–01)

D
FU–SR(1) → 1 BK → 502
FU–SR(3) → 2 R
3
GRDP → 4 G → 201

B
○ 8–1(1) X1(1) → 1 L1 BK
○ 8–1(3) → 2 L2 R
□ B(4) WHT X1(2) WHT → 3 LN W
□ B(3) WHT △B(10) WHT → 4 95–1(2) WHT

406
H1-1
R → X1 1A(1), X2 1A(2), X3 1A(3), X4 1A(4), X5 1A(5), G → GRD H1–5(GRD) GRN

H0-4
2A(1) → X1
2A(2) → X2
2A(3) → X3
2A(4) → X4
2A(5) → X5
X0–24(GRD) GRN → GRD
H2–2(GRD) GRN

X0-24
X1 2A(6)
X2 2A(7)
X3 2A(8)
X4 2A(9)
X5 2A(10)
GRD H0–4(GRD) GRN, H3–3(GRD) GRN

H1-5
X1 1A(6)
X2 1A(7)
X3 1A(8)
X4 1A(9)
X5 1A(10)
GRD H1–1(GRD) GRN, X1–21(GRD) GRN

H2-2
1A(11) → X1
1A(12) → X2
1A(13) → X3
1A(14) → X4
1A(15) → X5 → G
H0–4(GRD) GRN, H2–6(GRD) GRN → GRD
BK → 406

H3-3
W → X1 1A(21)
X2 1A(22)
X3 1A(23)
X4 1A(24)
G → X5 1A(25)
GRD X0–24(GRD) GRN, H3–7(GRD) GRN

404
X1-21
R → X1 2A(11)
X2 2A(12)
X3 2A(13)
X4 2A(14)
X5 2A(15)
G → GRD H1–5(GRD) GRN, X1–25(GRD) GRN

H2-6
1A(16) → X1
1A(17) → X2
1A(18) → X3
1A(19) → X4
1A(20) → X5
H2–2(GRD) GRN, X2–22(GRD) GRN → GRD

H3-7
X1 1A(26)
X2 1A(27)
X3 1A(28)
X4 1A(29)
X5 1A(30)
GRD H3–3(GRD) GRN, X3–23(GRD) GRN

X1-25
X1 2A(16)
X2 2A(17)
X3 2A(18)
X4 2A(19)
X5 2A(20)
GRD X1–21(GRD) GRN, X2–26(GRD) GRN

X2-22
3A(1) → X1
3A(2) → X2
3A(3) → X3
3A(4) → X4
3A(5) → X5 → G
H2–6(GRD) GRN, X2–26(GRD) GRN → GRD
BK → 404

X3-23
W → X1 3A(16)
X2 3A(17)
X3 3A(18)
X4 3A(19)
G → X5 3A(20)
GRD H3–7(GRD) GRN, X3–27(GRD) GRN

X2-26
3A(6) → X1
3A(7) → X2
3A(8) → X3
3A(9) → X4
3A(10) → X5
X2–22(GRD) GRN, X1–25(GRD) GRN → GRD

X3-27
X1 3A(21)
X2 3A(22)
X3 3A(23)
X4 3A(24)
X5 3A(25)
GRD X3–23(GRD) GRN, GRDP GRN

23-1
2 ⊘ 1 3
1.– 8–4(2)△
2.– B(8) △

H-1
1 ○ 2
1.– B(8) ETFE
2.– B(9) WHT ETFE

H-2
1 ○ 2
1.– B(8) ETFE
2.– B(9) WHT ETFE

GRDP
95–1(3) GRN, TB6(GRD) GRN → TB2(GRD) GRN, TB3(GRD) GRN, TB4(GRD) GRN, TB5(GRD) GRN

GRDP
96Z(3) GRN, X2–AX(GRD) GRN, X3–27(GRD) GRN, TB1(GRD) GRN → JBF–1(GRD) GRN, JBF–2(GRD) GRN, JBF–3(GRD) GRN, JBF–4(GRD) GRN

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HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
A	11–06–07	PER VENDOR DRAWINGS
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

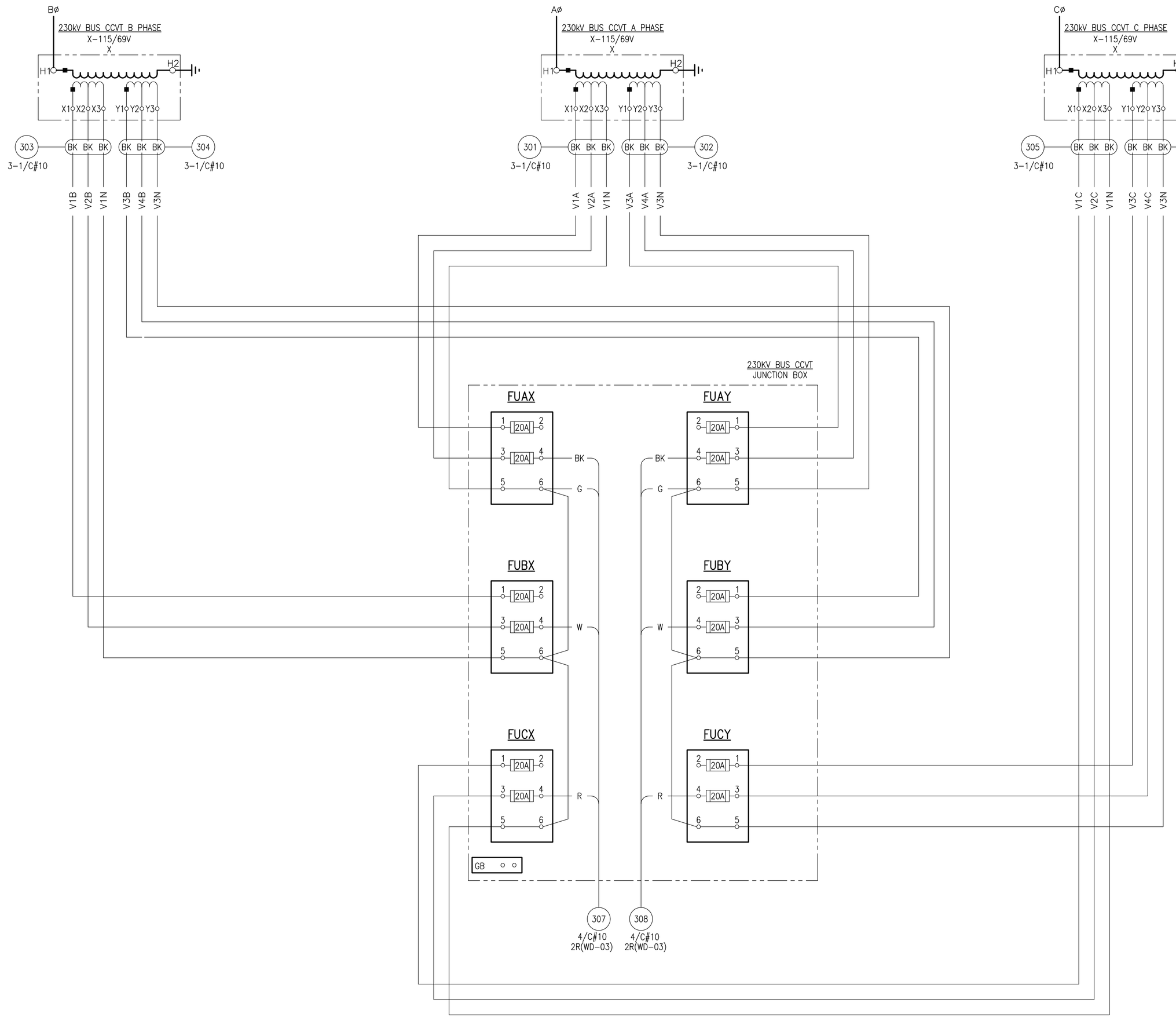
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION TRANSFORMER (2) CABINET CONNECTION DIAGRAM

0 1" 2"

FILENAME	TWESD–CD–04
SCALE	NONE

SHEET CD-04



ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

MORTENSON®

HDR Engineering, Inc.

acciona

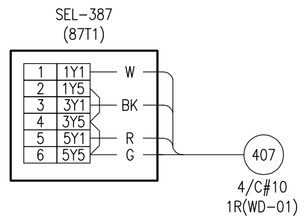
TATANKA WIND ENERGY

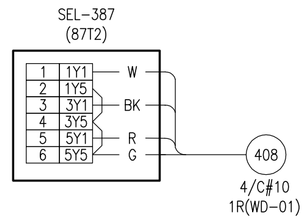
230/34.5kV PROJECT SUBSTATION
230 kV CCVT JUNCTION BOX
CONNECTION DIAGRAM

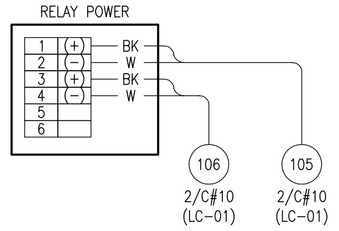
0 1" 2"

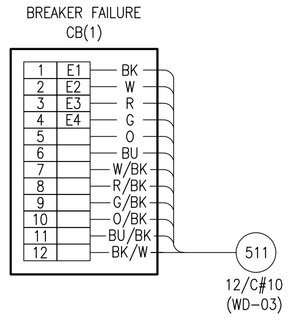
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SCALE	NONE

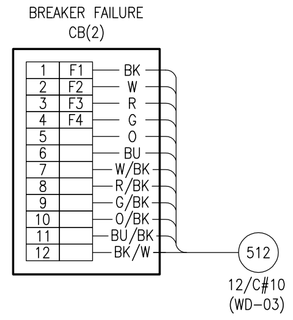
SHEET
CD-05











HOLD FOR
VENDOR INFO.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
34.5kV SWITCHGEAR 1 & 2
CONNECTION DIAGRAM

0 1" 2"

FILENAME	TWESD-CD-06
SCALE	NONE

SHEET
CD-06

D.C. CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
100					
101	DCPB1	CB(1) (MOTOR)	4C#10	200'	CB(1)-MTR
102	DCPB1	RELAY PNL(1R)	2C#10	200'	CB(1)-T1/C
103	DCPB1	RELAY PNL(1R)	2C#10	200'	87T1
104	DCPB1	RELAY PNL(1R)	2C#10	200'	CB(1)-T2
105	DCPB1	SWITCH GEAR T1	2C#10	50'	87MB1
106	DCPB1	SWITCH GEAR T1	2C#10	50'	87MB2
107	DCPB1	CB(2) (MOTOR)	4C#10	200'	CB(2)-MTR
108	DCPB1	RELAY PNL(1R)	2C#10	200'	CB(2)-T1/C
109	DCPB1	RELAY PNL(1R)	2C#10	200'	87T2
110	DCPB1	RELAY PNL(1R)	2C#10	200'	CB(2)-T2
111	DCPB1	RELAY PNL(2R)	2C#10	50'	21AP
112	DCPB1	RELAY PNL(2R)	2C#10	50'	21BP
113	DCPB1	BATT. CHAR.	2C#8	50'	CHARG.
114	DCPB1	RELAY PNL(2R)	2C#10	50'	2030-1/2
115	DCPB1	PANEL 2R	2C#10	50'	BKR FAIL
116	BATTERY	DC DISC.	2C#4/0	20'	DC
117	DC DISC.	DC PANEL	2C#4/0	30'	DC
118	DCPB1	RELAY PNL(2R)	2C#10	50'	2516
119	DCPB1	MDU COMM. RACK	2C#10	50'	MDU TONE PWR

P.T. CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
300					
301	AøCCVT	230kV CCVT JBOX	3-1C#10	40'	AøX
302	AøCCVT	230kV CCVT JBOX	3-1C#10	40'	AøY
303	BøCCVT	230kV CCVT JBOX	3-1C#10	40'	BøX
304	BøCCVT	230kV CCVT JBOX	3-1C#10	40'	BøY
305	CøCCVT	230kV CCVT JBOX	3-1C#10	40'	CøX
306	CøCCVT	230kV CCVT JBOX	3-1C#10	40'	CøY
307	230kV CCVT JBOX	PANEL 2R	4C#10	350'	21AP
308	230kV CCVT JBOX	PANEL 2R	4C#10	350'	21BP

A.C. CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
200					
201	ACPB1	XFMR (1)	4C#4	160'	T1
202	ACPB1	XFMR (2)	4C#10	190'	T2
203	ACPB1	CB(1)	4C#10	200'	CB(1)
204	ACPB1	CB(2)	4C#10	200'	CB(2)
205	ACPB1	BATT. CHAR.	4C#10	50'	CHARG.
206	ACPB1	L1 JB	4C#10	200'	LIGHTS
207	ACPB1	A/C UNIT	5C#4	30'	POWER
208	ACPB2	DRY-TYPE	5C#1/0	30'	POWER
209	ATS 1	ATS 2	(3)4-350KCM 1-#2	20'	POWER
210	STAT. AUX1	ATS 1	(3)4-350KCM 1-#2	100'	POWER
211	ATS 2	ALT SRC DISC.	(3)4-350KCM 1-#2	100'	POWER
212	ACPB1	DRY-TYPE	4-250KCM 1-#2	30'	POWER
213	SWGR 1	STAT. AUX 1	3#1/0 KCM	75'	POWER (35KV)
214	ATS 2	ACPB2	(3)4-350KCM (3)2 AWG.	50'	POWER
215	STAT. AUX2	ATS 1	(3)4-350KCM 1-#2	100'	POWER
216	L1 JB	L2 JB	4C#10	50'	LIGHTS
217	L2 JB	L3 JB	4C#10	40'	LIGHTS
218	ACPB1	L4 JB	4C#10	200'	LIGHTS
219	L4 JB	L5 JB	4C#10	50'	LIGHTS
220	L5 JB	L6 JB	4C#10	40'	LIGHTS
221	SWGR 2	STAT. AUX 2	3#1/0	75'	POWER (35KV)
222	ACPB2	ACPB3	4#500KCM 1-#2	50'	POWER
223	ACPB1	ION 8600	2C#12	10'	POWER

FIBER OPTIC CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
6500	X	X	X	X'	X
6501	SEL-311C-1	FIBER TERM. BOX	2"	35'	
6502	SEL-311C-2	FIBER TERM. BOX	2"	35'	
6503	OPGW	FIBER TERM. BOX	2"	200'	
6504	SEL-2516	SEL-2030-2 (PRT 1)	2"	20'	

COMMUNICATION CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
6700	X	X	X	X'	X
6701	2030-1(PRT 1)	SEL-387 (87T1)	C273A	50'	
6702	2030-1(PRT 2)	SEL-351 (50MB1)	C273A	50'	
6703	2030-1(PRT 3)	SEL-387(87MB1)	C273A	50'	
6704	2030-1(PRT 4)	SEL-351(FD1:2)	C273A	40'	
6705	2030-1(PRT 5)	SEL-351(FD2:2)	C273A	40'	
6706	2030-1(PRT 6)	SEL-351(FD3:2)	C273A	30'	
6707	2030-1(PRT 7)	SEL-351(FD4:2)	C273A	30'	
6708	(NOT USED)				
6709	2030-1(PRT 9)	SEL-387(87T2)	C273A	80'	
6710	2030-1(PRT 10)	SEL-351(50MB2)	C273A	80'	
6711	2030-1(PRT 11)	SEL-387(87MB2)	C273A	80'	
6712	2030-1(PRT 12)	SEL-351(FD5:2)	C273A	80'	
6713	2030-1(PRT 13)	SEL-351(FD6:2)	C273A	70'	
6714	2030-1(PRT 14)	SEL-351(FD7:2)	C273A	70'	
6715	2030-1(PRT 15)	SEL-351(FD8:2)	C273A	60'	
6716	2030-1(PRT 16)	OPER. BUILD	C276		
6717	2030-1(PRT 8)	SEL-311C(21AP)	C273A	20'	
6718	2030-2(PRT 2)	SEL-311C(21BP)	C273A	20'	
6719	2030-2(PRT 9)	SEL-351(AUX1)	C273A	60'	
6720	2030-2(PRT 10)	SEL-351(AUX2)	C273A	90'	
6721	ARB. 1088B	BNC CONN.	C953	20'	
6722	BNC CONN.	2030-1(IRIG-B)	C953	20'	
6723	BNC CONN.	2030-2(IRIG-B)	C953	20'	
6724	2030-2(PRT 3)	SEL-501(51T1)	C273A		
6725	2030-2(PRT 4)	SEL-501(51T2)	C273A		
6726	2030-2(PRT 11)	SEL-501(508F)	C273A		
6727	2030-2(PRT 16)	OPER. BLDG.	C276		
6728	2030-2(PRT 12)	SEL-351(FD1:3)	C273A	40'	
6729	2030-2(PRT 13)	SEL-351(FD2:3)	C273A	40'	
6730	2030-2(PRT 14)	SEL-351(FD3:3)	C273A	30'	
6731	2030-2(PRT 15)	SEL-351(FD4:3)	C273A	30'	
6732	2030-2(PRT 5)	SEL-351(FD5:3)	C273A	80'	
6733	2030-2(PRT 6)	SEL-351(FD6:3)	C273A	70'	
6734	2030-2(PRT 7)	SEL-351(FD7:3)	C273A	70'	
6735	2030-2(PRT 8)	SEL-351(FD8:3)	C273A	60'	

C.T. CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
400					
401	CB(1)	RELAY PNL (1R)	4C#10	190'	87T1
402	CB(2)	RELAY PNL (1R)	4C#10	190'	87T2
403	XFMR (1)	RELAY PNL (1R)	4C#10	150'	87T1
404	XFMR (2)	RELAY PNL (1R)	4C#10	180'	87T2
405	XFMR (1)	RELAY PNL (1R)	4C#10	150'	51T1
406	XFMR (2)	RELAY PNL (1R)	4C#10	180'	51T2
407	MB1	RELAY PNL (1R)	4C#10	60'	87T1
408	MB2	RELAY PNL (1R)	4C#10	80'	87T2
409	CB(1)	RELAY PNL (2R)	4C#10	190'	21AP
410	CB(1)	RELAY PNL (2R)	4C#10	190'	21BP
411	CB(1)	RELAY PNL (2R)	4C#10	190'	50BF
412	CB(2)	RELAY PNL (2R)	4C#10	190'	21AP
413	CB(2)	RELAY PNL (2R)	4C#10	190'	21BP
414	CB(2)	RELAY PNL (2R)	4C#10	190'	50BF

CONTROL CABLES

CABLE No.	FROM	TO	COND	L'GTH	APPLICATION
500					
501	XFMR (1)	RELAY PNL (1R)	12C#10	130'	87T1
502	XFMR (2)	RELAY PNL (1R)	12C#10	130'	87T2
503	CB(1)	RELAY PNL (1R)	12C#10	170'	CB(1)-T1/C
504	CB(1)	RELAY PNL (1R)	12C#10	170'	CB(1)-T2/ALMS
505	CB(2)	RELAY PNL (1R)	12C#10	170'	CB(2)-T1/C
506	CB(2)	RELAY PNL (1R)	12C#10	170'	CB(2)-T2/ALMS
507	CB(1) (AUX)	RELAY PNL (1R)	12C#10	170'	87T1
508	CB(2) (AUX)	RELAY PNL (1R)	12C#10	170'	87T2
509	RELAY PNL (1R)	RELAY PNL (2R)	12C#10	10'	CB1
510	RELAY PNL (1R)	RELAY PNL (2R)	12C#10	10'	CB2
511	RELAY PNL (2R)	SWGR1	12C#10	30'	MB1
512	RELAY PNL (2R)	SWGR2	12C#10	60'	MB2
513	XFMR (1)	RELAY PNL (1R)	12C#10	130'	ALARMS
514	XFMR (2)	RELAY PNL (1R)	12C#10	130'	ALARMS
515	RELAY PNL (1R)	RELAY PNL (2R)	12C#10	10'	MB1,MB2
516	RELAY PNL (2R)	MDU TONE	2C#10	100'	SPS
517	CB(1)	RELAY PNL (1R)	4C#10	170'	CB(1)
518	CB(2)	RELAY PNL (1)	4C#10	170'	CB(2)

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HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
C	11-19-07	REMOVED TEMP SWGR
B	10-23-07	PER VENDOR DRAWINGS
A	09-19-07	ISSUED FOR REVIEW - SPS UPGRADE
1	09-04-07	ADD NEW METERED FDR&PANEL FOR O+M BUILDING
0	03-30-07	ISSUED FOR CONSTUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

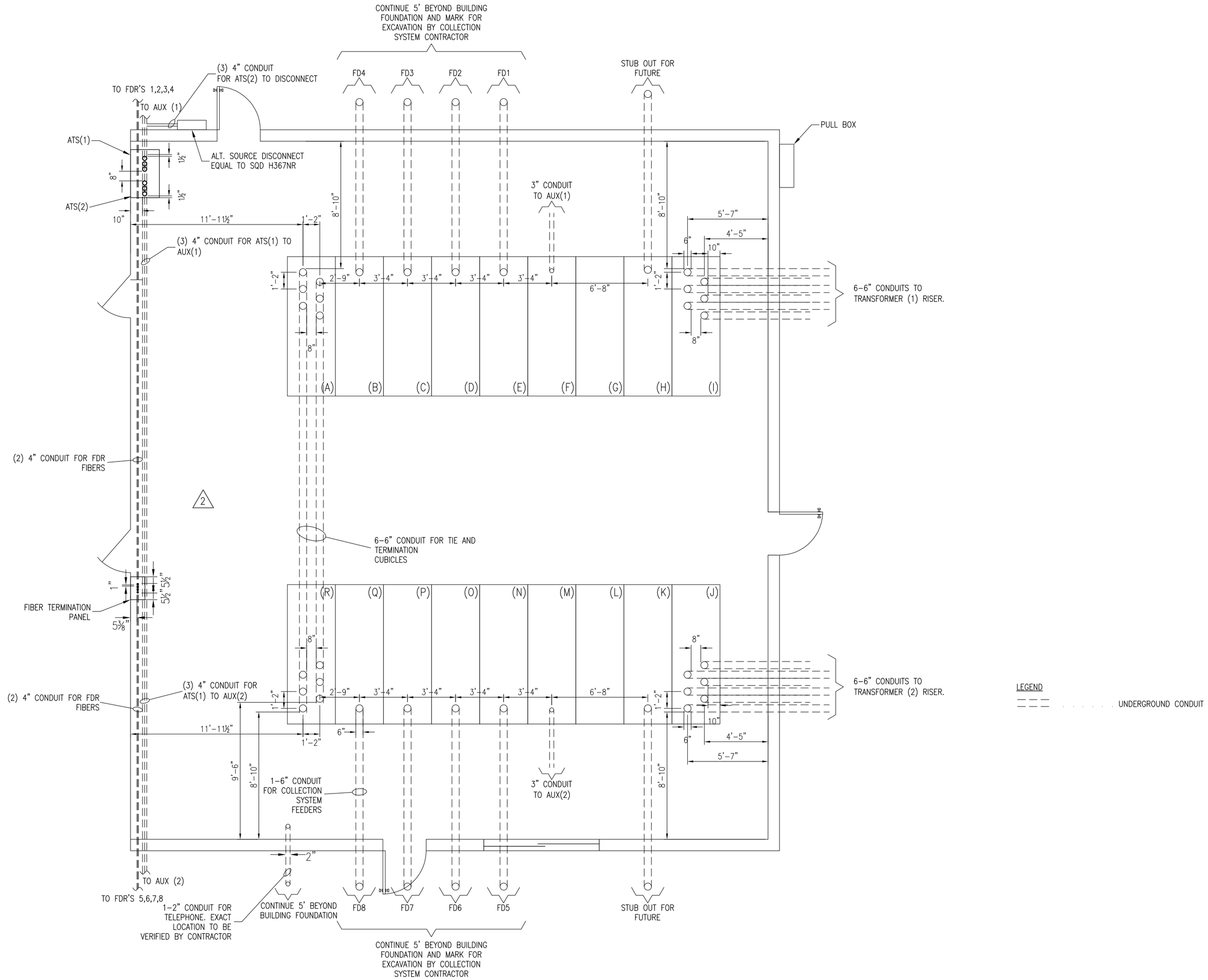
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION CABLE LIST

0 1" 2"

FILENAME	TWESD-CL-01
SCALE	NONE

SHEET **CL-01**



MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
2	09-28-07	CONTROL ROOM CHANGES
1	09-04-07	REVISED PER MANUF. DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

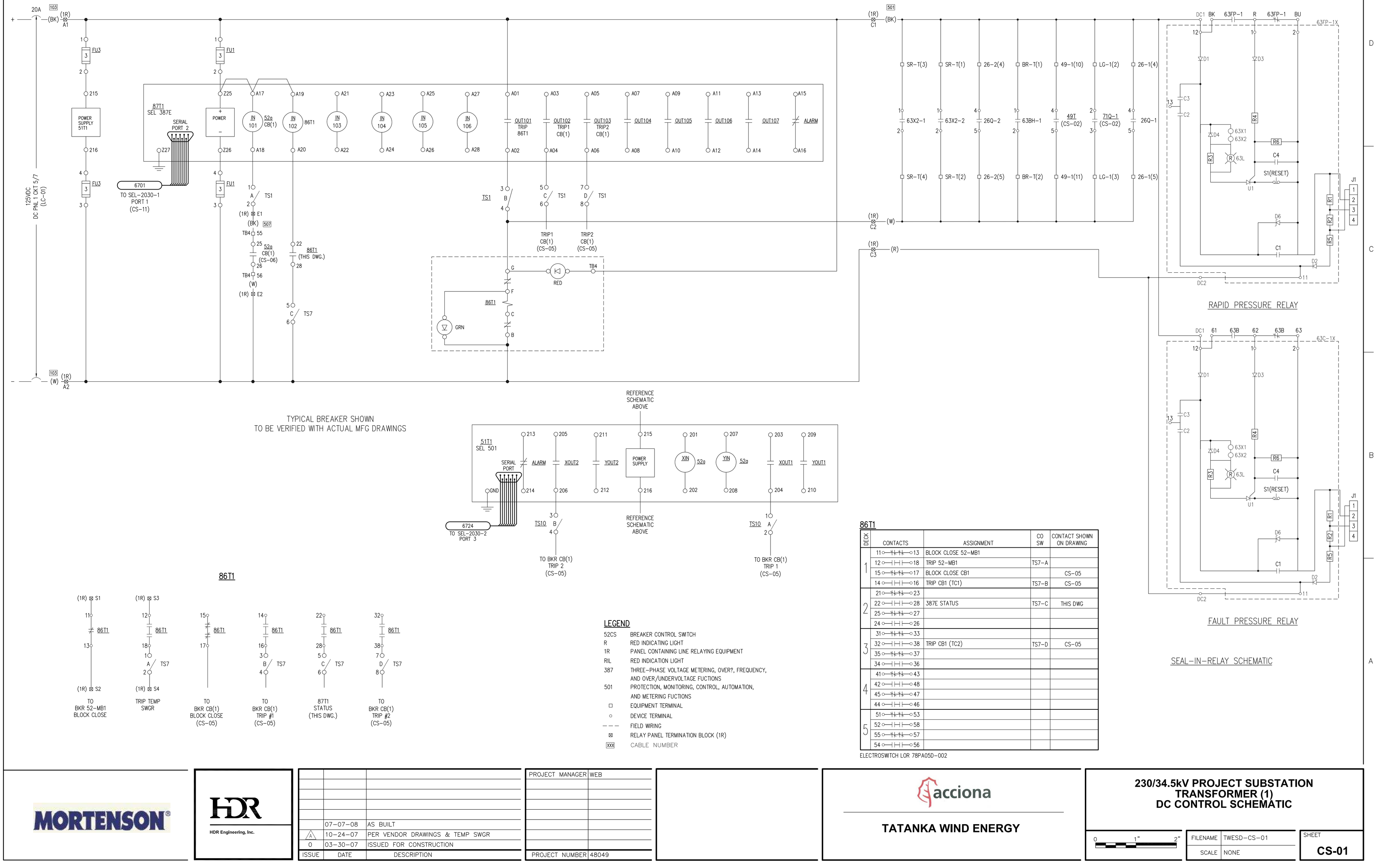
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION ELECTRICAL BUILDING CONDUIT PLAN

0 1" 2"

FILENAME	TWESD-CP-01
SCALE	1/4"=1'

SHEET
CP-01



86T1

LEGEND

52CS	BREAKER CONTROL SWITCH
R	RED INDICATING LIGHT
1R	PANEL CONTAINING LINE RELAYING EQUIPMENT
RIL	RED INDICATION LIGHT
387	THREE-PHASE VOLTAGE METERING, OVER?, FREQUENCY, AND OVER/UNDERVOLTAGE FUCTIONS
501	PROTECTION, MONITORING, CONTROL, AUTOMATION, AND METERING FUCTIONS
□	EQUIPMENT TERMINAL
○	DEVICE TERMINAL
– – –	FIELD WIRING
⊠	RELAY PANEL TERMINATION BLOCK (1R)
XXX	CABLE NUMBER

86T1

DECK	CONTACTS	ASSIGNMENT	CO SW	CONTACT SHOWN ON DRAWING
1	11 – 13	BLOCK CLOSE 52-MB1		
	12 – 18	TRIP 52-MB1	TS7-A	
	15 – 17	BLOCK CLOSE CB1		CS-05
	14 – 16	TRIP CB1 (TC1)	TS7-B	CS-05
2	21 – 23			
	22 – 28	387E STATUS	TS7-C	THIS DWG
	25 – 27			
	24 – 26			
3	31 – 33			
	32 – 38	TRIP CB1 (TC2)	TS7-D	CS-05
	35 – 37			
	34 – 36			
4	41 – 43			
	42 – 48			
	45 – 47			
	44 – 46			
5	51 – 53			
	52 – 58			
	55 – 57			
	54 – 56			

ELECTROSWITCH LOR 78PA05D-002

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-24-07	PER VENDOR DRAWINGS & TEMP SWGR
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

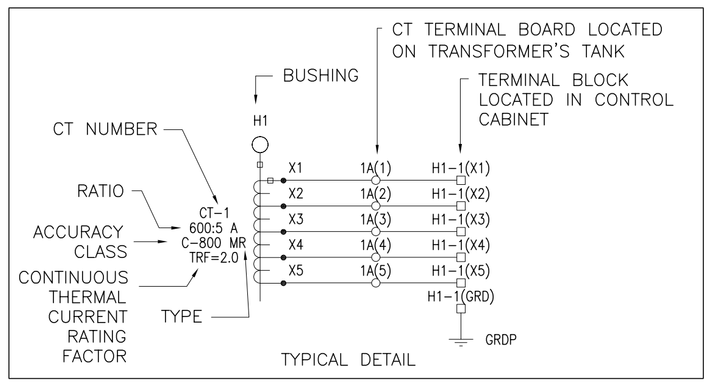
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION TRANSFORMER (1) DC CONTROL SCHEMATIC

0 1" 2"

FILENAME	TWESD-CS-01
SCALE	NONE

SHEET CS-01



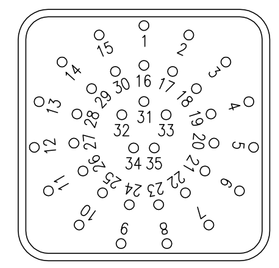
TYPICAL DETAIL

W A R N I N G !
SHORT CIRCUIT CURRENT TRANSFORMER TERMINAL BLOCKS DURING TESTING AND SHIPMENT

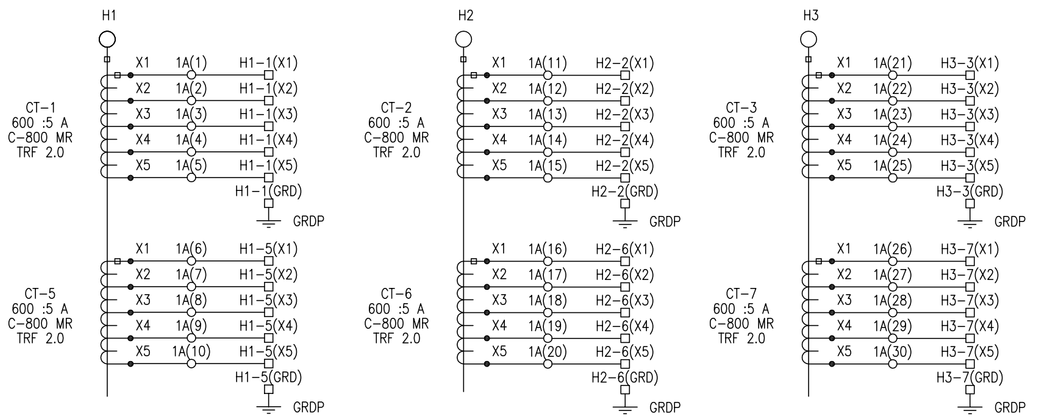
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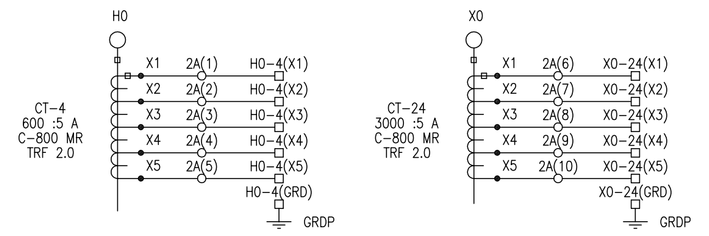
1.– CONDUCTOR TYPE MTW/TEW/AWM, 105°C, 600 V, #12 AWG FOR CT'S EXTERNAL WIRING
2.– CONDUCTOR TYPE ETFE, 150°C, 600 V, # 10 AWG. FOR CT'S INTERNAL WIRING
3.– SEE DRAWING G204901D905 FOR TERMINAL BLOCK LOCATIONS.
4.– TERMINAL BLOCKS FOR CT'S ARE SHORTING TYPE, 600 V, 30 A, 6 POLES.

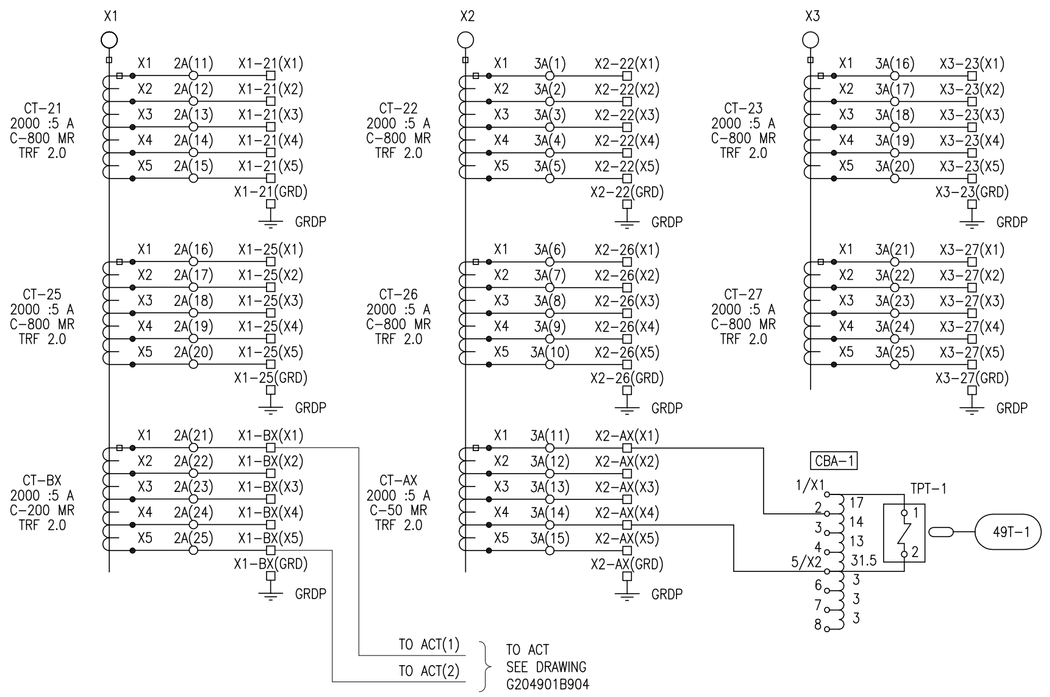
CT'S TERMINAL BOARD



LEGEND	DESCRIPTION
1A/2A/3A	CT'S TERMINAL BOARD.
49T–1	WINDING TEMPERATURE INDICATOR
CBA–1	CURRENT BALANCING AUTOTRANSFORMER
TPT–1	THERMAL PLATE
H1–1..X2–AX	TERMINAL BLOCKS FOR CT'S



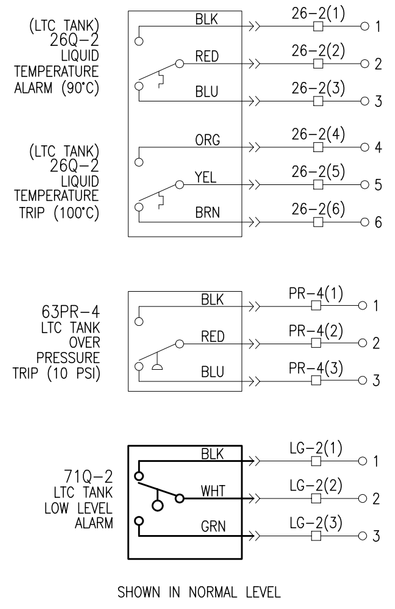




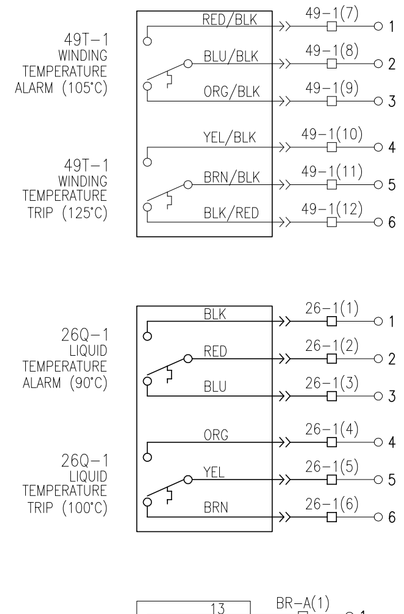
600:5A	
RATIO	TERMINALS
50:5A	X2–X3
100:5A	X1–X2
150:5A	X1–X3
200:5A	X4–X5
250:5A	X3–X4
300:5A	X2–X4
400:5A	X1–X4
450:5A	X3–X5
500:5A	X2–X5
600:5A	X1–X5

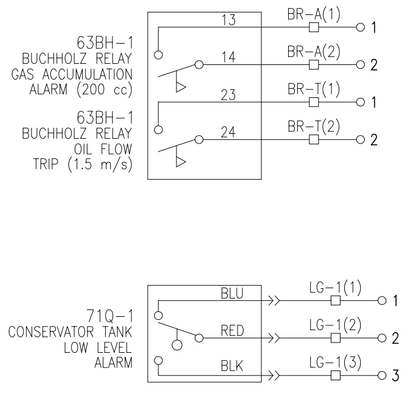
2000:5A	
RATIO	TERMINALS
300:5A	X3–X4
400:5A	X1–X2
500:5A	X4–X5
800:5A	X2–X3
800:5A	X3–X5
1100:5A	X2–X4
1200:5A	X1–X3
1500:5A	X1–X4
1600:5A	X2–X5
2000:5A	X1–X5

3000:5A	
RATIO	TERMINALS
300:5A	X3–X4
500:5A	X4–X5
800:5A	X3–X5
1000:5A	X1–X2
1200:5A	X2–X3
1500:5A	X2–X4
2000:5A	X2–X5
2200:5A	X1–X3
2500:5A	X1–X4
3000:5A	X1–X5

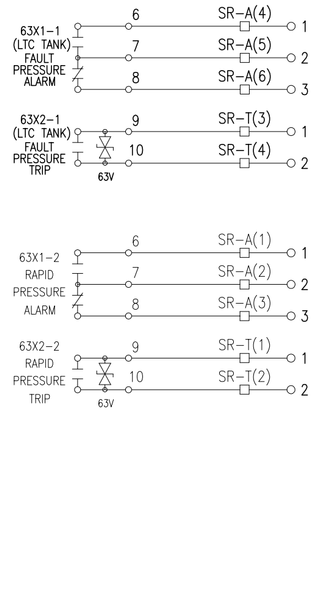


SHOWN IN NORMAL LEVEL





SHOWN IN NORMAL LEVEL



ALARM CONTACTS

LEGEND

XXX – CABLE NUMBER

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
A	10–25–07	PER VENDOR DRAWINGS
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

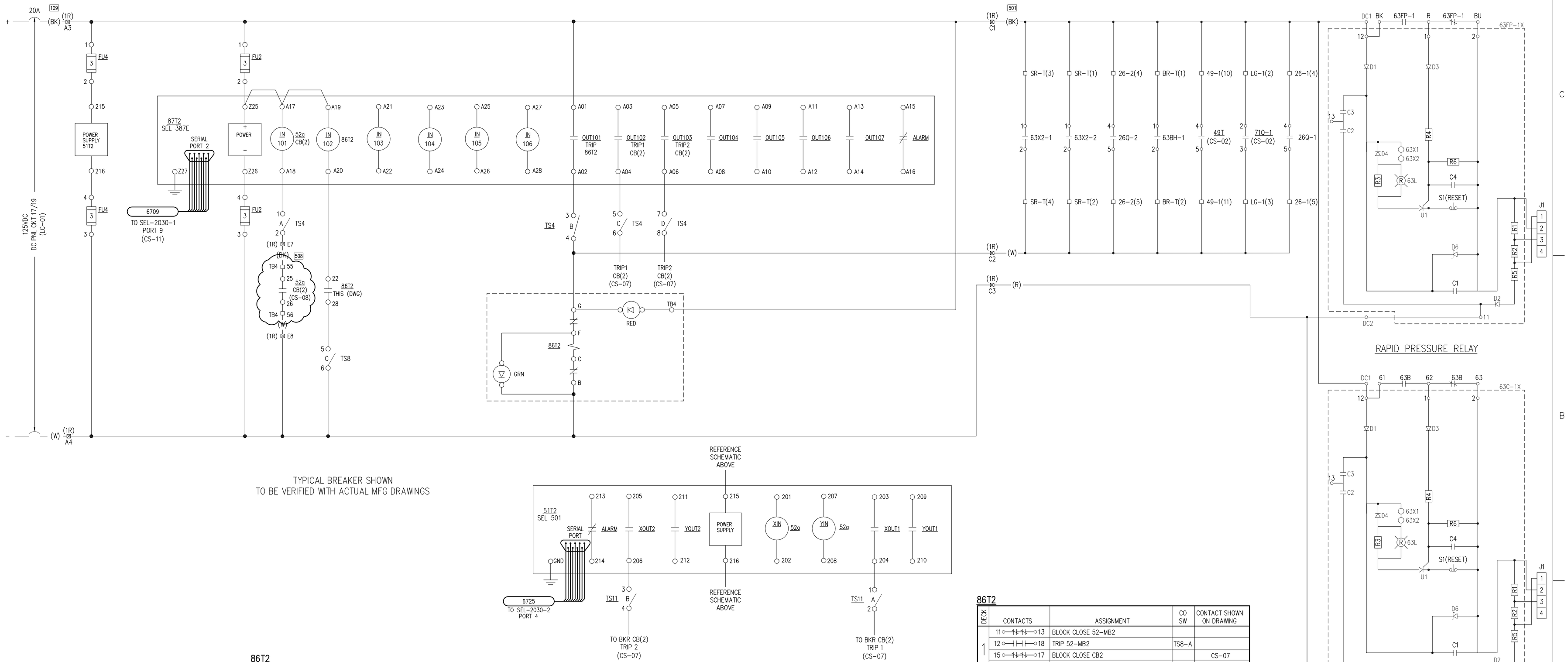
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION TRANSFORMER (1) AC CONTROL SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD–CS–02
SCALE	NONE

SHEET CS-02



LEGEND

52CS	BREAKER CONTROL SWITCH
R	RED INDICATING LIGHT
1R	PANEL CONTAINING LINE RELAYING EQUIPMENT
RIL	RED INDICATION LIGHT
387	THREE-PHASE VOLTAGE METERING, OVER?, FREQUENCY, AND OVER/UNDERVOLTAGE FUCTIONS
501	PROTECTION, MONITORING, CONTROL, AUTOMATION, AND METERING FUCTIONS
□	EQUIPMENT TERMINAL
○	DEVICE TERMINAL
– – –	FIELD WIRING
⊠	RELAY PANEL TERMINATION BLOCK (1R)
XXX	CABLE NUMBER

86T2

DECK	CONTACTS	ASSIGNMENT	CO SW	CONTACT SHOWN ON DRAWING
1	11–13	BLOCK CLOSE 52-MB2		
	12–18	TRIP 52-MB2	TS8-A	
	15–17	BLOCK CLOSE CB2		CS-07
	14–16	TRIP CB2 (TC1)	TS8-B	CS-07
2	21–23			
	22–28	387E STATUS	TS8-C	THIS DWG
	25–27			
	24–26			
3	31–33			
	32–38	TRIP CB2 (TC2)	TS8-D	CS-07
	35–37			
	34–36			
4	41–43			
	42–48			
	45–47			
	44–46			
5	51–53			
	52–58			
	55–57			
	54–56			

ELECTROSWITCH LOR 78PA05D-002

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-25-07	PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

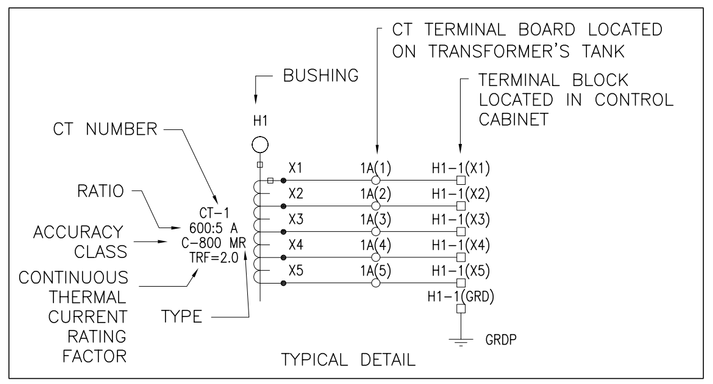
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION TRANSFORMER (2) DC CONTROL SCHEMATIC

0 1" 2"

FILENAME	TWESD-CS-03
SCALE	NONE

SHEET CS-03



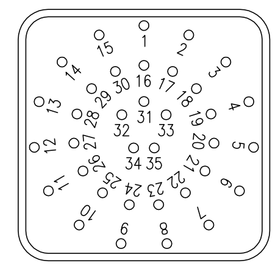
TYPICAL DETAIL

W A R N I N G !
SHORT CIRCUIT CURRENT TRANSFORMER TERMINAL BLOCKS DURING TESTING AND SHIPMENT

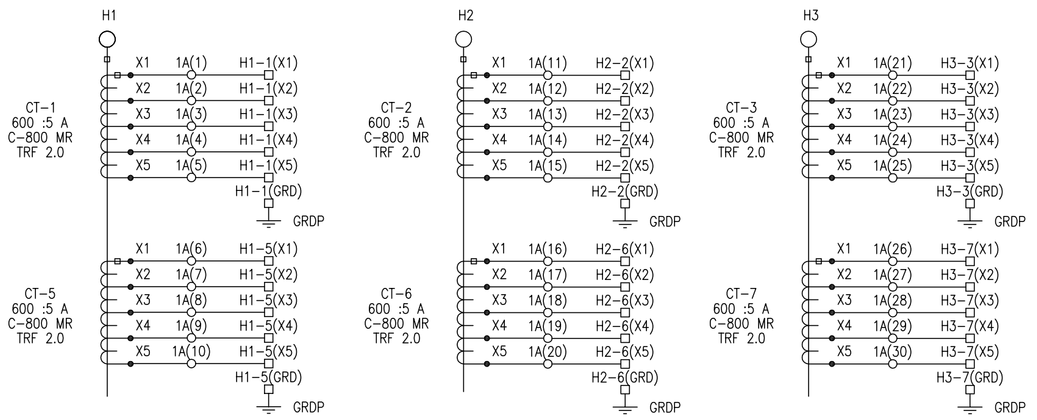
NOTES:

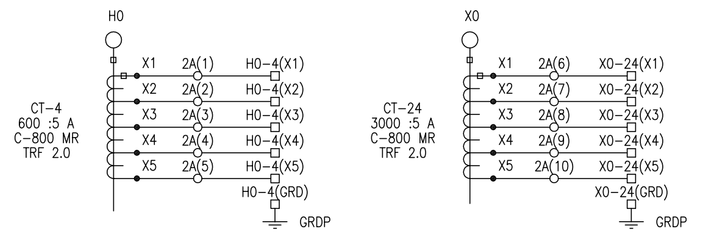
1.– CONDUCTOR TYPE MTW/TEW/AWM, 105°C, 600 V, #12 AWG FOR CT'S EXTERNAL WIRING
2.– CONDUCTOR TYPE ETFE, 150°C, 600 V, # 10 AWG. FOR CT'S INTERNAL WIRING
3.– SEE DRAWING G204901D905 FOR TERMINAL BLOCK LOCATIONS.
4.– TERMINAL BLOCKS FOR CT'S ARE SHORTING TYPE, 600 V, 30 A, 6 POLES.

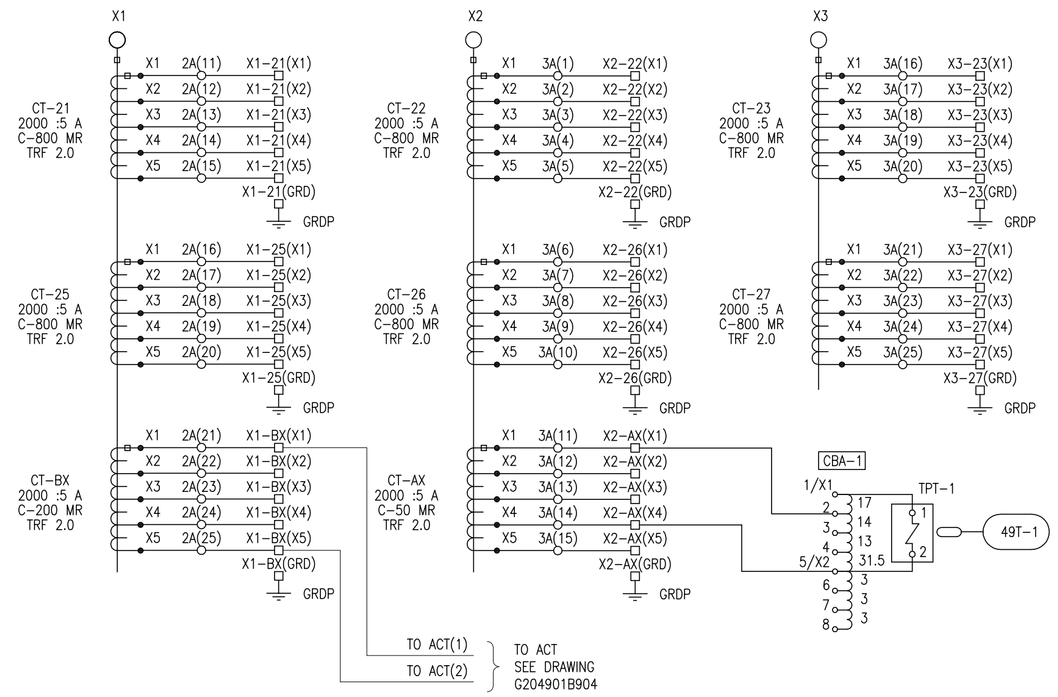
CT'S TERMINAL BOARD



LEGEND	DESCRIPTION
1A/2A/3A	CT'S TERMINAL BOARD.
49T–1	WINDING TEMPERATURE INDICATOR
CBA–1	CURRENT BALANCING AUTOTRANSFORMER
TPT–1	THERMAL PLATE
H1–1..X2–AX	TERMINAL BLOCKS FOR CT'S



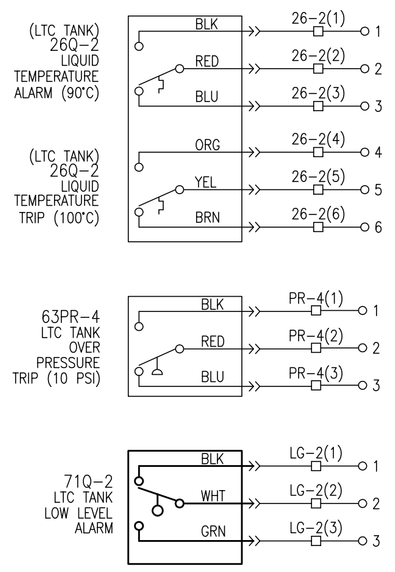




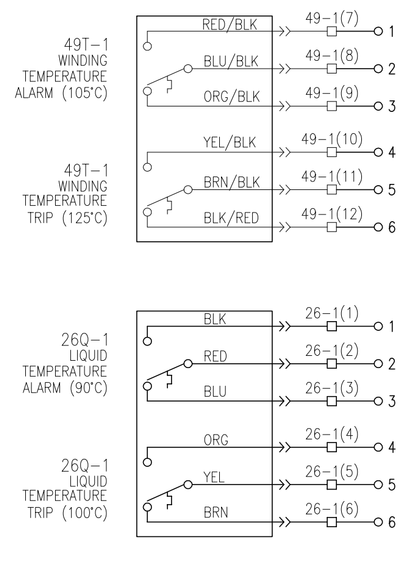
600:5A	
RATIO	TERMINALS
50:5A	X2–X3
100:5A	X1–X2
150:5A	X1–X3
200:5A	X4–X5
250:5A	X3–X4
300:5A	X2–X4
400:5A	X1–X4
450:5A	X3–X5
500:5A	X2–X5
600:5A	X1–X5

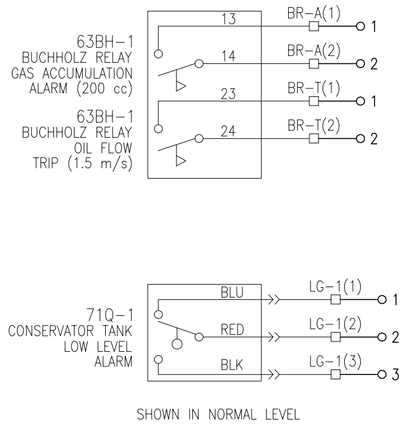
2000:5A	
RATIO	TERMINALS
300:5A	X3–X4
400:5A	X1–X2
500:5A	X4–X5
800:5A	X2–X3
800:5A	X3–X5
1100:5A	X2–X4
1200:5A	X1–X3
1500:5A	X1–X4
1600:5A	X2–X5
2000:5A	X1–X5

3000:5A	
RATIO	TERMINALS
300:5A	X3–X4
500:5A	X4–X5
800:5A	X3–X5
1000:5A	X1–X2
1200:5A	X2–X3
1500:5A	X2–X4
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2200:5A	X1–X3
2500:5A	X1–X4
3000:5A	X1–X5

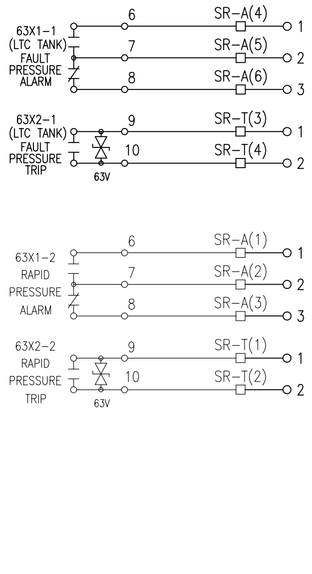


SHOWN IN NORMAL LEVEL





SHOWN IN NORMAL LEVEL



ALARM CONTACTS

LEGEND

XXX – CABLE NUMBER

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
A	10–25–07	PER VENDOR DRAWINGS
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

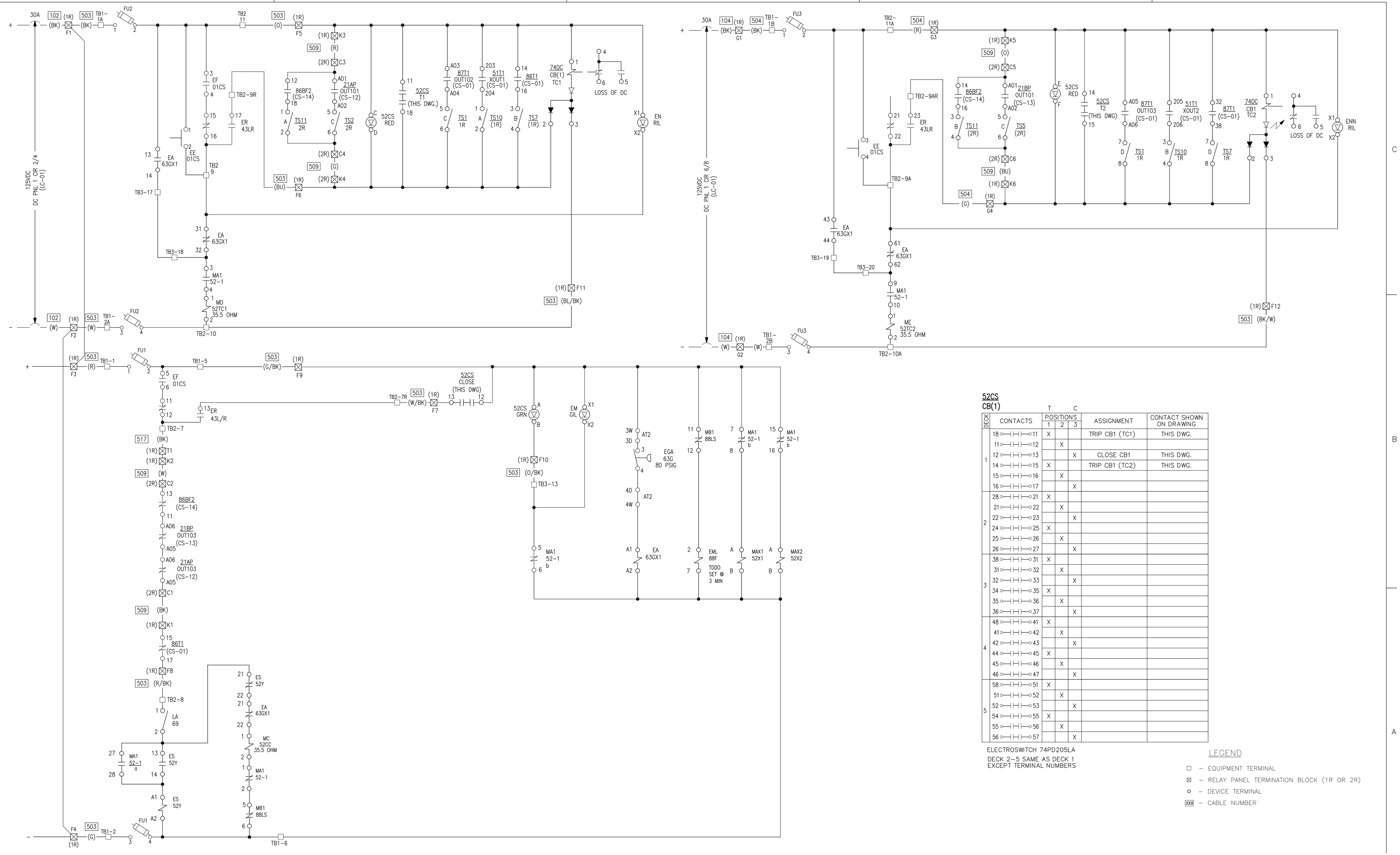
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION TRANSFORMER (2) AC CONTROL SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD–CS–04
SCALE	NONE

SHEET CS-04



52CS
CB(1)

DECK	CONTACTS	T	C		ASSIGNMENT	CONTACT SHOWN ON DRAWING
		POSITIONS 1	2	3		
1	18 — 11	X			TRIP CB1 (TC1)	THIS DWG.
	11 — 12		X			
	12 — 13			X	CLOSE CB1	THIS DWG.
	14 — 15	X			TRIP CB1 (TC2)	THIS DWG.
	15 — 16		X			
	16 — 17			X		
2	28 — 21	X				
	21 — 22		X			
	22 — 23			X		
	24 — 25	X				
	25 — 26		X			
	26 — 27			X		
3	38 — 31	X				
	31 — 32		X			
	32 — 33			X		
	34 — 35	X				
	35 — 36		X			
	36 — 37			X		
4	48 — 41	X				
	41 — 42		X			
	42 — 43			X		
	44 — 45	X				
	45 — 46		X			
	46 — 47			X		
5	58 — 51	X				
	51 — 52		X			
	52 — 53			X		
	54 — 55	X				
	55 — 56		X			
	56 — 57			X		

ELECTROSWITCH 74PD205LA
DECK 2–5 SAME AS DECK 1 EXCEPT TERMINAL NUMBERS

LEGEND
- □ – EQUIPMENT TERMINAL
- ⊠ – RELAY PANEL TERMINATION BLOCK (1R OR 2R)
- o – DEVICE TERMINAL
- XXX – CABLE NUMBER

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
B	11–19–07	REVISED WIRING
A	10–12–07	REVISED PER VENDOR DRAWINGS
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

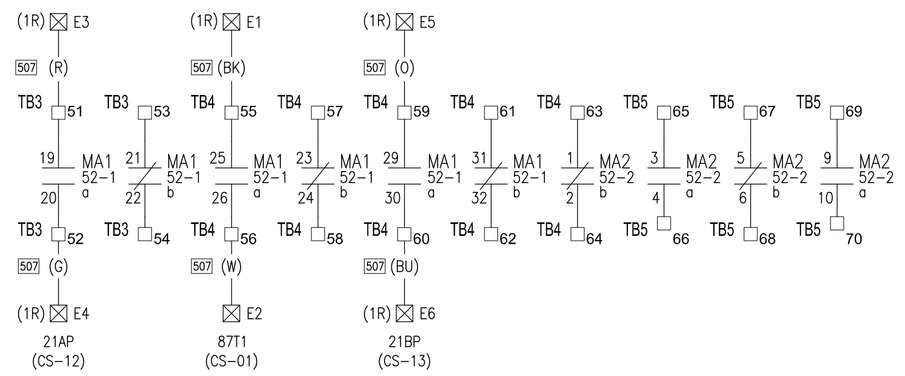
230/34.5kV PROJECT SUBSTATION TRIP AND CLOSE (CB1) DC SCHEMATIC DIAGRAM

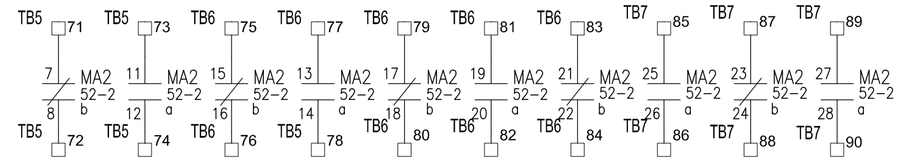
0 1" 2"

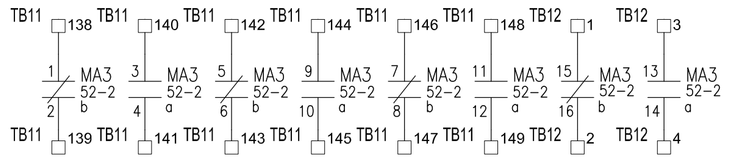
FILENAME	TWESD–CS–05
SCALE	NONE

SHEET **CS-05**

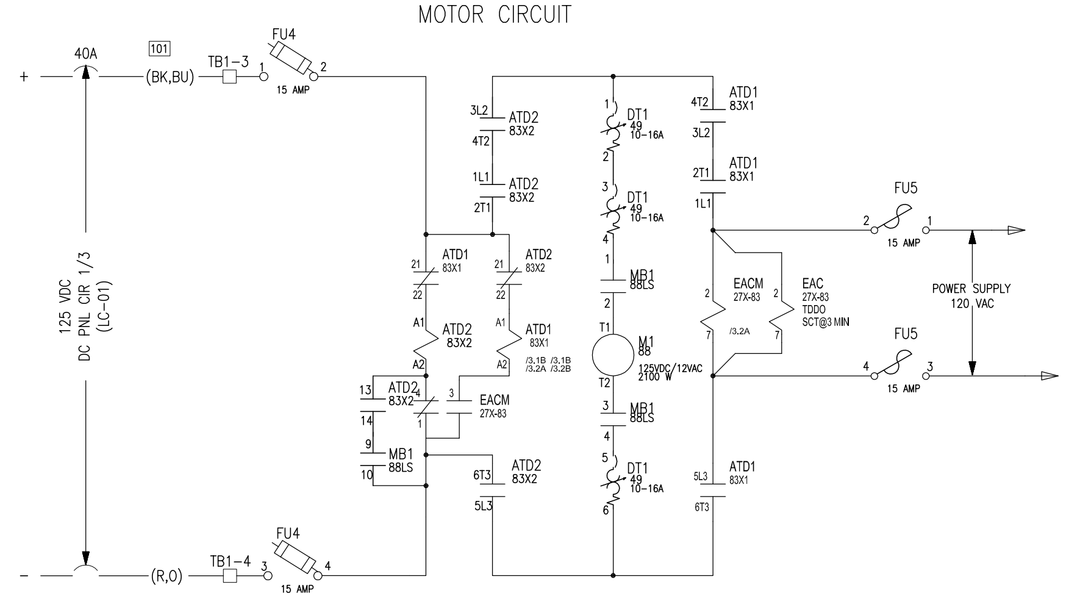
AUXILIARY SWITCHES

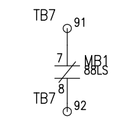




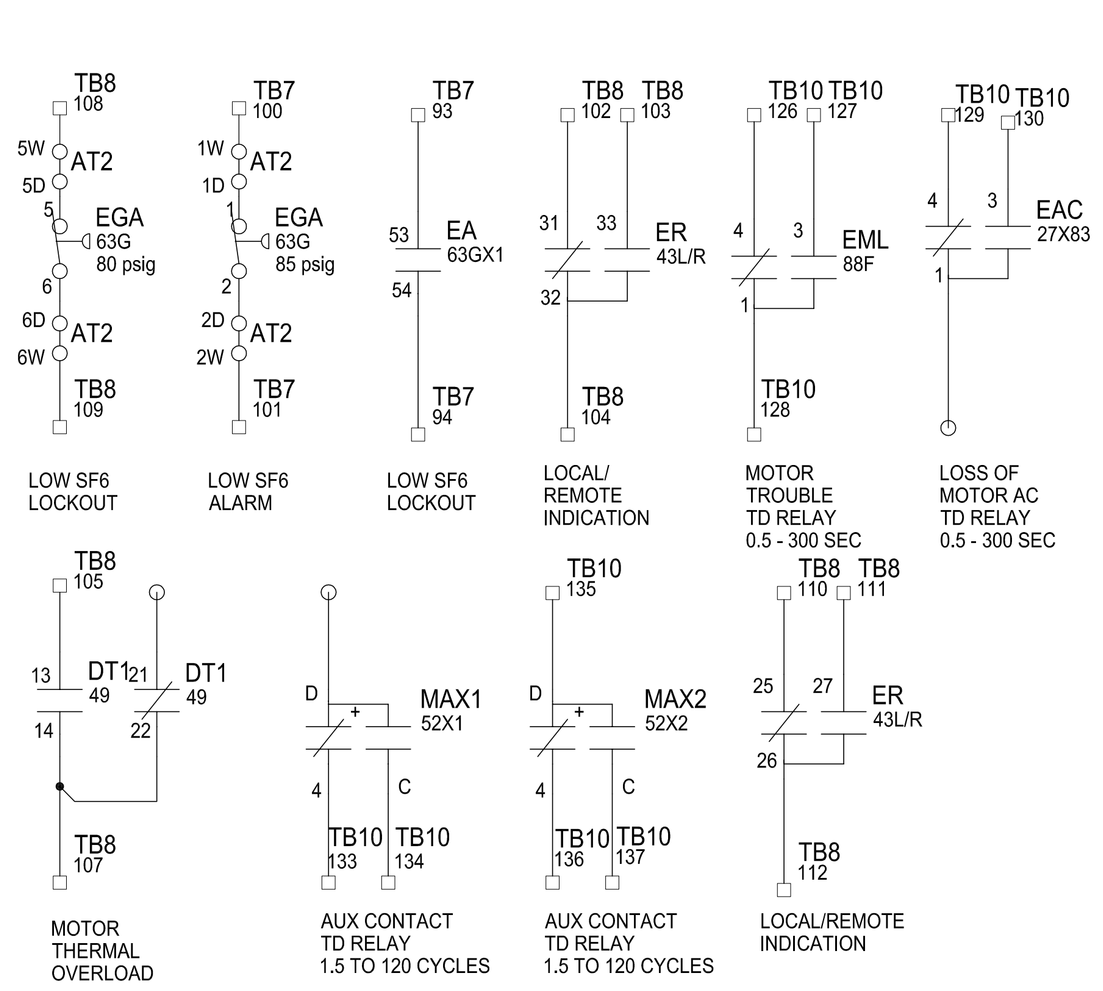


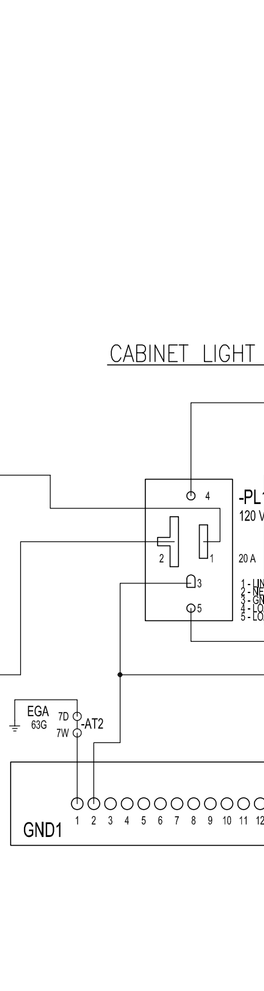
MOTOR CIRCUIT

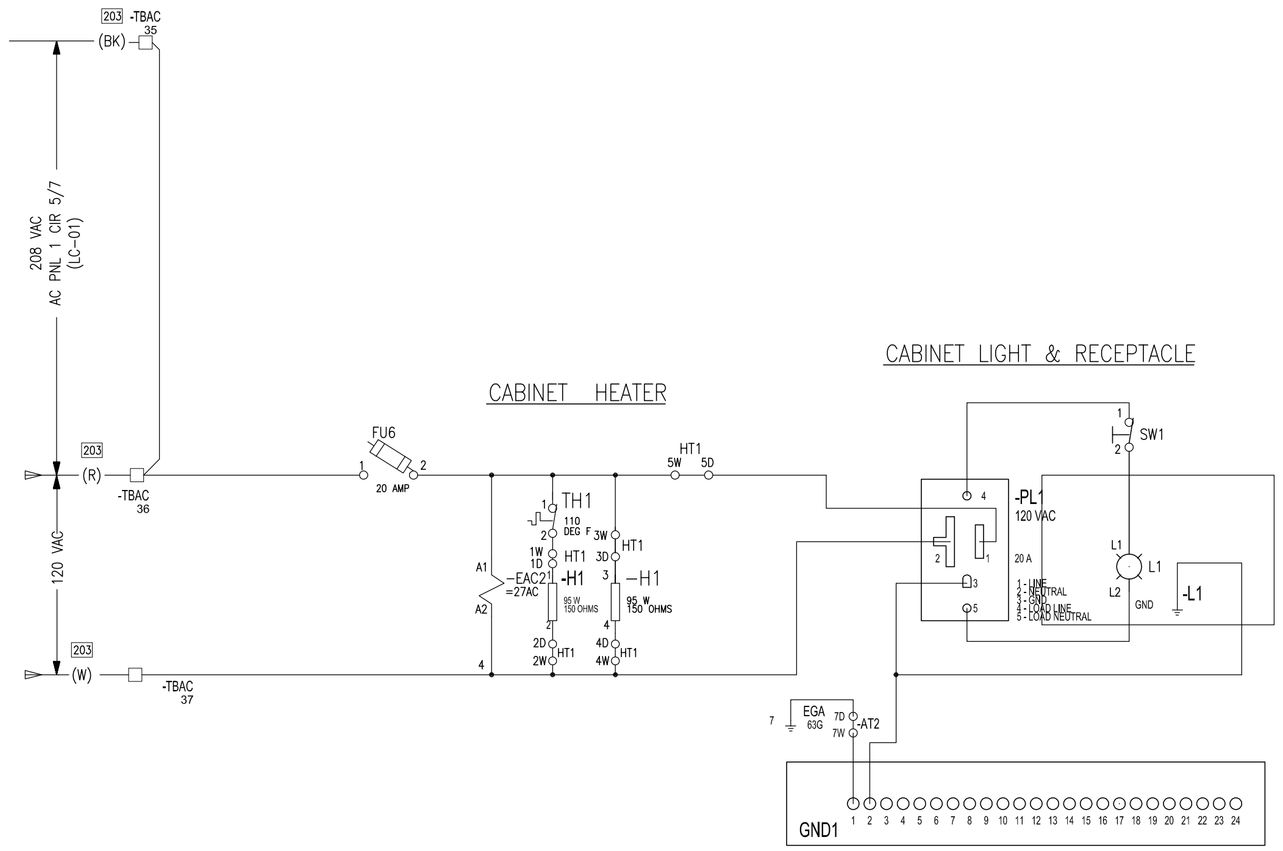




SPARE MOTOR LIMIT SWITCH CONTACT







LEGEND

- □ – EQUIPMENT TERMINAL
- ⊠ – RELAY PANEL TERMINATION BLOCK (1R OR 2R)
- ○ – DEVICE TERMINAL
- XXX – CABLE NUMBER

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	MODIFIED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

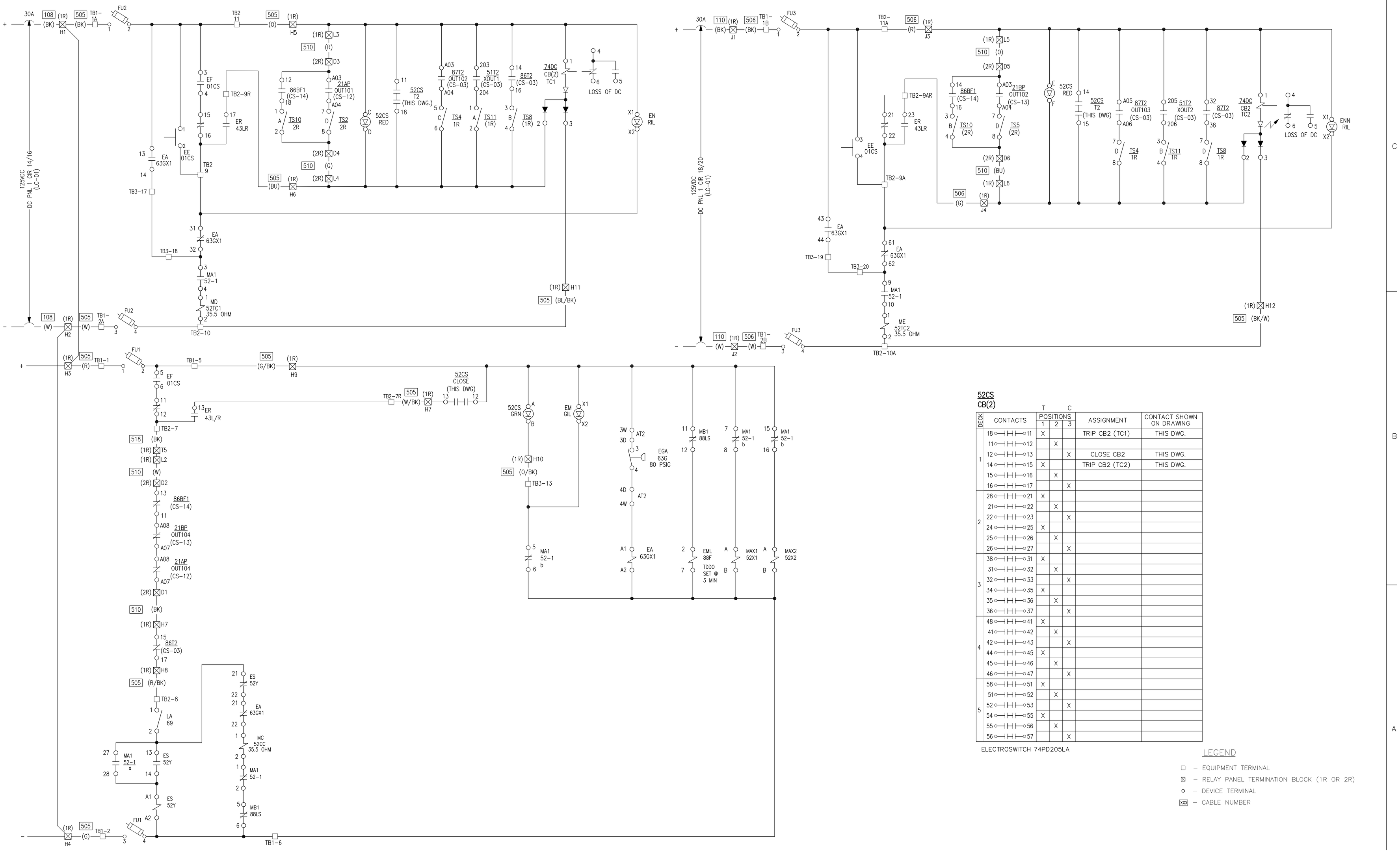
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION (CB1)
AC & DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD-CS-06
SCALE	NONE

SHEET **CS-06**



52CS
CB(2)

DECK	CONTACTS	T	C	ASSIGNMENT	CONTACT SHOWN ON DRAWING
		POSITIONS 1	2	3	
1	18 — 11	X			TRIP CB2 (TC1) — THIS DWG.
	11 — 12		X		
	12 — 13			X	CLOSE CB2 — THIS DWG.
	14 — 15	X			TRIP CB2 (TC2) — THIS DWG.
	15 — 16		X		
	16 — 17			X	
2	28 — 21	X			
	21 — 22		X		
	22 — 23			X	
	24 — 25	X			
	25 — 26		X		
	26 — 27			X	
3	38 — 31	X			
	31 — 32		X		
	32 — 33			X	
	34 — 35	X			
	35 — 36		X		
	36 — 37			X	
4	48 — 41	X			
	41 — 42		X		
	42 — 43			X	
	44 — 45	X			
	45 — 46		X		
	46 — 47			X	
5	58 — 51	X			
	51 — 52		X		
	52 — 53			X	
	54 — 55	X			
	55 — 56		X		
	56 — 57			X	

ELECTROSWITCH 74PD205LA

LEGEND

- □ – EQUIPMENT TERMINAL
- ⊠ – RELAY PANEL TERMINATION BLOCK (1R OR 2R)
- o – DEVICE TERMINAL
- [XXX] – CABLE NUMBER

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
B	11-19-07	REVISED WIRING
A	10-12-07	REVISED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

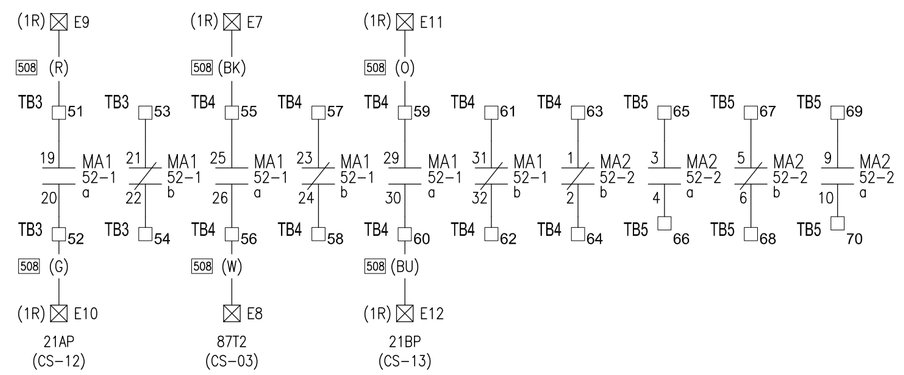
230/34.5kV PROJECT SUBSTATION TRIP AND CLOSE (CB2) DC SCHEMATIC DIAGRAM

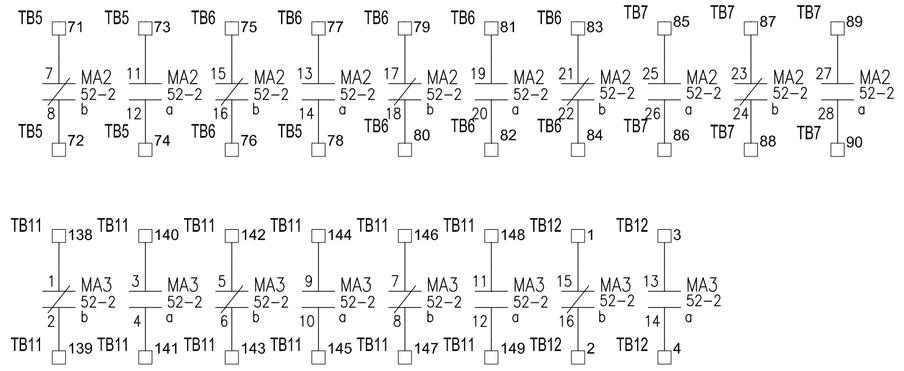
0 1" 2"

FILENAME	TWESD-CS-07
SCALE	NONE

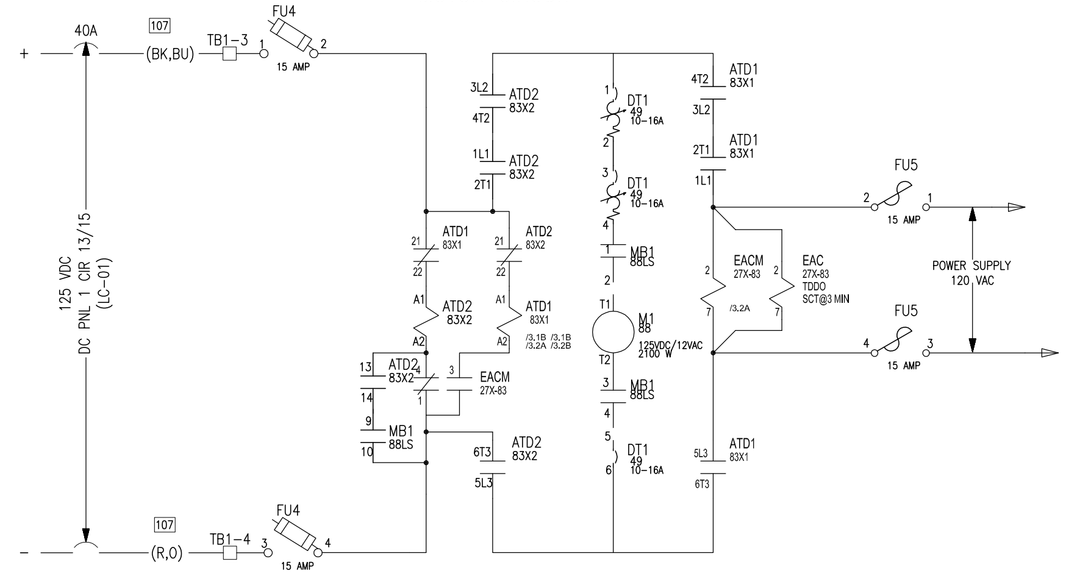
SHEET **CS-07**

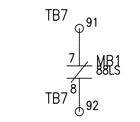
AUXILIARY SWITCHES



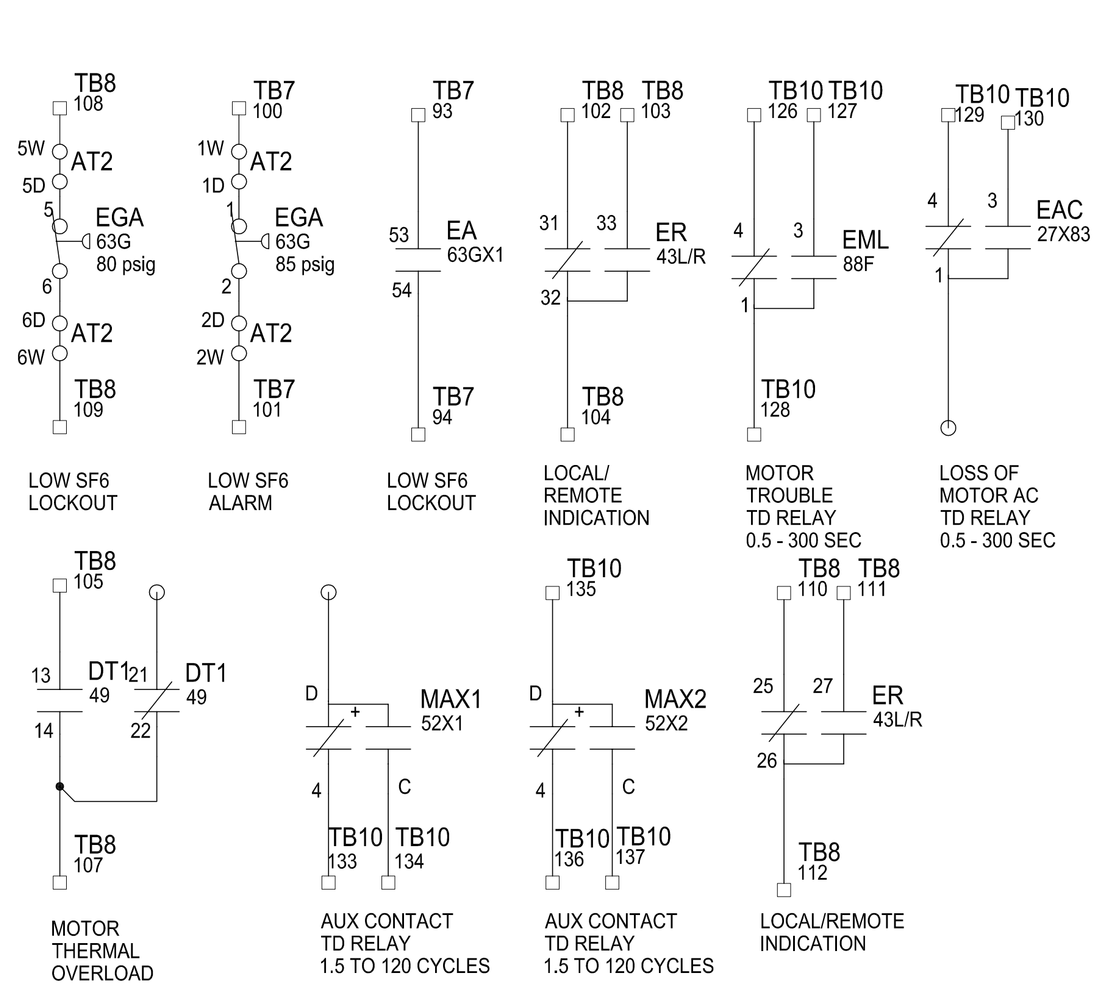


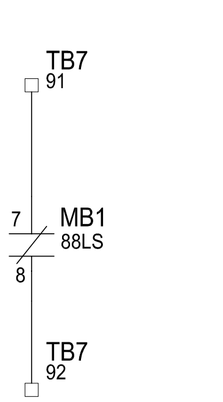
MOTOR CIRCUIT



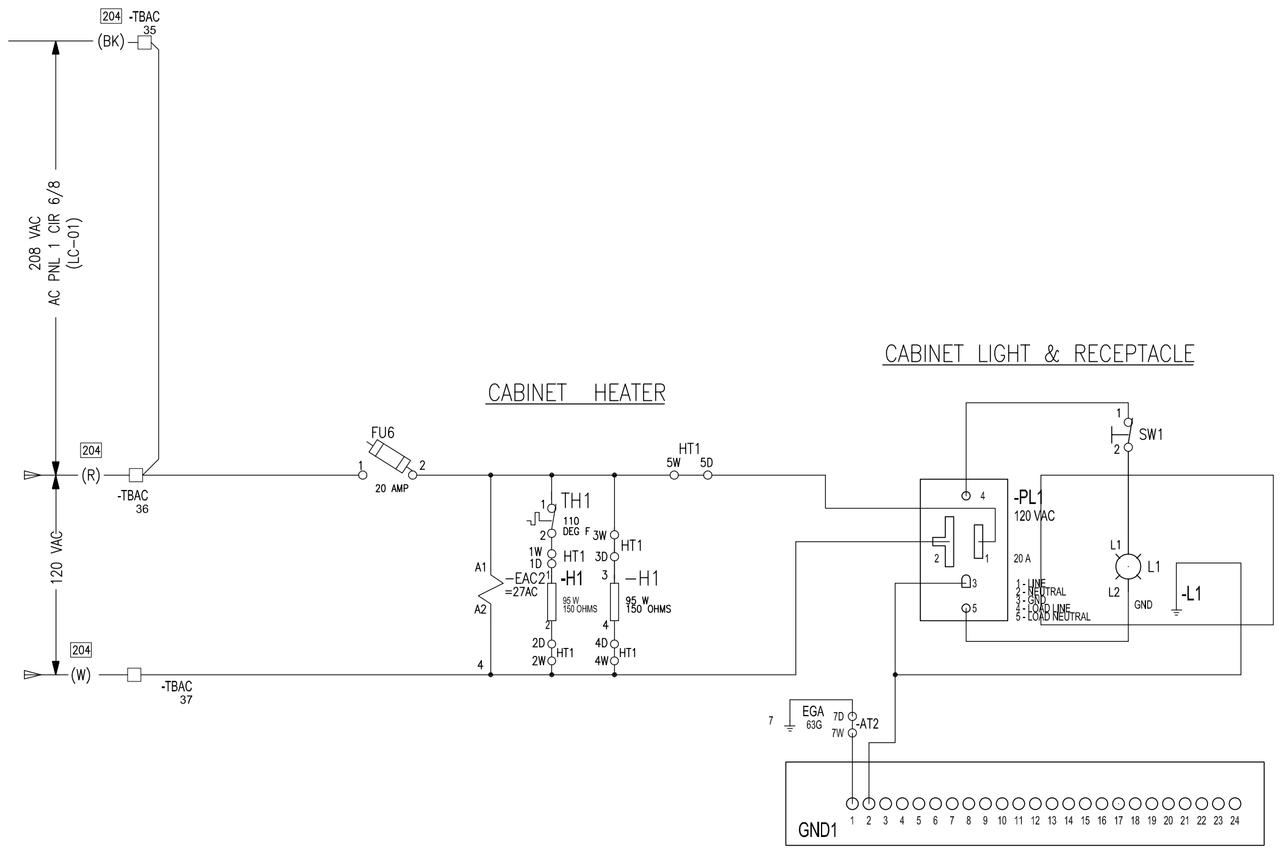


SPARE MOTOR LIMIT SWITCH CONTACT





SPARE MOTOR LIMIT SWITCH CONTACTS



LEGEND

- □ – EQUIPMENT TERMINAL
- ⊠ – RELAY PANEL TERMINATION BLOCK (1R OR 2R)
- ○ – DEVICE TERMINAL
- XXX – CABLE NUMBER

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	MODIFIED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

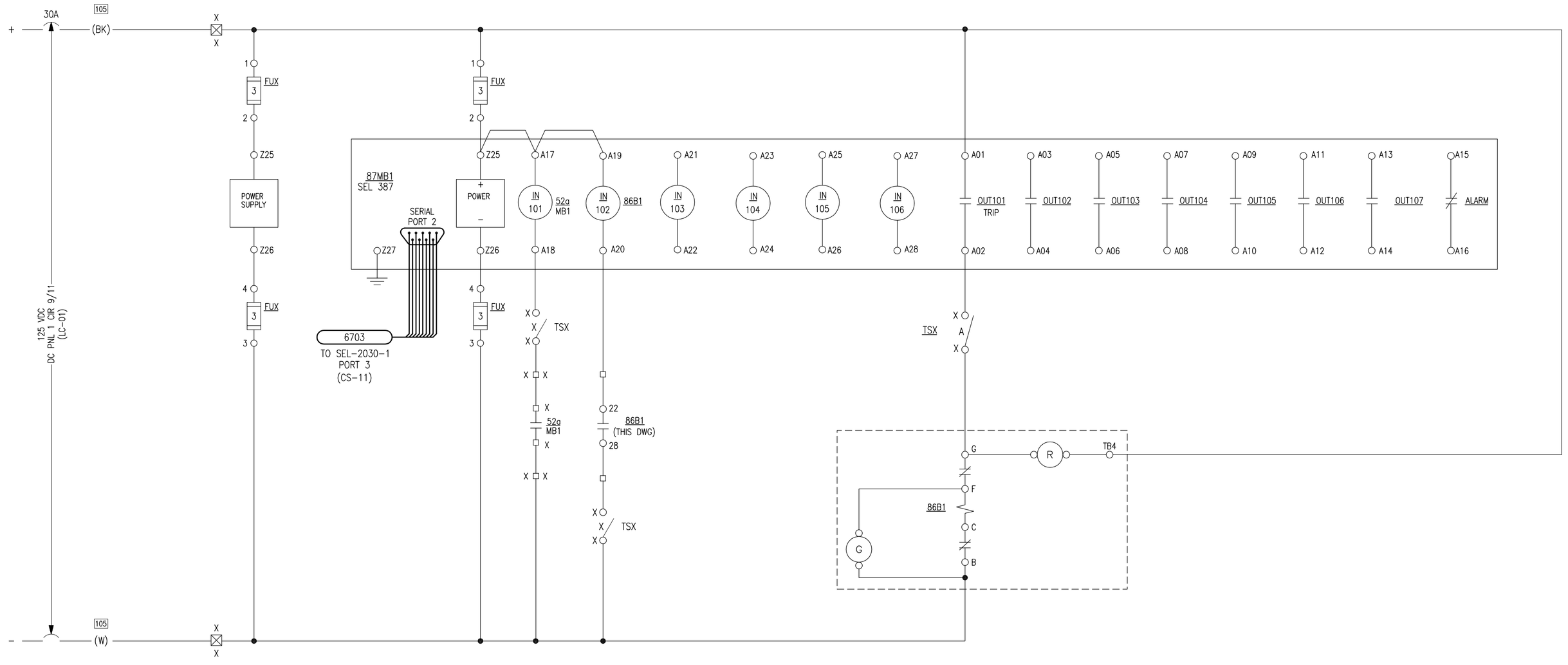
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION (CB2)
AC & DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD-CS-08
SCALE	NONE

SHEET **CS-08**



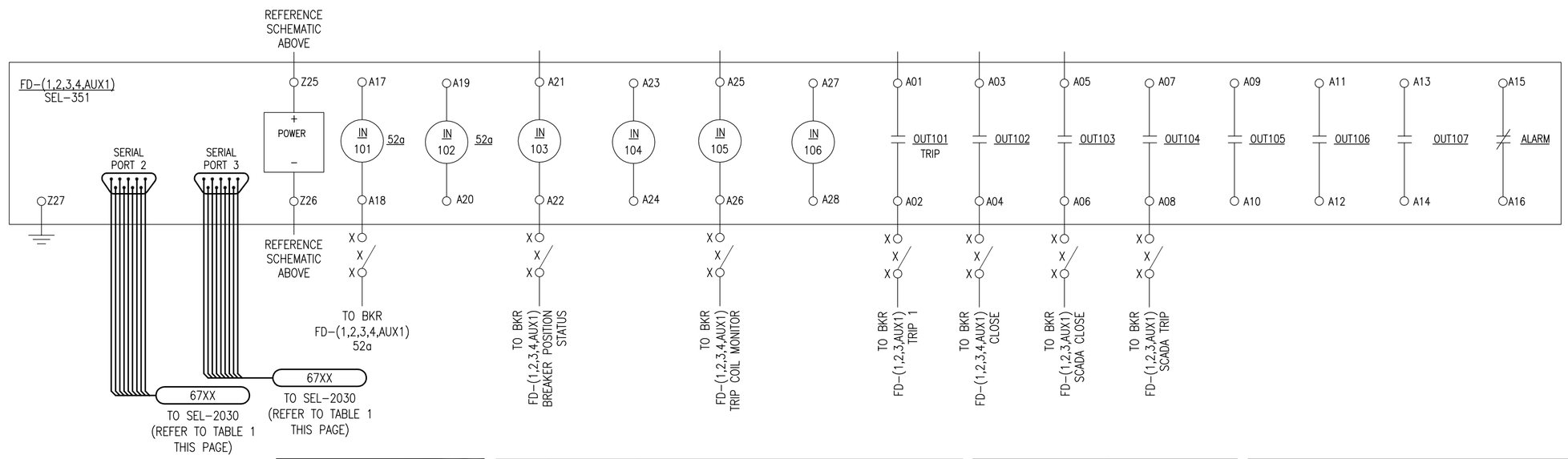


TABLE 1

FD-X	FROM/PORT	TO/PORT	CABLE #	DWG #
FD-1	SEL-351/PORT 2	SEL-2030-1/PORT 4	6704	CS-11
	SEL-351/PORT 3	SEL-2030-2/PORT 12	6728	CS-11
FD-2	SEL-351/PORT 2	SEL-2030-1/PORT 5	6705	CS-11
	SEL-351/PORT 3	SEL-2030-2/PORT 13	6729	CS-11
FD-3	SEL-351/PORT 2	SEL-2030-1/PORT 6	6706	CS-11
	SEL-351/PORT 3	SEL-2030-2/PORT 14	6730	CS-11
FD-4	SEL-351/PORT 2	SEL-2030-1/PORT 7	6707	CS-11
	SEL-351/PORT 3	SEL-2030-2/PORT 15	6731	CS-11
FD-AUX1	SEL-352/PORT 2	SEL-2030-2/PORT 9	6719	CS-11

86B1

DECK	CONTACTS	ASSIGNMENT	CO SW	CONTACT SHOWN ON DRAWING
1	11 ○—||—○ 13	BLOCK CLOSE 52-MB1		
	12 ○—| |—○ 18	TRIP 52-MB1		
	15 ○—||—○ 17	BLOCK CLOSE 52-TB		
	14 ○—| |—○ 46	TRIP 52-TB		
2	21 ○—||—○ 23			
	22 ○—| |—○ 28	387 STATUS		THIS DWG
	25 ○—||—○ 27			
	24 ○—| |—○ 26			
3	31 ○—||—○ 33	BLOCK CLOSE 52-FD1		
	32 ○—| |—○ 38	TRIP 52-FD1		
	35 ○—||—○ 37	BLOCK CLOSE 52-FD2		
	34 ○—| |—○ 36	TRIP 52-FD2		
4	41 ○—||—○ 43	BLOCK CLOSE 52-FD3		
	42 ○—| |—○ 48	TRIP 52-FD3		
	45 ○—||—○ 47	BLOCK CLOSE 52-FD4		
	44 ○—| |—○ 46	TRIP 52-FD4		
5	51 ○—||—○ 53	BLOCK CLOSE 52-AUX1		
	52 ○—| |—○ 58	TRIP 52-AUX1		
	55 ○—||—○ 57			
	54 ○—| |—○ 56			

ELECTROSWITCH LOR 78PA05D-002

LEGEND

52CS	BREAKER CONTROL SWITCH
R	RED INDICATING LIGHT
1R	PANEL CONTAINING LINE RELAYING EQUIPMENT
RIL	RED INDICATION LIGHT
387E	THREE-PHASE VOLTAGE METERING, OVER?, FREQUENCY, AND OVER/UNDERVOLTAGE FUCTIONS
351	DIRECTIONAL RELAY
□	EQUIPMENT TERMINAL
○	DEVICE TERMINAL
XXX	CABLE NUMBER

HOLD FOR SWGR VENDOR INFO.

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

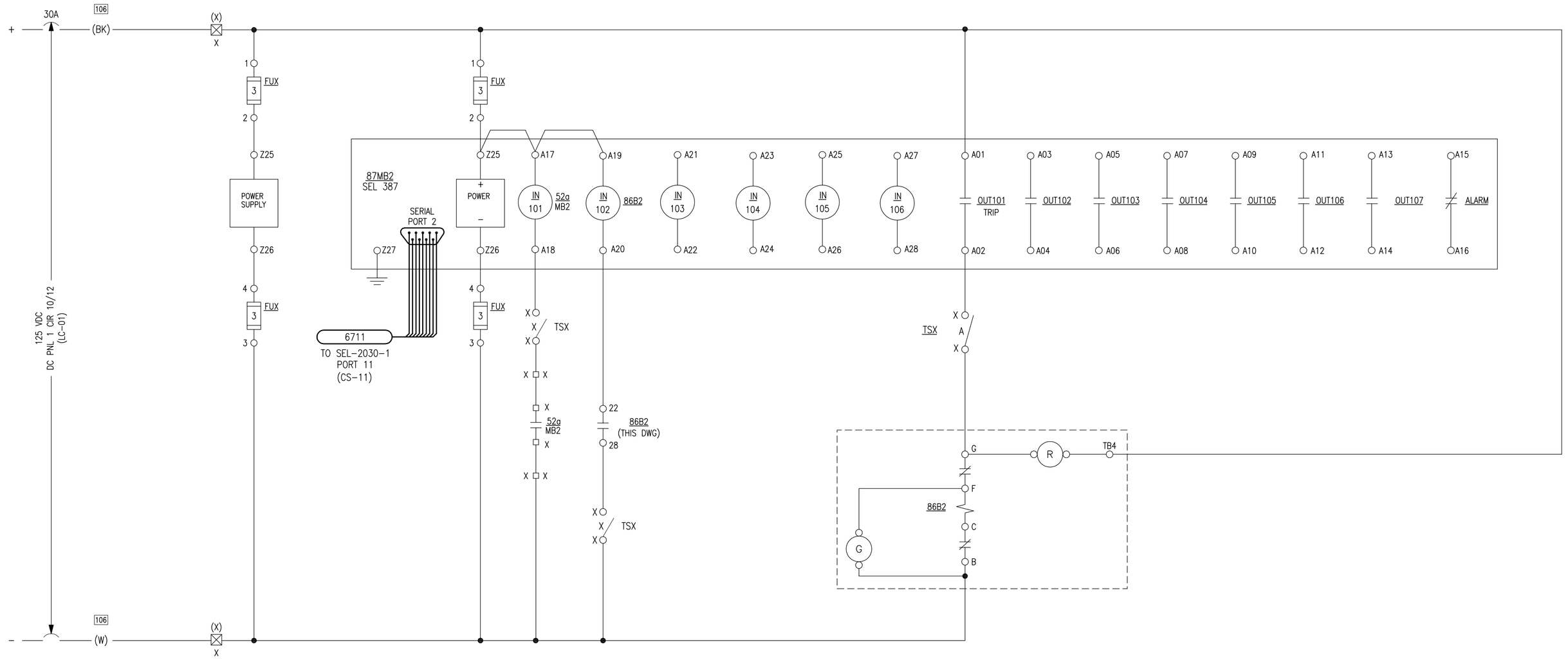
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION BUS DIFFERENTIAL DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD-CS-09
SCALE	NONE

SHEET CS-09



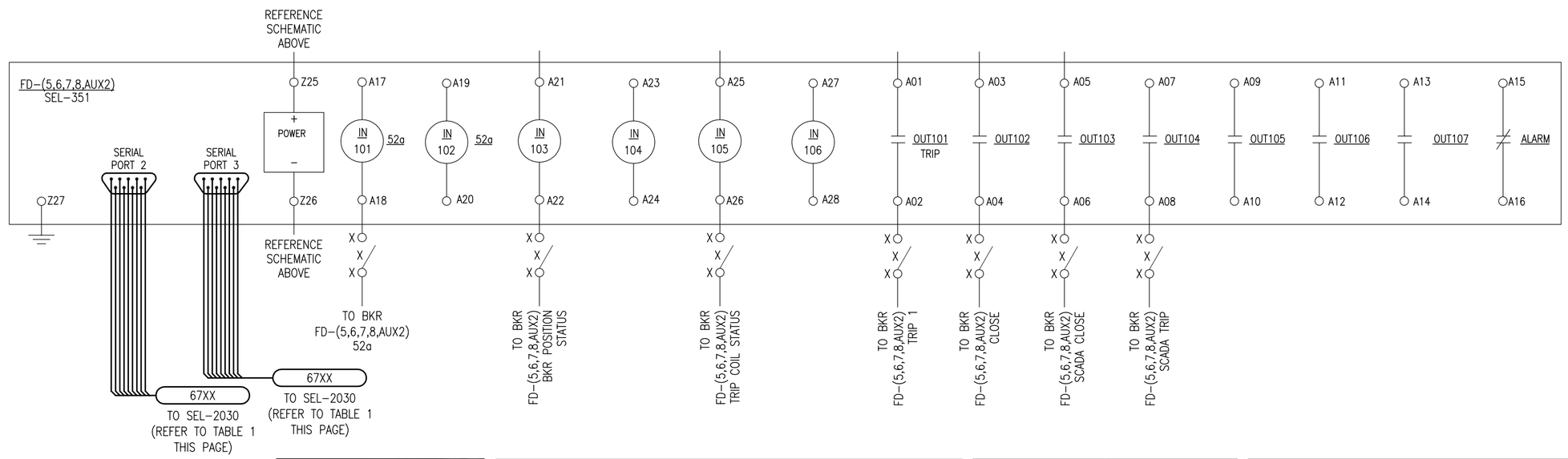


TABLE 1

FD-X	FROM/PORT	TO/PORT	CABLE #	DWG #
FD-5	SEL-351/PORT 2	SEL-2030-1/PORT 12	6712	CS-11
	SEL-351/PORT 3	SEL-2030-2/PORT 5	6732	CS-11
FD-6	SEL-351/PORT 2	SEL-2030-1/PORT 13	6713	CS-11
	SEL-351/PORT 3	SEL-2030-2/PORT 6	6733	CS-11
FD-7	SEL-351/PORT 2	SEL-2030-1/PORT 14	6714	CS-11
	SEL-351/PORT 3	SEL-2030-2/PORT 7	6734	CS-11
FD-8	SEL-351/PORT 2	SEL-2030-1/PORT 15	6715	CS-11
	SEL-351/PORT 3	SEL-2030-2/PORT 8	6735	CS-11
FD-AUX2	SEL-352/PORT 2	SEL-2030-2/PORT 10	6720	CS-11

86B2

DECK	CONTACTS	ASSIGNMENT	CO SW	CONTACT SHOWN ON DRAWING
1	11 ○—||—○ 13	BLOCK CLOSE 52-MB2		
	12 ○—| |—○ 18	TRIP 52-MB2		
	15 ○—||—○ 17	BLOCK CLOSE 52-TB		
	16 ○—| |—○ 14	TRIP 52-TB		
2	21 ○—||—○ 23			
	22 ○—| |—○ 28	387 STATUS		THIS DWG
	25 ○—||—○ 27			
	26 ○—| |—○ 24			
3	31 ○—||—○ 33	BLOCK CLOSE 52-FD5		
	32 ○—| |—○ 38	TRIP 52-FD5		
	35 ○—||—○ 37	BLOCK CLOSE 52-FD6		
	36 ○—| |—○ 34	TRIP 52-FD6		
4	41 ○—||—○ 43	BLOCK CLOSE 52-FD7		
	42 ○—| |—○ 48	TRIP 52-FD7		
	45 ○—||—○ 47	BLOCK CLOSE 52-FD8		
	46 ○—| |—○ 44	TRIP 52-FD8		
5	51 ○—||—○ 53	BLOCK CLOSE 52-AUX2		
	52 ○—| |—○ 58	TRIP 52-AUX2		
	55 ○—||—○ 57			
	56 ○—| |—○ 54			

ELECTROSWITCH LOR 78PA05D-002

LEGEND

52CS	BREAKER CONTROL SWITCH
R	RED INDICATING LIGHT
1R	PANEL CONTAINING LINE RELAYING EQUIPMENT
RIL	RED INDICATION LIGHT
387E	THREE-PHASE VOLTAGE METERING, OVER?, FREQUENCY, AND OVER/UNDERVOLTAGE FUCTIONS
351	DIRECTIONAL RELAY
□	EQUIPMENT TERMINAL
○	DEVICE TERMINAL
XXX	CABLE NUMBER

HOLD FOR SWGR VENDOR INFO.

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

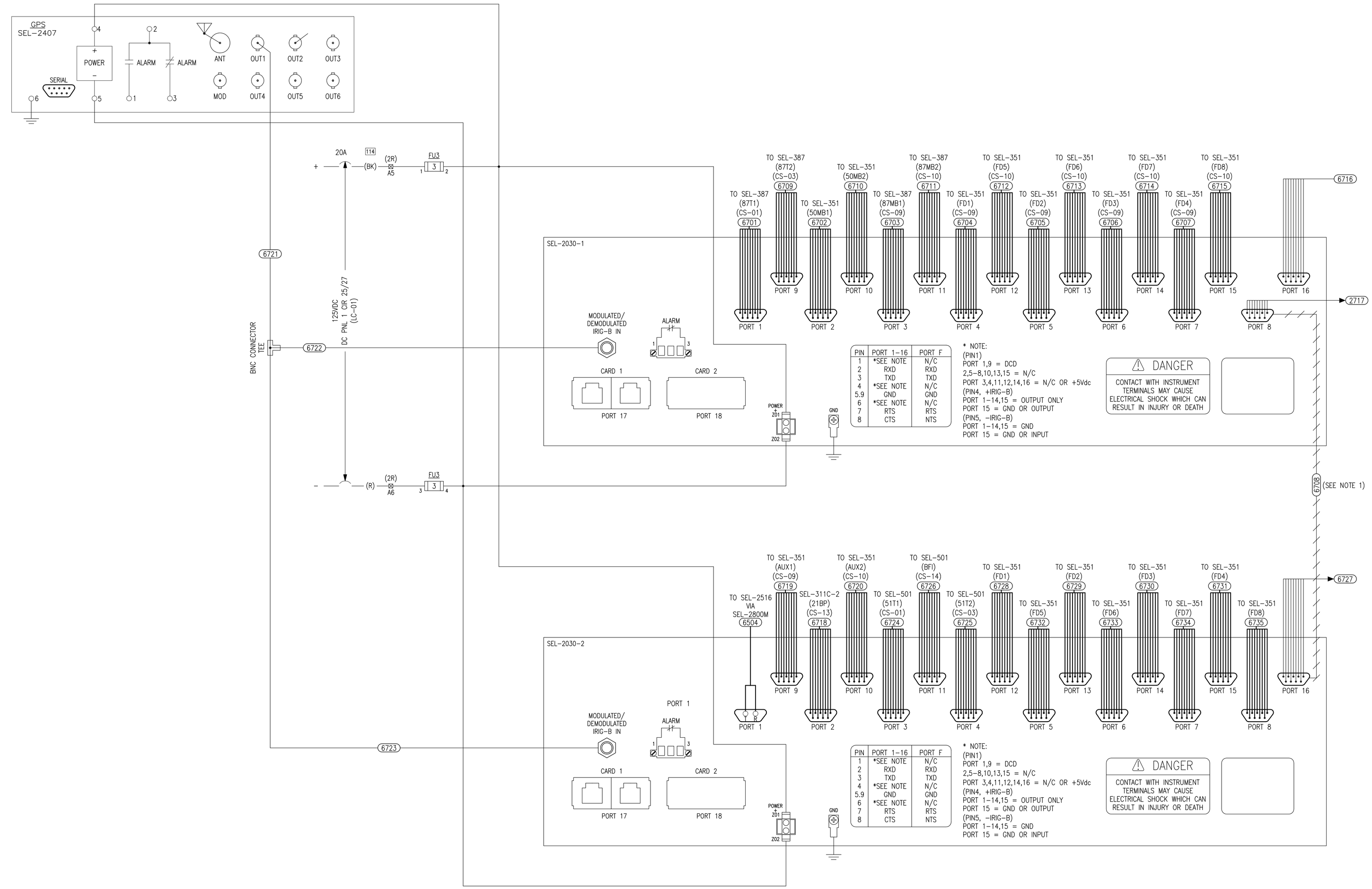
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
BUS DIFFERENTIAL
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD-CS-10
SCALE	NONE

SHEET CS-10



LEGEND

⊠ RELAY PANEL TERMINATION BLOCK (2R)
XXX CABLE NUMBER

NOTES:
1. REMOVE CABLE 6708 CONNECTING SEL-2030-1 PORT 8 AND SEL-2030-2 PORT 16.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

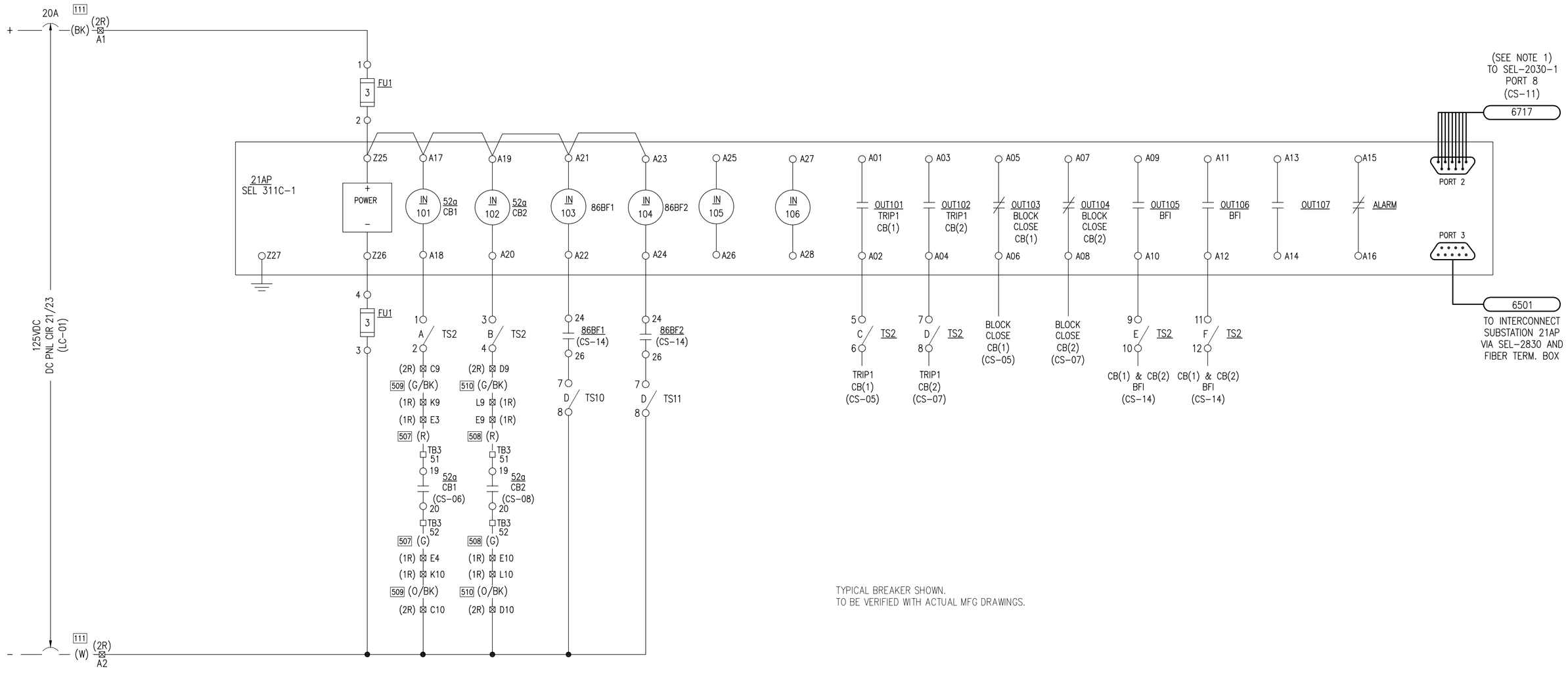
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
RELAY COMMUNICATIONS EQUIPMENT
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD-CS-11
SCALE	NONE

SHEET
CS-11



TYPICAL BREAKER SHOWN.
TO BE VERIFIED WITH ACTUAL MFG DRAWINGS.

LEGEND

2R	PANEL CONTAINING LINE RELAYING EQUIPMENT
311C	THREE-PHASE VOLTAGE METERING, OVER?, FREQUENCY, AND OVER/UNDERVOLTAGE FUCTIONS
□	EQUIPMENT TERMINAL
○	DEVICE TERMINAL
⊠	RELAY PANEL TERMINATION BLOCK (1R OR 2R)
XXX	CABLE NUMBER

NOTES:
1. REROUTE CABLE 6717 CONNECTING SEL-311C-1 PORT 2 AND SEL-2030-2 PORT 1 TO SEL-2030-1 PORT 8. REPLACE CABLE IF NECESSARY.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-11-07	ISSUED FOR REVIEW – SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

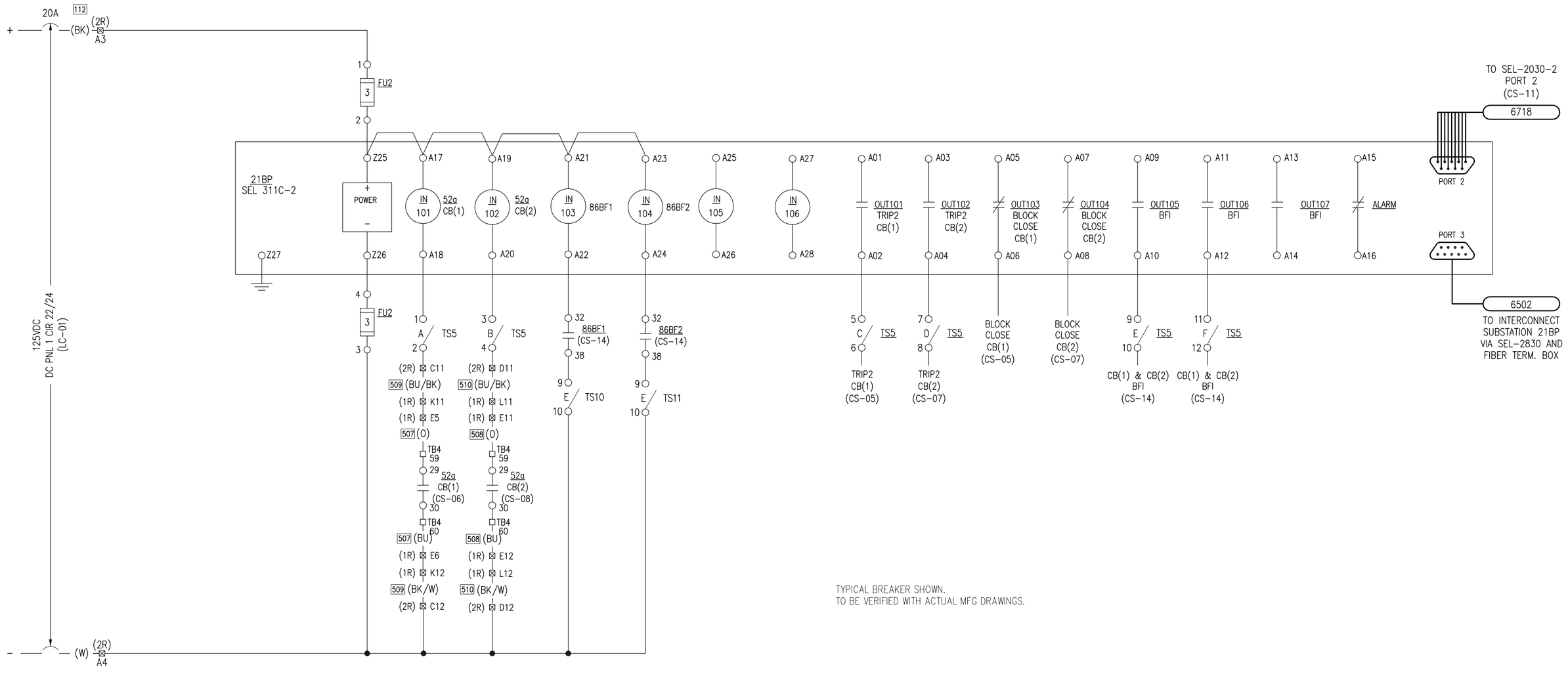
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION 21AP DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD-CS-12.dwg
SCALE	NONE

SHEET CS-12



TYPICAL BREAKER SHOWN.
TO BE VERIFIED WITH ACTUAL MFG DRAWINGS.

LEGEND

2R	PANEL CONTAINING LINE RELAYING EQUIPMENT
311C	THREE-PHASE VOLTAGE METERING, OVER?, FREQUENCY, AND OVER/UNDERVOLTAGE FUCTIONS
□	EQUIPMENT TERMINAL
○	DEVICE TERMINAL
⊠	RELAY PANEL TERMINATION BLOCK (1R OR 2R)
XXX	CABLE NUMBER

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

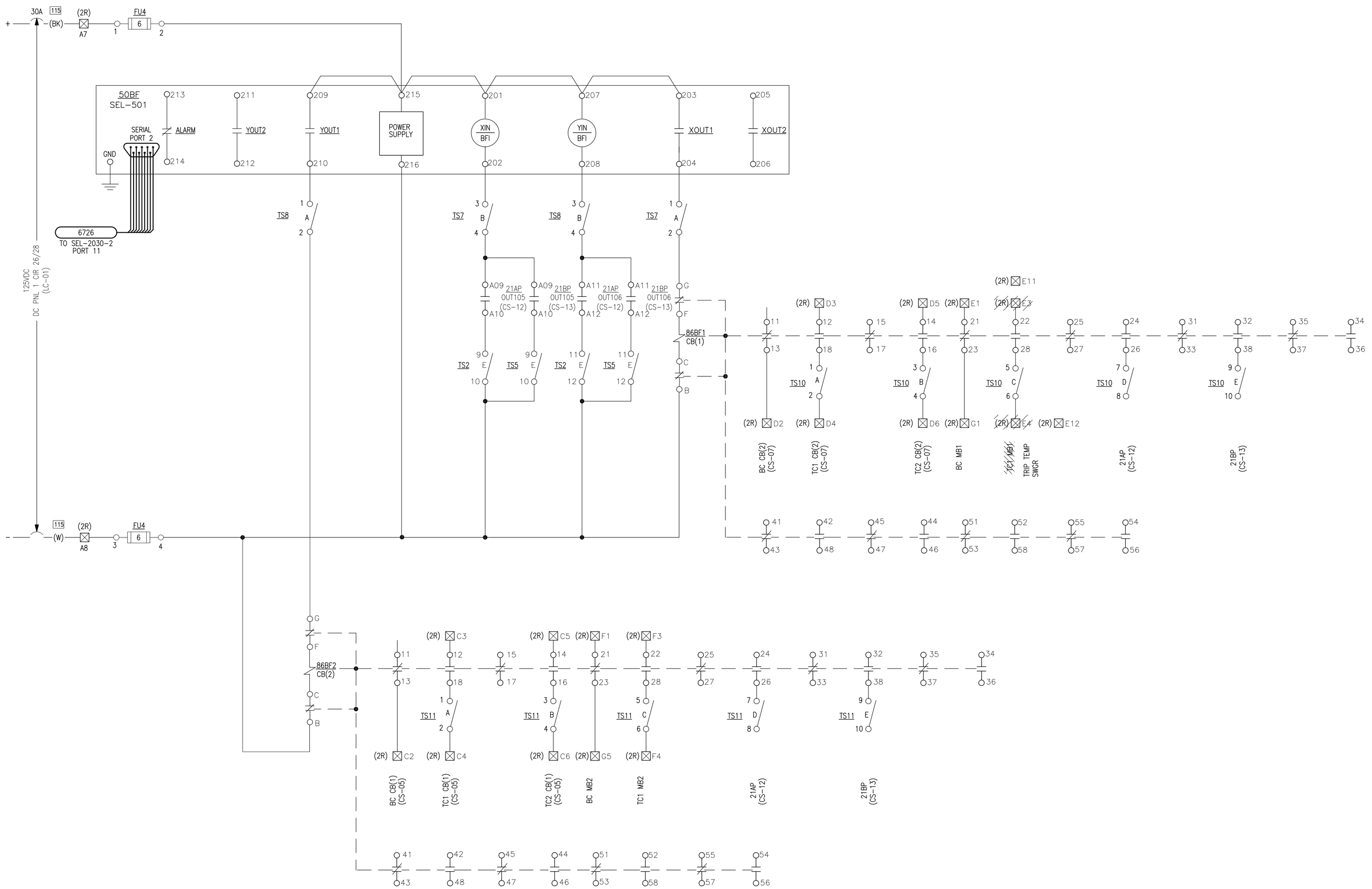
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
21BP
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD-CS-13.dwg
SCALE	NONE

SHEET
CS-13



LEGEND

2R	PANEL CONTAINING LINE RELAYING EQUIPMENT
311C	THREE-PHASE VOLTAGE METERING, OVER?, FREQUENCY, AND OVER/UNDERVOLTAGE FUCTIONS
□	EQUIPMENT TERMINAL
○	DEVICE TERMINAL
⊠	RELAY PANEL TERMINATION BLOCK (1R OR 2R)
XXX	CABLE NUMBER

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-24-07	ISSUED FOR REVIEW-TEMP SWGR
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

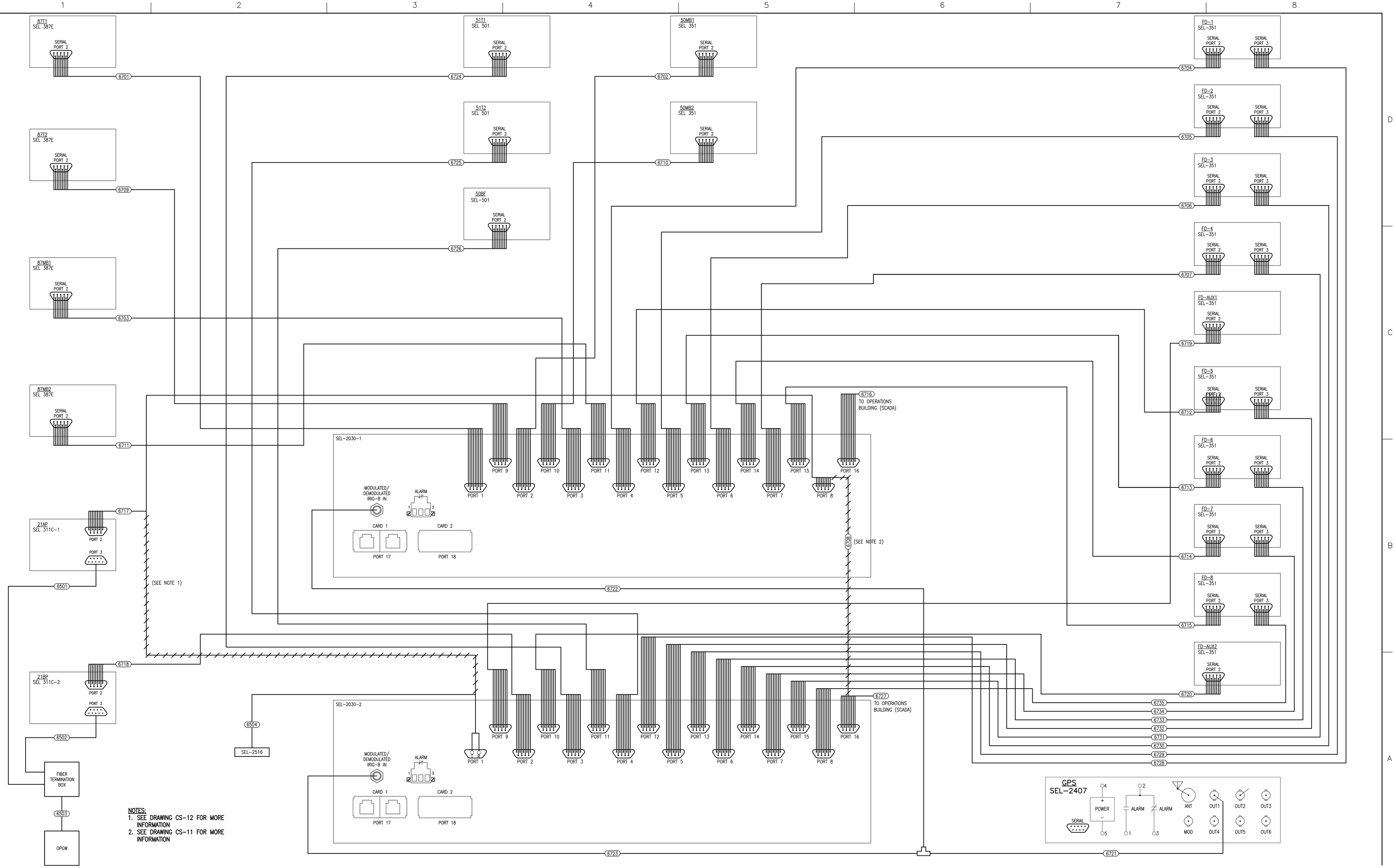
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION (CB1) & (CB2) BREAKER FAILURE DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD-CS-14.DWG
SCALE	NONE

SHEET
CS-14



NOTES:
1. SEE DRAWING CS-12 FOR MORE INFORMATION
2. SEE DRAWING CS-11 FOR MORE INFORMATION

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-7-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION COMMUNICATION CONTROL SCHEMATIC

0 1" 2"

FILENAME	TWESD-CS-15
SCALE	NONE

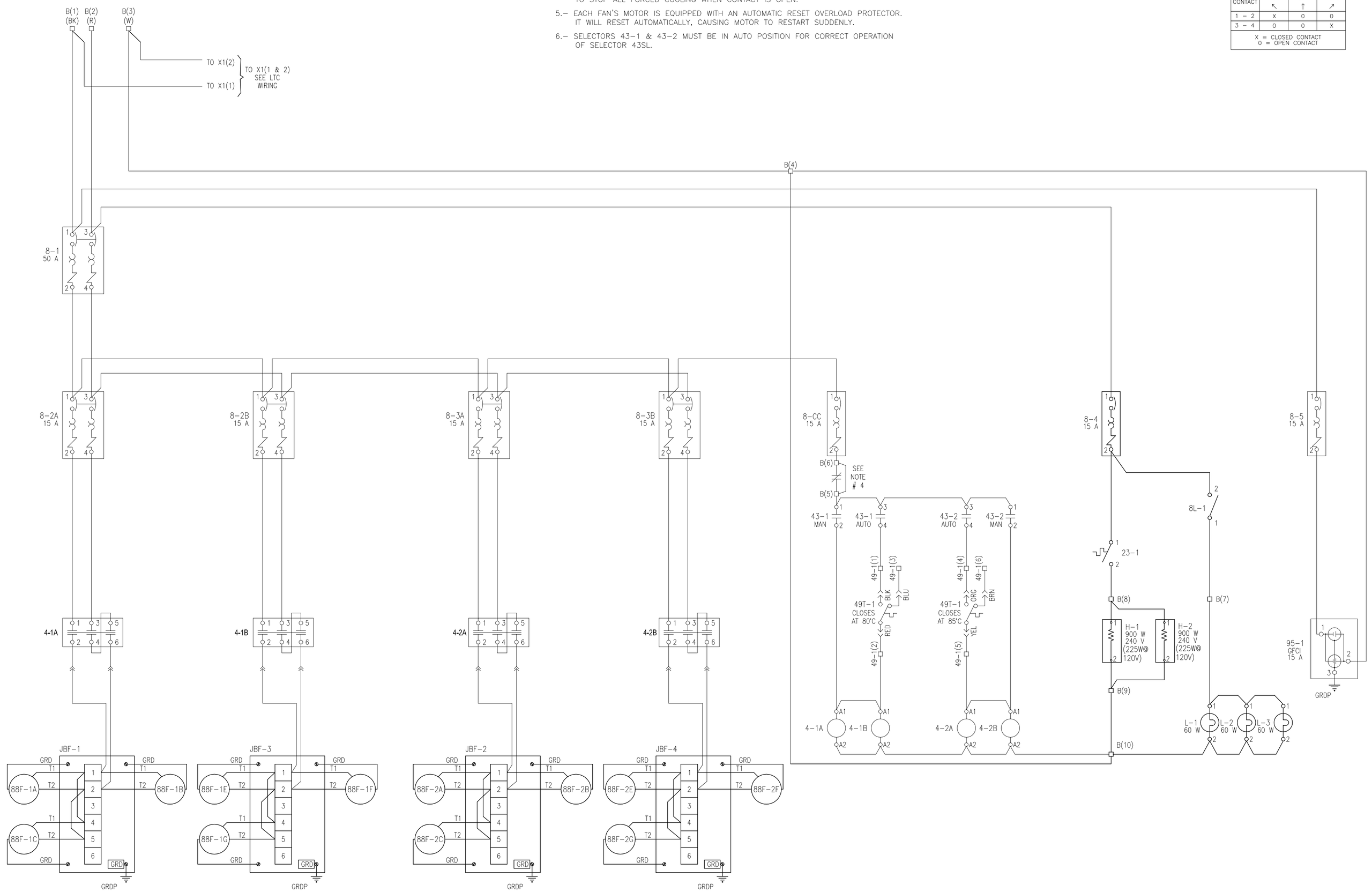
SHEET CS-15

NOTES:

1.– COOLING SYSTEM DIAGRAM IS SHOWN IN DE–ENERGIZED POSITION .
2.– CONDUCTOR TYPE MTW/TEW/AWM , 105°C, 600 V.
3.– SEE DRAWING G2049010905 (CONTROL CABINET LAYOUT) FOR LOCATION OF TERMINAL BLOCKS AND ACCESSORIES.
4.– REMOVABLE JUMPER FOR INSERTION OF REMOTE CONTACT BY OTHERS TO STOP ALL FORCED COOLING WHEN CONTACT IS OPEN.
5.– EACH FAN'S MOTOR IS EQUIPPED WITH AN AUTOMATIC RESET OVERLOAD PROTECTOR. IT WILL RESET AUTOMATICALLY, CAUSING MOTOR TO RESTART SUDDENLY.
6.– SELECTORS 43–1 & 43–2 MUST BE IN AUTO POSITION FOR CORRECT OPERATION OF SELECTOR 43SL.

43–1/43–2 FAN OPERATION MODE SELECTOR			
CONTACT	MAN ↖	OFF ↑	AUTO ↗
1 – 2	X	0	0
3 – 4	0	0	X
X = CLOSED CONTACT 0 = OPEN CONTACT			

LEGEND	DESCRIPTION
8–1	CIRCUIT BREAKER FOR MAIN COOLING CIRCUIT
8–2A/2B	CIRCUIT BREAKER FOR STAGE ONAF–1
8–3A/3B	CIRCUIT BREAKER FOR STAGE ONAF–2
8–4	CIRCUIT BREAKER FOR CONTROL CABINET INTERNAL SERVICES (HEATER & LIGHT)
8–5	CIRCUIT BREAKER FOR CONVENIENCE OUTLET
4–1A/1B	CONTACTOR FOR STAGE ONAF–1
4–2A/2B	CONTACTOR FOR STAGE ONAF–2
43–1	SELECTOR CONTROL SWITCH FOR STAGE ONAF–1
43–2	SELECTOR CONTROL SWITCH FOR STAGE ONAF–2
95–1	CONVENIENCE OUTLET
8–CC	CIRCUIT BREAKER FOR COOLING CONTROL CIRCUIT
88F–1/2	FAN MOTORS
8L–1	LIGHT SWITCH (DOOR OPERATED)
L–1/2/3	LIGHT (CONTROL CABINET)
H–1/2	HEATER WITH THERMOSTAT (CONTROL CABINET)
49T–1	WINDING TEMPERATURE INDICATOR
JBF–1..4	JUNCTION BOX FANS
23–1	THERMOSTAT (CONTROL CABINET)



SYMBOLOGY

- FAN MOTOR
- LIGHT (CONTROL CABINET)
- HEATER (CONTROL CABINET)
- GROUND PLATE
- NORMALLY OPEN CONTACT
- NORMALLY CLOSED CONTACT
- OPERATING COIL
- TERMINAL BLOCK
- CONVENIENCE OUTLET
- TEMPERATURE SWITCH
- SWITCH
- CIRCUIT BREAKER
- DISCONNECT DEVICE

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–7–08	AS BUILT
A	10/25/07	PER VENDOR DRAWING
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION TRANSFORMER (1) COOLING SYSTEM DIAGRAM

0 1" 2"

FILENAME	TWESD–CS–16
SCALE	NONE

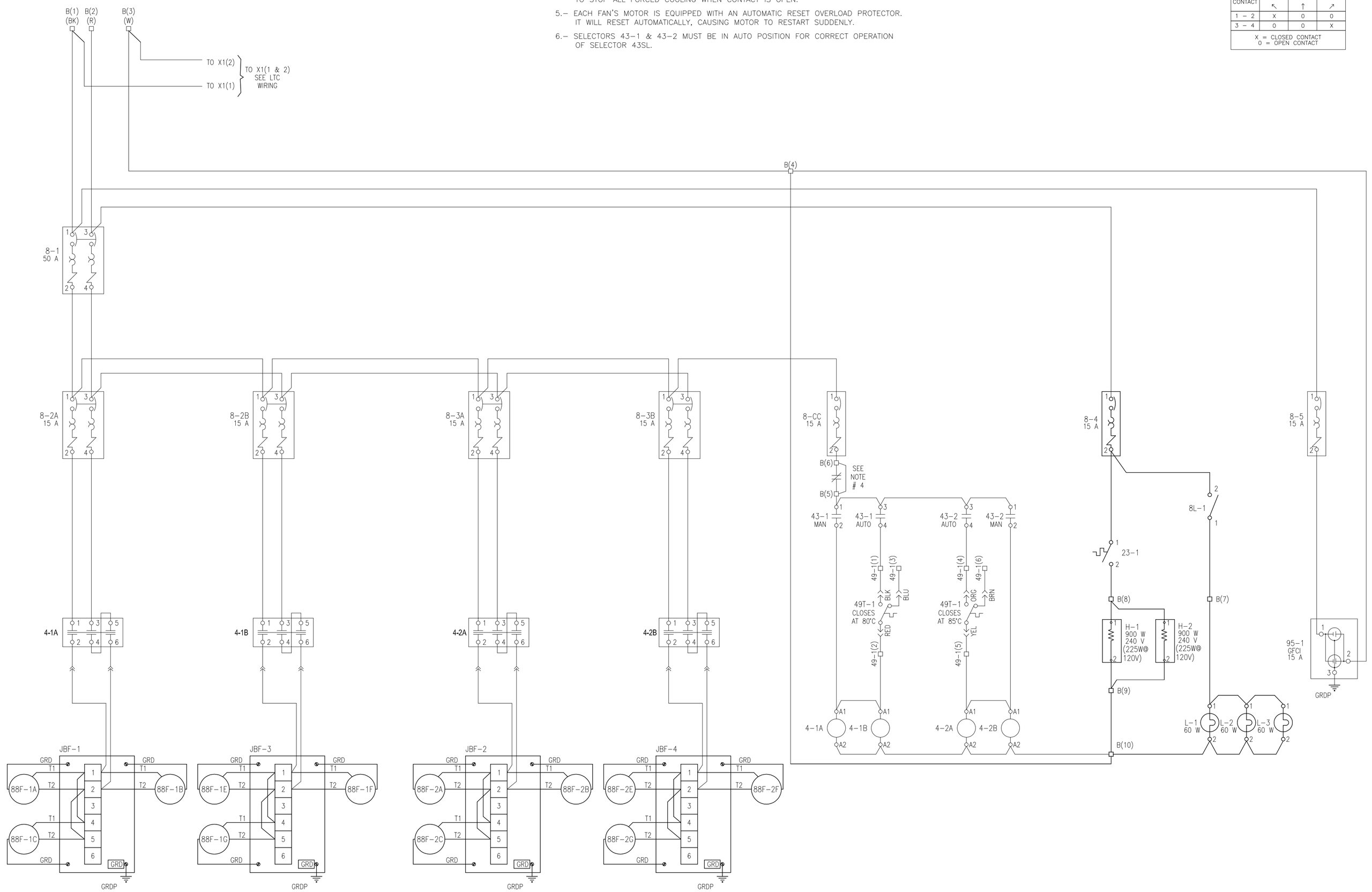
SHEET **CS-16**

NOTES:

1.– COOLING SYSTEM DIAGRAM IS SHOWN IN DE–ENERGIZED POSITION .
2.– CONDUCTOR TYPE MTW/TEW/AWM , 105°C, 600 V.
3.– SEE DRAWING G2049010905 (CONTROL CABINET LAYOUT) FOR LOCATION OF TERMINAL BLOCKS AND ACCESSORIES.
4.– REMOVABLE JUMPER FOR INSERTION OF REMOTE CONTACT BY OTHERS TO STOP ALL FORCED COOLING WHEN CONTACT IS OPEN.
5.– EACH FAN'S MOTOR IS EQUIPPED WITH AN AUTOMATIC RESET OVERLOAD PROTECTOR. IT WILL RESET AUTOMATICALLY, CAUSING MOTOR TO RESTART SUDDENLY.
6.– SELECTORS 43–1 & 43–2 MUST BE IN AUTO POSITION FOR CORRECT OPERATION OF SELECTOR 43SL.

43–1/43–2 FAN OPERATION MODE SELECTOR			
CONTACT	MAN ↖	OFF ↑	AUTO ↗
1 – 2	X	0	0
3 – 4	0	0	X
X = CLOSED CONTACT 0 = OPEN CONTACT			

LEGEND	DESCRIPTION
8–1	CIRCUIT BREAKER FOR MAIN COOLING CIRCUIT
8–2A/2B	CIRCUIT BREAKER FOR STAGE ONAF–1
8–3A/3B	CIRCUIT BREAKER FOR STAGE ONAF–2
8–4	CIRCUIT BREAKER FOR CONTROL CABINET INTERNAL SERVICES (HEATER & LIGHT)
8–5	CIRCUIT BREAKER FOR CONVENIENCE OUTLET
4–1A/1B	CONTACTOR FOR STAGE ONAF–1
4–2A/2B	CONTACTOR FOR STAGE ONAF–2
43–1	SELECTOR CONTROL SWITCH FOR STAGE ONAF–1
43–2	SELECTOR CONTROL SWITCH FOR STAGE ONAF–2
95–1	CONVENIENCE OUTLET
8–CC	CIRCUIT BREAKER FOR COOLING CONTROL CIRCUIT
88F–1/2	FAN MOTORS
8L–1	LIGHT SWITCH (DOOR OPERATED)
L–1/2/3	LIGHT (CONTROL CABINET)
H–1/2	HEATER WITH THERMOSTAT (CONTROL CABINET)
49T–1	WINDING TEMPERATURE INDICATOR
JBF–1..4	JUNCTION BOX FANS
23–1	THERMOSTAT (CONTROL CABINET)



SYMBOLOGY

- FAN MOTOR
- LIGHT (CONTROL CABINET)
- HEATER (CONTROL CABINET)
- GROUND PLATE
- NORMALLY OPEN CONTACT
- NORMALLY CLOSED CONTACT
- OPERATING COIL
- TERMINAL BLOCK
- CONVENIENCE OUTLET
- TEMPERATURE SWITCH
- SWITCH
- CIRCUIT BREAKER
- DISCONNECT DEVICE

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–7–08	AS BUILT
A	10/25/07	PER VENDOR DRAWING
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

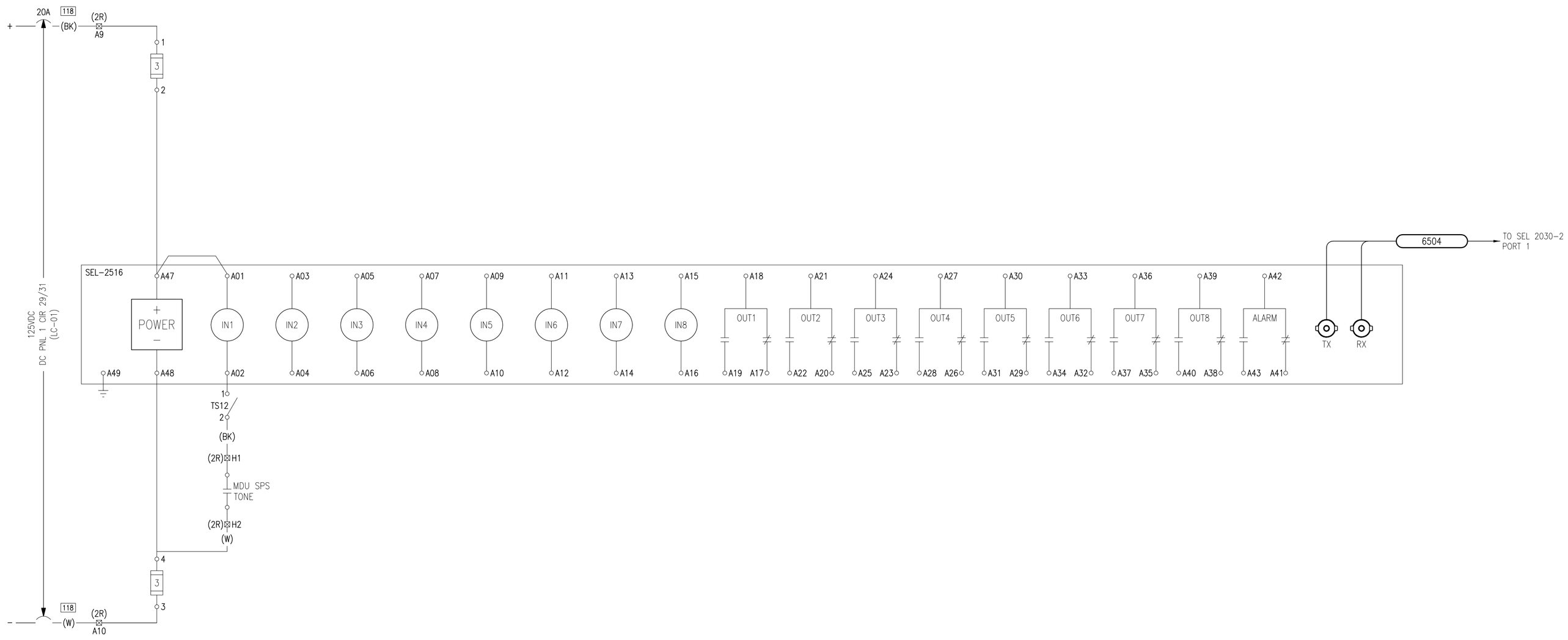
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION TRANSFORMER (2) COOLING SYSTEM DIAGRAM

0 1" 2"

FILENAME	TWESD–CS–17
SCALE	NONE

SHEET **CS-17**



LEGEND

2R	PANEL CONTAINING LINE RELAYING EQUIPMENT
311C	THREE-PHASE VOLTAGE METERING, OVER?, FREQUENCY, AND OVER/UNDERVOLTAGE FUCTIONS
□	EQUIPMENT TERMINAL
○	DEVICE TERMINAL
⊠	RELAY PANEL TERMINATION BLOCK (1R OR 2R)
XXX	CABLE NUMBER

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-7-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW - SPS UPGRADE

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

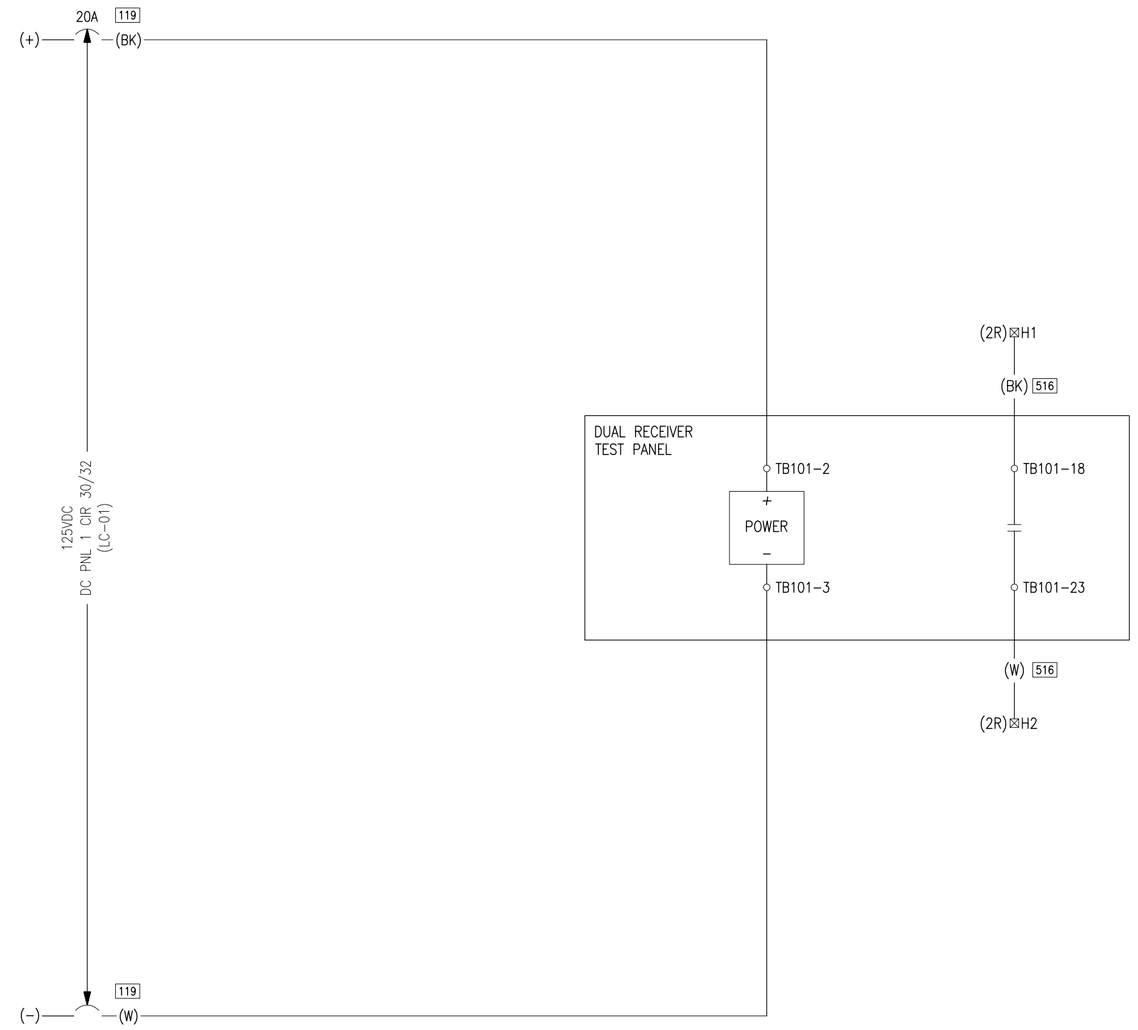
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
SEL-2516
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD-CS-18.DWG
SCALE	NONE

SHEET
CS-18



LEGEND

- □ EQUIPMENT TERMINAL
- ○ DEVICE TERMINAL
- ⊠ RELAY PANEL TERMINATION BLOCK
- XXX CABLE NUMBER

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-7-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

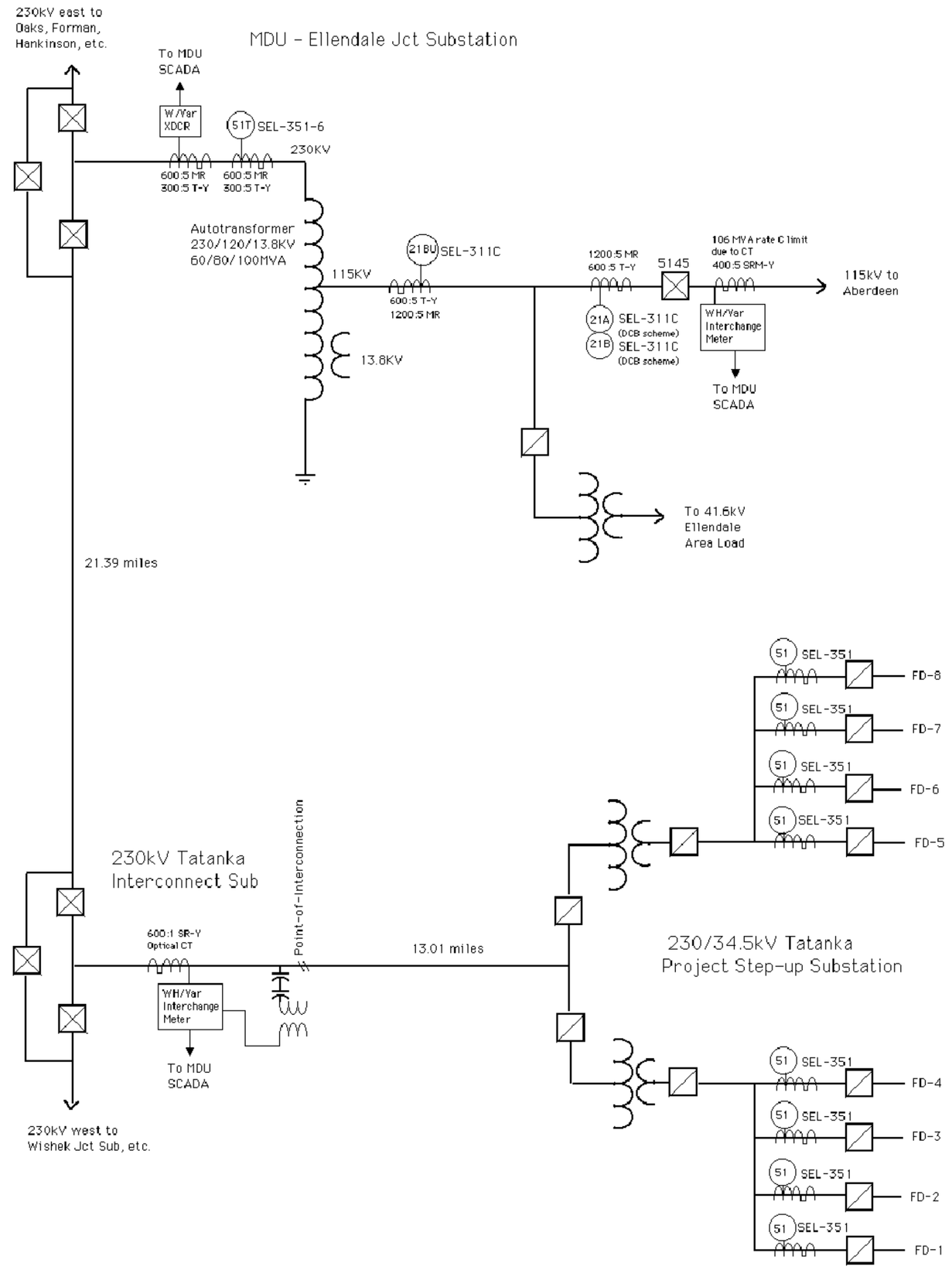
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
MDU TONE EQUIPMENT
DC SCHEMATIC DIAGRAM

0 1" 2"

FILENAME	TWESD-CS-19.DWG
SCALE	NONE

SHEET CS-19



SPS Purpose - To avoid or to delay various transmission system upgrades, Acciona Energy and MDU have agreed to install a Special Protection System (SPS) for the Tatanka Wind Farm. The upgrades that are obviated by this SPS scheme include replacement of the Ellendale 230/115kV autotransformer, re-building of the Ellendale-to-Aberdeen 115kV line, and/or construction of additional 230kV transmission lines and facilities that would originate from the Interconnection Substation.

SPS Scheme Initiation - The SPS scheme will be initiated by protective relays that are located at MDU's Ellendale Jct Substation. The relays will monitor current flow in the 230/115kV autotransformer and current over the 115kV Ellendale-to-Aberdeen transmission line. Time-overcurrent or a definite time delay will be used by each relay to avoid nuisance tripping. When an overcurrent at either location exceeds the magnitude and time parameters, the relay involved will set a latch that triggers a REDUCE signal. The REDUCE signal will remain latched until the current level that triggered it has dropped to some fraction (probably 90%) of the triggering value.

SPS Scheme Action - Once an overcurrent level is detected by the SPS, a REDUCE signal will be transmitted from the Ellendale substation via two independent communication paths to the Tatanka Project Step-up Substation.

Receipt of the REDUCE signal shall initiate actions in the Tatanka Supervisory Control and Data Acquisition (SCADA) system to cause the Tatanka wind farm to reduce power output at a pre-defined rate. Power will be reduced to a point at which the REDUCE signals will de-assert when the sensed current at the Ellendale substation reduces below the RESET level. To serve as a redundant protection control, timers in the Tatanka Step-Up substation will sequentially trip 34.5kV collection system breakers to force a power reduction, in case the SCADA system fails to reduce wind farm output, or fails to reduce the power level quickly enough. If the SPS is functioning normally, it will not be necessary to trip any circuit breakers because the REDUCE signal will de-assert before the timers time-out.

SPS Scheme Reset - The REDUCE signal will de-assert when the sensed current that triggered that event falls to some fraction of the triggering current level (probably 90%). The hysteresis that results will ensure that the system operating point is driven far enough away from the triggering threshold to avoid oscillations.

Following SPS Scheme Reset - Once the REDUCE signal de-asserts, the Tatanka SCADA system enters a HOLD mode, where it operates at a reduced power output limit. This limit will be maintained by the SCADA system until the MDU electric system operator informs the Tatanka operator that the limit can be raised. At that time, the operating power limit can be adjusted to some higher value, or removed altogether. During the "HOLD" mode, collection system circuit breaker configuration may be changed by the Tatanka operators, as long as the power limit in effect is not exceeded.

SPS Scheme Arming - The SPS scheme shall be "armed" and ready to operate at all times. When one of the two redundant communication channels is removed from normal service for maintenance, the remaining channel shall be considered adequate for SPS operation, and the Tatanka facility power output shall not be limited, as long as Tatanka operators remain in contact with MDU operators. If a failure of equipment or one or more communication channels is detected by supervisory circuits, the SCADA system shall adjust the power output limit as required by the reliability coordinator and the SPS Operating Guide.

SPS Scheme Redundancy - The SPS shall use redundant relays at the Ellendale substation, and two independent communication paths from the Ellendale substation to the Tatanka interconnection and Step-Up substations. Within the Tatanka facility, the redundancy is achieved by having two independent methods of reducing power: (1) using the SCADA system to reduce power and (2) tripping 34.5kV circuits breakers to open up parts of the collection system.

See Also
Drawing 57-2269-1
Ellendale to Tatanka SPS
Logic Description

Ellendale to Tatanka SPS
Logic Description
For
Ellendale to Tatanka Wind Farm
Generation Reduction

MDU	ELLENDALE JCT SUBSTATION	
DRAWN BY: DHR	MONTANA-DAKOTA UTILITIES CO.	SCALE:
DATE:	DRAWING NO: 100287-1 / FILE NO: 57-2269-1	APPROVED:

57-2269-1

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-7-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

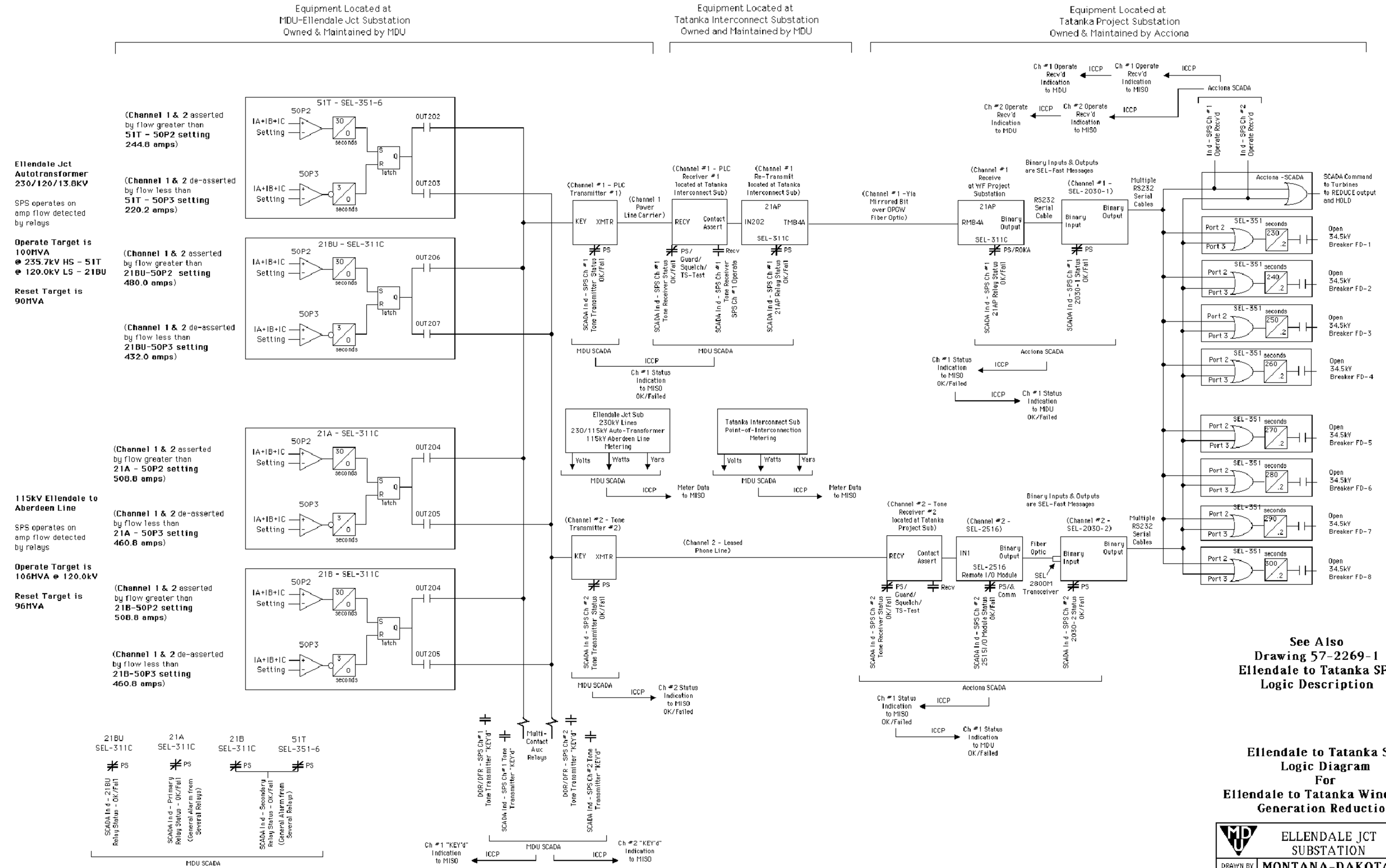
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
SPS LOGIC DESCRIPTION

0 1" 2"

FILENAME	TWESD-CS-20.DWG
SCALE	NONE

SHEET CS-20



See Also
Drawing 57-2269-1
Ellendale to Tatanka SPS
Logic Description

Ellendale to Tatanka SPS
Logic Diagram
For
Ellendale to Tatanka Wind Farm
Generation Reduction

MDU	ELLENDALE JCT SUBSTATION	
DRAWN BY: DHR	MONTANA-DAKOTA UTILITIES CO.	SCALE:
DATE:	DRAWING NO: 100207-2 / FILE NO: 57-2269-2	APPROVED:

57-2269-2

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-7-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW - SPS UPGRADE

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

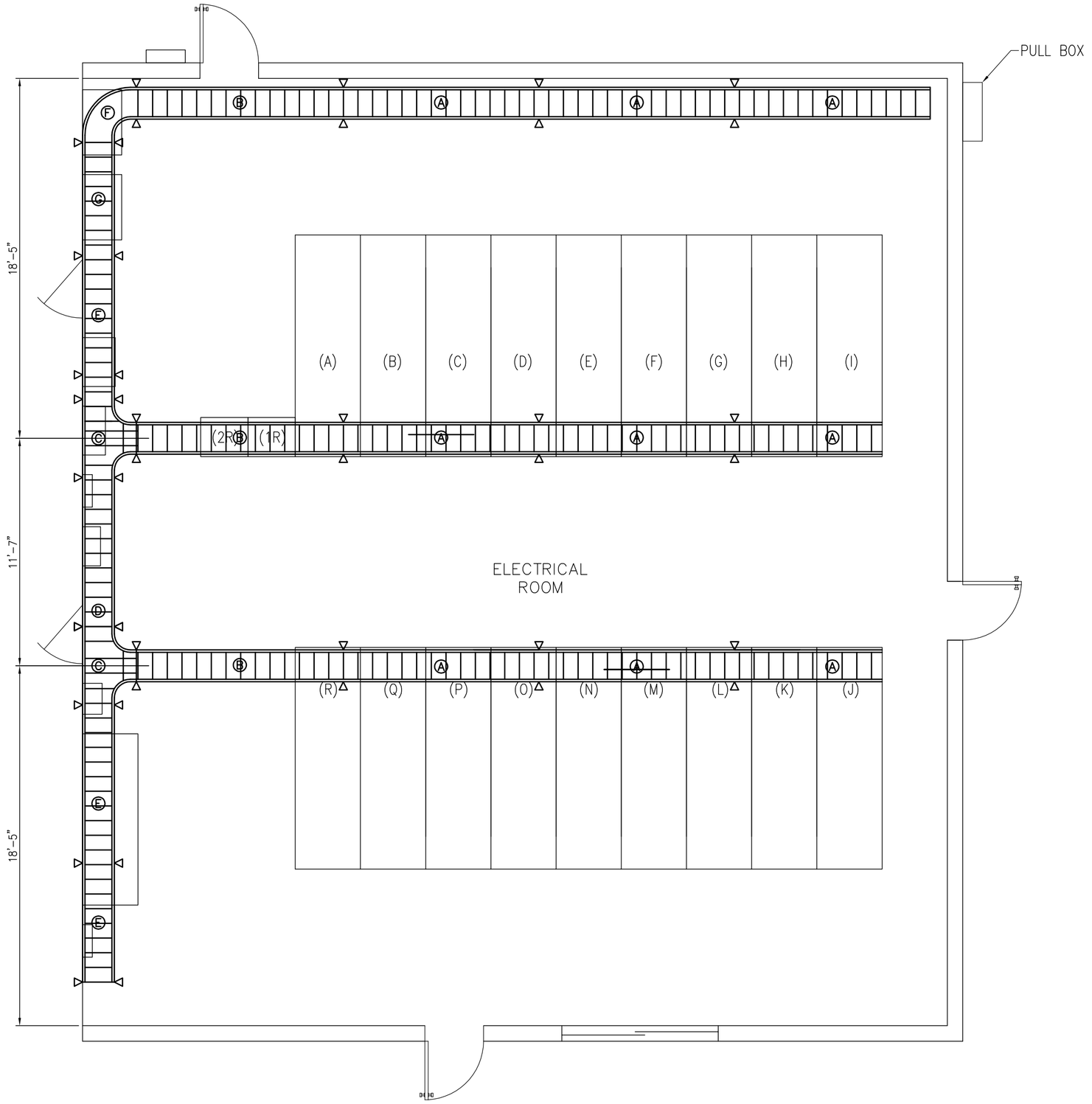
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
SPS LOGIC DIAGRAM

0 1" 2"

FILENAME	TWESD-CS-21.DWG
SCALE	NONE

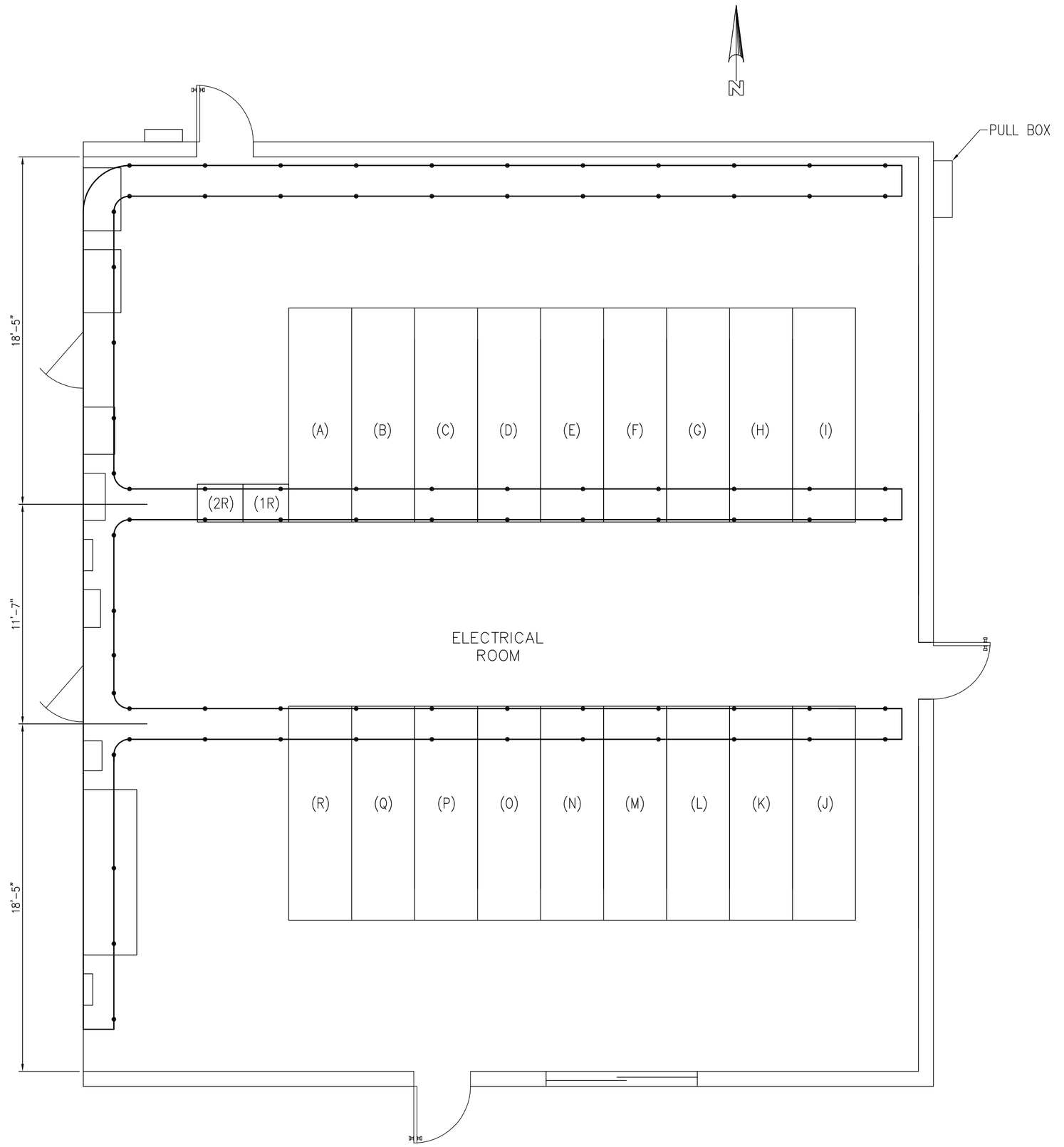
SHEET **CS-21**



CABLE TRAY LAYOUT

CABLETRAY IS SET AT 10'-0" FROM THE FLOOR TO THE BOTTOM OF THE TRAY. 18" WIDE, 6" DEEP B-LINE CABLETRAY.

▽ SPLICE PLATE LOCATIONS
Ⓐ 18" B-LINE CABLETRAY-26A09-18-144(90120")
Ⓑ 18" B-LINE CABLETRAY-26A09-18-144(30127")
Ⓒ 18" B-LINE CABLETRAY-6A-18-HT12(2048")
Ⓓ 18" B-LINE CABLETRAY-26A09-18-144(1066")
Ⓔ 18" B-LINE CABLETRAY-26A09-18-144(4073")
Ⓕ 18" B-LINE CABLETRAY-6A-18-90HB12(1024")
Ⓖ 18" B-LINE CABLETRAY-26A09-18-144(1060")



UNISTRUT LAYOUT

- 1/2"x48 1/2" STEEL ROD LOCATIONS

HARDWARE BY CONTRACTOR
-HANGER ROD CLAMPS (92N-5326)
-SPRINGLESS NUTS
-1/2" NUTS
-1/2" WASHERS
-LOCKWASHERS
-1-5/8" SOLID UNISTRUT
-STEEL RODS

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
2	09-28-07	CONTROL ROOM CHANGES
1	09-04-07	REVISED PER MANUF. DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

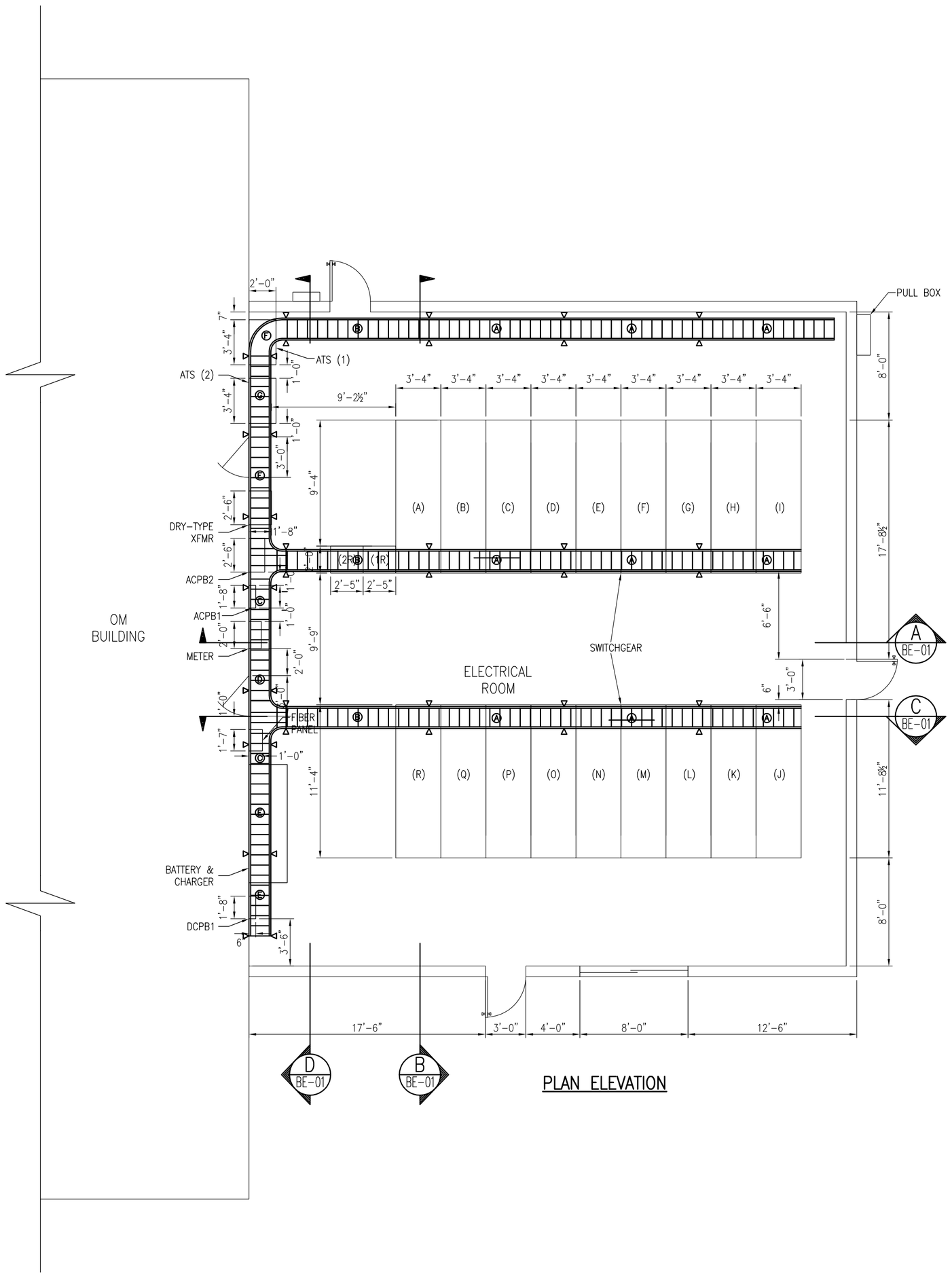
TATANKA WIND ENERGY

PROJECT SUBSTATION 230/34.5kV
CABLE TRAY LAYOUT

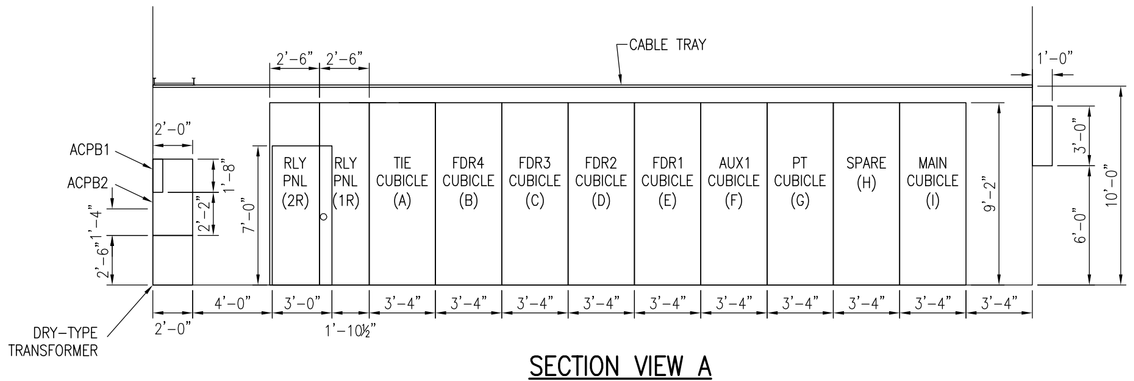
0 1" 2"

FILENAME	TWESD-CT-01
SCALE	1/4"=1'

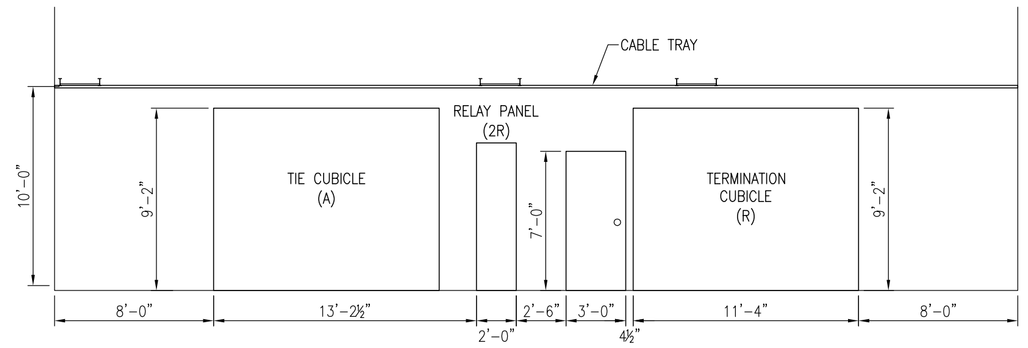
SHEET
CT-01



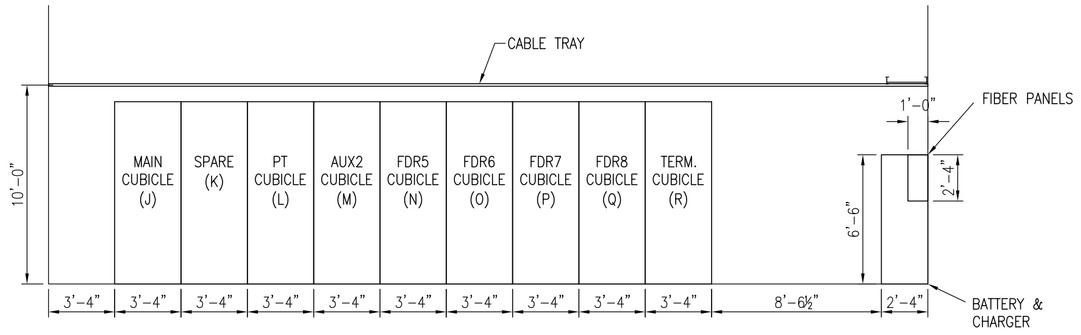
PLAN ELEVATION



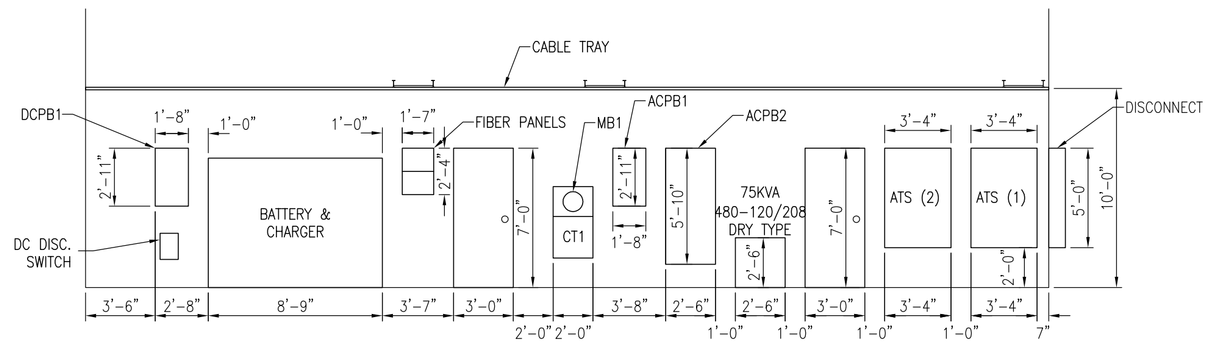
SECTION VIEW A



SECTION VIEW B



SECTION VIEW C



SECTION VIEW D

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
2	09-28-07	CONTROL ROOM CHANGES
1	09-04-07	ADD NEW METERED FDR&PANEL FOR O+M BUILDING
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

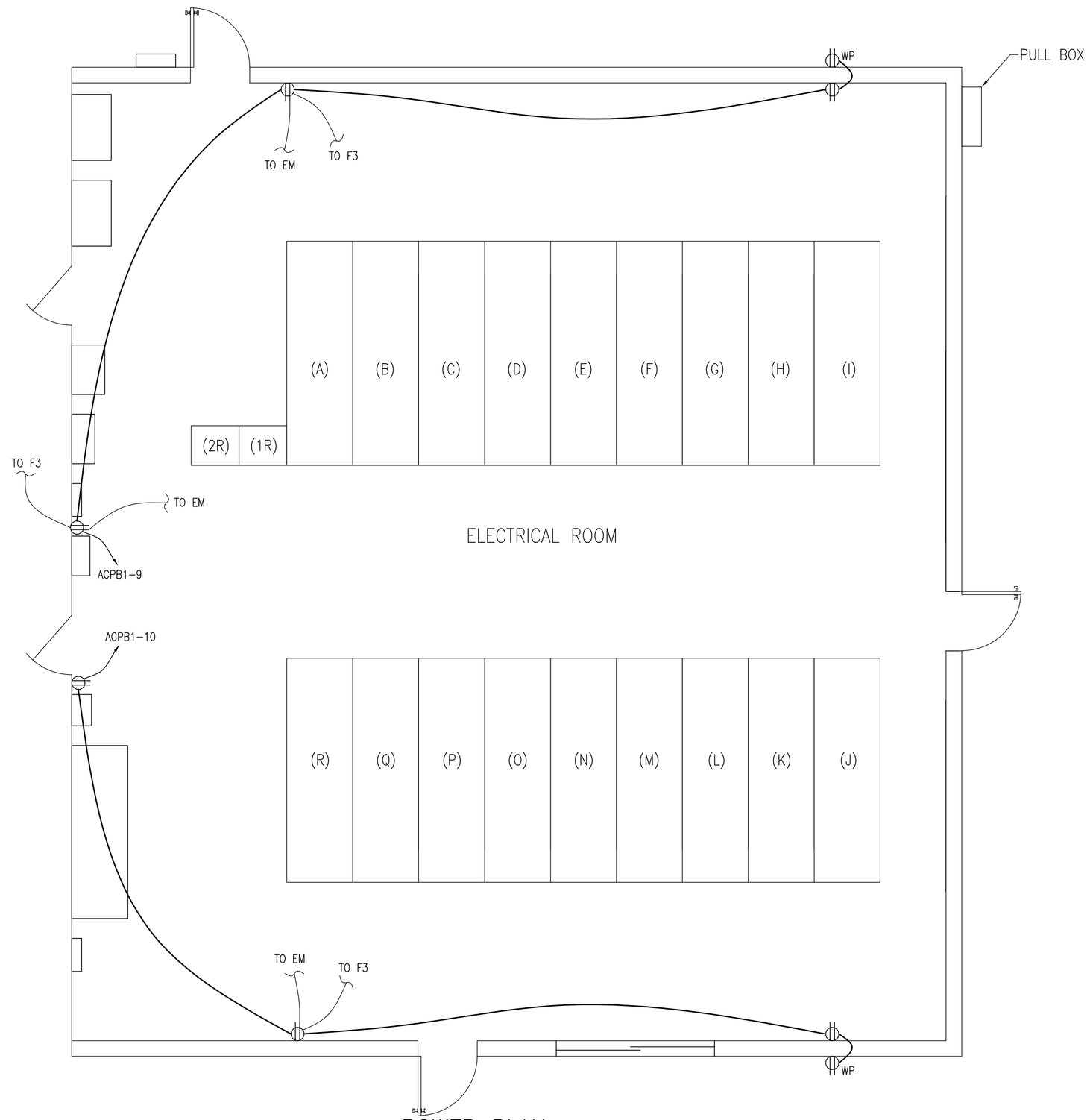
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION ELECTRICAL BUILDING ELEVATIONS

0 1" 2"

FILENAME	TWESD-EB-01
SCALE	3/16"=1'

SHEET **EB-01**



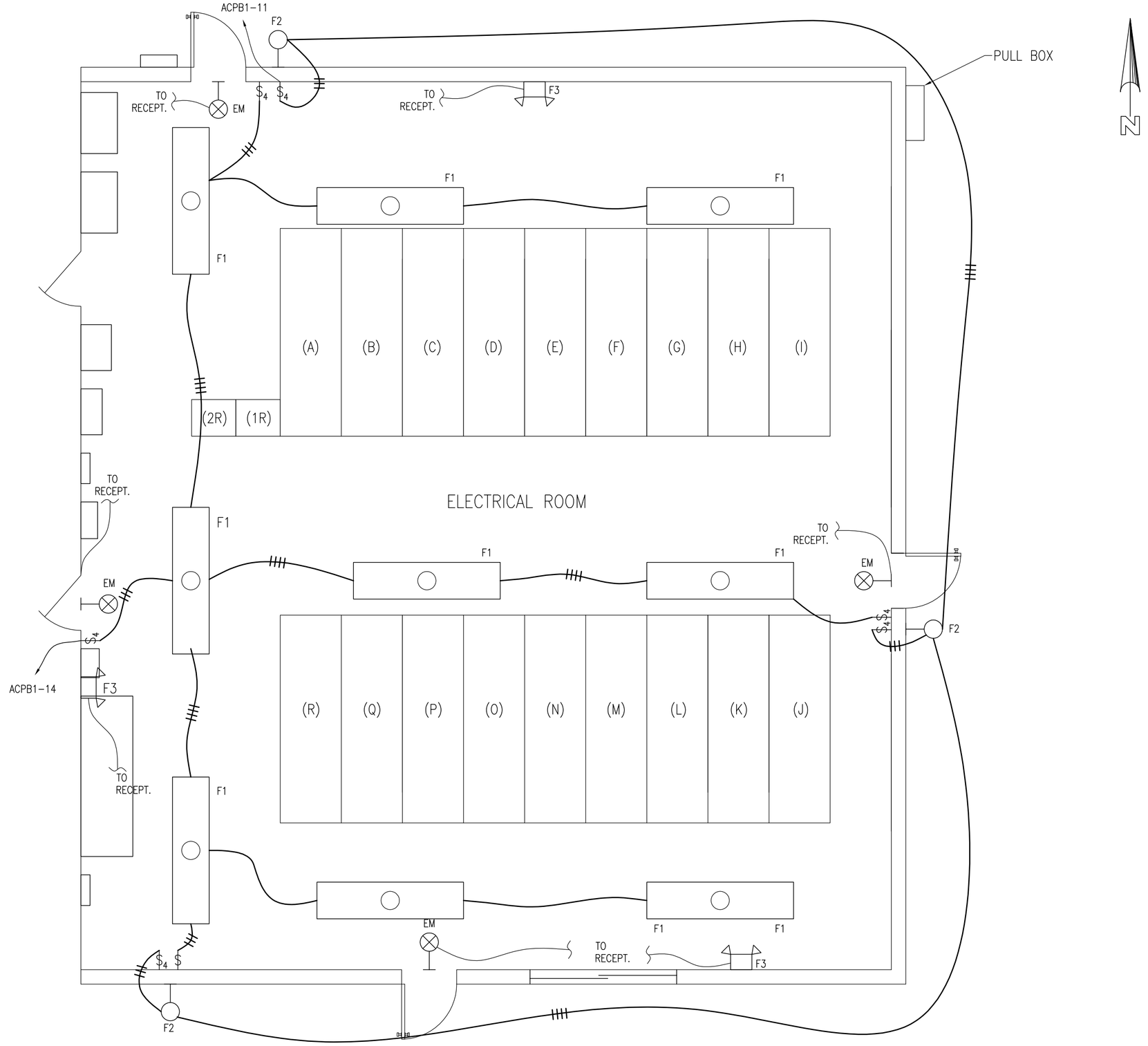
POWER PLAN

NOTES
1. ALL EXTERIOR RECEPTACLES SHALL BE GFI/WP TYPE WITH WEATHERPROOF WHILE IN USE COVER.
2. ALL INTERIOR RECEPTACLES SHALL BE EQUAL TO LEVITON-5252, MOUNTED AT 1'-6" A.F.F.

GENERAL ARRANGEMENT NOTES
1. REFER TO WRITTEN SPECIFICATIONS FOR BUILDING DESIGN REQUIREMENTS.
2. POSITION HORIZONTAL SUPPORT CHANNELS AS CONVENIENT FOR MOUNTING EQUIPMENT.
3. PROVIDE ADEQUATE REINFORCING MEMBERS INSIDE WALL TO SUPPORT EQUIPMENT.
4. CONTROL BUILDING MATERIAL LIST DEFINES ONLY MAJOR MATERIAL REQUIREMENTS; CONTRACTOR SHALL FURNISH ALL MATERIALS REQUIRED TO MAKE A COMPLETE INSTALLATION AS SHOWN ON THIS DRAWING.

PLAN ELEVATION

ELECTRICAL NOTES
1. MATERIAL LIST INDICATES STANDARDS OF QUALITY FOR MATERIAL TO BE FURNISHED. ANY MATERIALS OF EQUAL QUALITY, AS JUDGED BY ENGINEER, SHALL BE CONSIDERED ACCEPTABLE.
2. MATERIAL LIST DEFINES ONLY MAJOR MATERIAL REQUIREMENTS; CONTRACTOR SHALL FURNISH ALL MATERIALS REQUIRED TO MAKE A COMPLETE INSTALLATION AS SHOWN ON THIS DRAWING.
3. REFER TO "AC AND DC PANEL LAYOUTS", FOR ADDITIONAL WIRING DEVICE AND HARDWARE DETAILS.



LIGHTING PLAN

NOTES
1. SINGLE SWITCH TO BE EQUAL TO LEVITON-1221-2, MOUNTED AT 4'-0" A.F.F.
2. THREE WAY SWITCHES TO BE EQUAL TO LEVITON-1223-2, MOUNTED AT 4'-0" A.F.F.
3. FOUR WAY SWITCHES TO BE EQUAL TO LEVITON-1224-2, MOUNTED AT 4'-0" A.F.F.

FIXTURE SCHEDULE

TYPE	MFR	MODEL #	DESCRIPTION	VOLT	MOUNTING	LAMP	SYMBOL
F1	LITHONIA	AF-2-96HO-MVOLT-GEB10RS	800 MILLIAMPERE, HIGH OUTPUT, 8-FOOT, RAPID START, SUSPENDED	120V	SUSPENDED @ 10' FROM FLOOR LEVEL.	2-110W	
F2	FAIL-SAFE	HV-V-50S-120V	HEAVY DUTY, CORROSION RESISTANT CASTALUMINUM, PORCELAIN SOCKET	120V	WALL MOUNTED @ 7'-0" A.F.F.	1-70W	
F3	DUAL-LITE	A575V	SIX VOLT-EMERGENCY LIGHT, NICKLE CADMIUM BATTERIES	120V	WALL MOUNTED @ 7'-6" A.F.F.	2-25W	
EM	EXIT LIGHT	LEDRBB-ETL	INJECTION MOLDED, VO FLAME RETARDANT, HIGH IMPACT, NI-CAD BATTERY	120V	WALL MOUNTED @ 7'-6" A.F.F.	1-22W	

* ALL FIXTURES "OR APPROVED EQUAL"

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-7-08	AS BUILT
2	09-28-07	CONTROL ROOM CHANGES
1	09-04-07	REVISED PER MANUF. DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

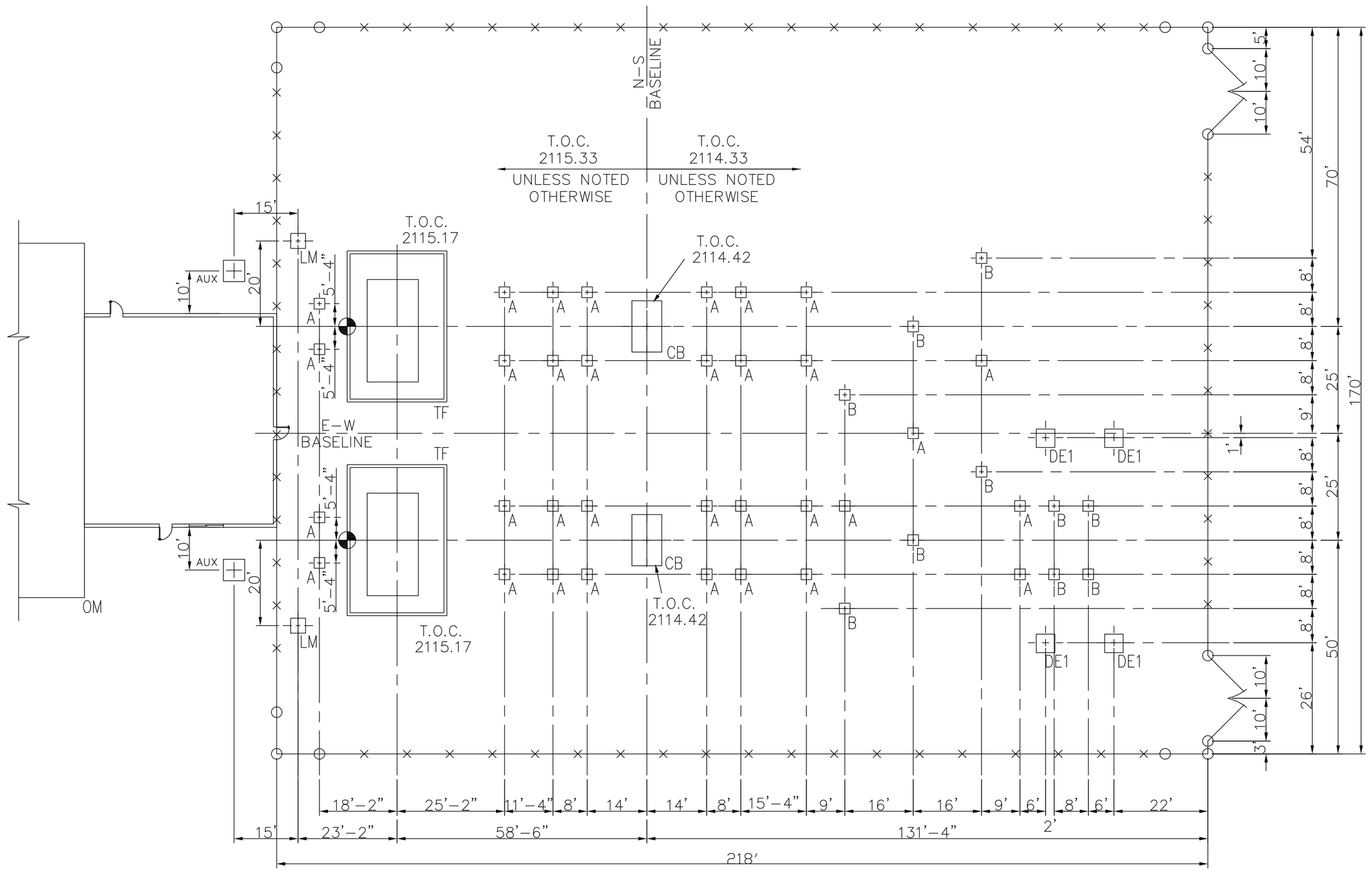
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
ELECTRICAL BUILDING POWER & LIGHTING

0 1" 2"

FILENAME	TWESD-EB-02
SCALE	1/4"=1'

SHEET **EB-02**



FOUNDATION SCHEDULE				
FOUNDATION DESIGNATION	DRAWING REFERENCE	QTY	CONCRETE REQUIREMENTS PER UNIT	CONCRETE REQUIREMENTS TOTAL
A	TWESD-FD-02	33	2.6	85.8
B	TWESD-FD-02	10	2.6	26
CB	TWESD-FD-02	2	4.7	9.4
DE1	TWESD-FD-02	4	8.6	34.4
LM	TWESD-FD-02	2	5.9	11.8
TF	TWESD-FD-03	2	72.1	144.2
AUX	TWESD-FD-03	2	.9	1.8

NOTES:

1. T.O.C. = TOP OF CONCRETE
2. CONSTRUCTION JOINTS WILL NOT BE ALLOWED WITHOUT PRIOR WRITTEN CONSENT FROM THE OWNER, UNLESS OTHERWISE NOTED ON THE DRAWINGS.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
2	09-28-07	CONTROL ROOM CHANGES
1	06-21-07	REVISED T.O.C. ELEVATION
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

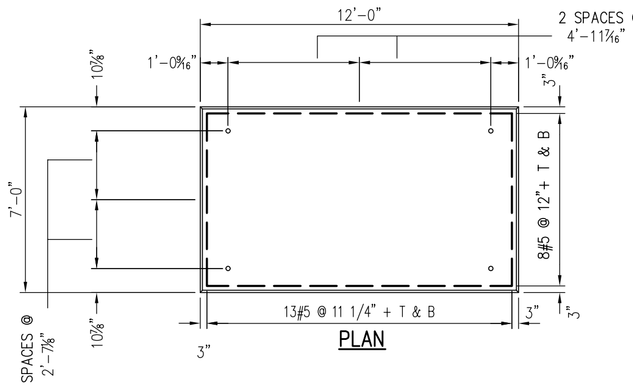
230/34.5kV PROJECT SUBSTATION FOUNDATION PLAN

0 1" 2"

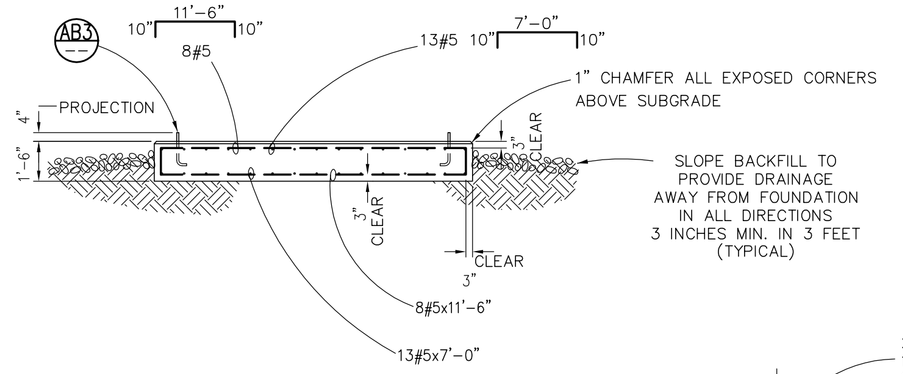
FILENAME	TWESD-FD-01
SCALE	NONE

SHEET FD-01

MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	4.7 c.y.	PER SPEC.
REBAR #5	 418.2 lb.	PER SPEC.
ANCHOR BOLTS	4	1" DIA. A36 FURNISHED BY CONTRACTOR



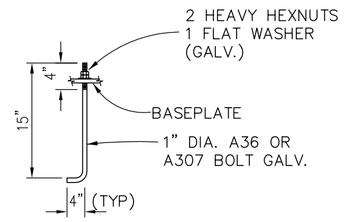
PLAN



ELEVATION

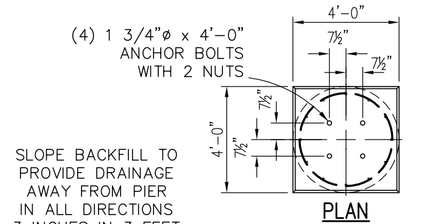
230KV PCB FOUNDATION (CB FD01)

0 1 2 3 4 5

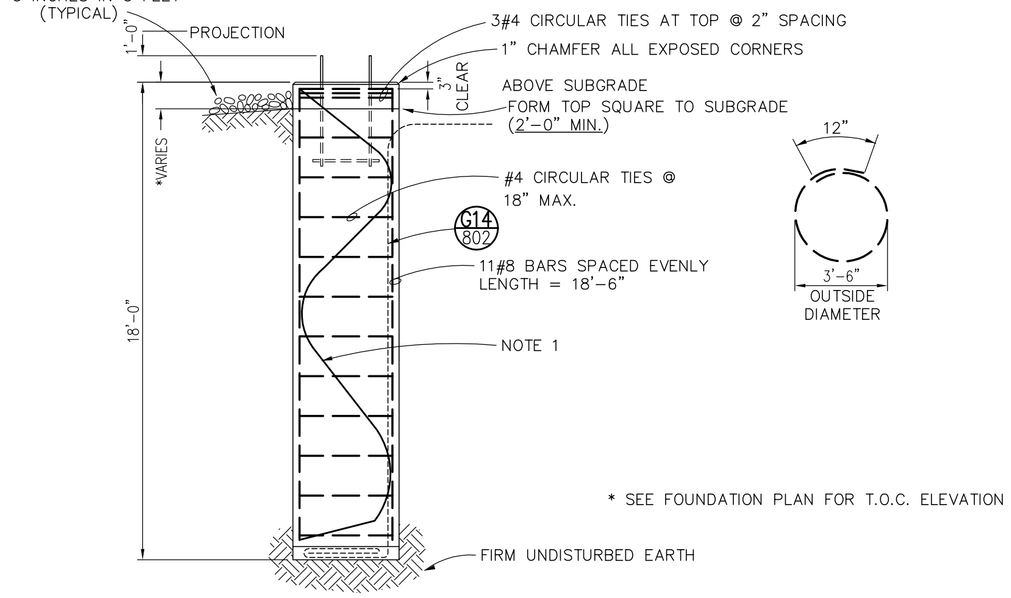


ANCHOR BOLT DETAIL (AB3)
SCALE: N.T.S.

MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	8.6 c.y.	PER SPEC.
REBAR #4 #8	 145 lb. 543.3 lb.	PER SPEC.
ANCHOR BOLTS	4	FURNISHED BY DE FABRICATOR INSTALLED BY CONTRACTOR



PLAN



* SEE FOUNDATION PLAN FOR T.O.C. ELEVATION

ELEVATION

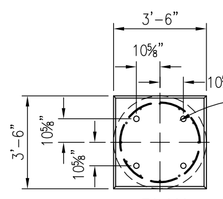
FOUNDATION (DE1 FD01)

0 1 2 3 4 5

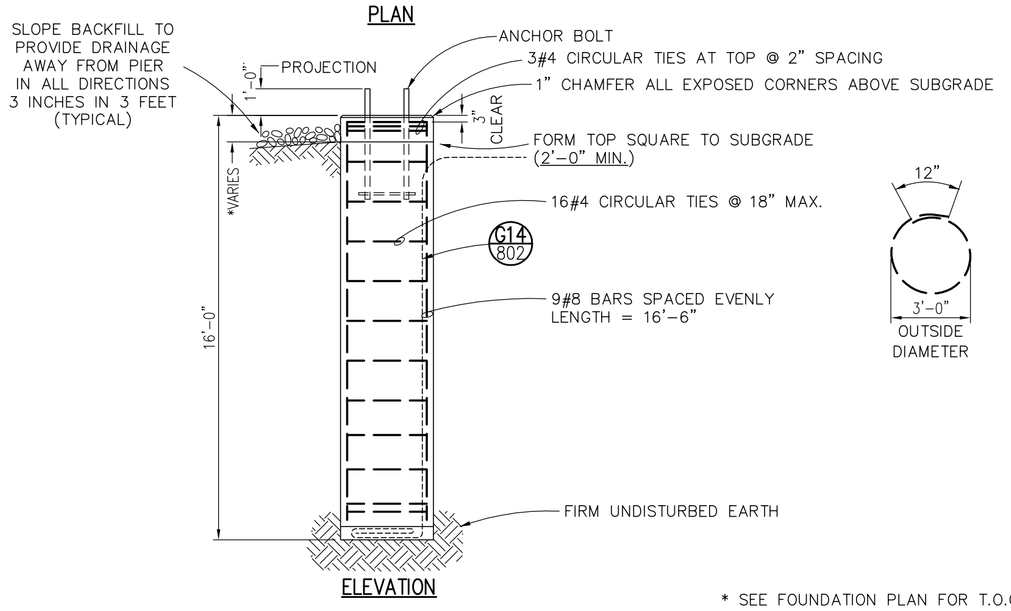
NOTE:

1. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING MATERIALS AND LABOR TO ADEQUATELY BRACE THE REBAR CAGE TO WITHSTAND CONSTRUCTION LOADS.

MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	5.9c.y.	PER SPEC.
REBAR #4 #8	 110 lb. 396.5 lb.	PER SPEC.
ANCHOR BOLTS	4	FURNISHED BY FABRICATOR INSTALLED BY CONTRACTOR



PLAN



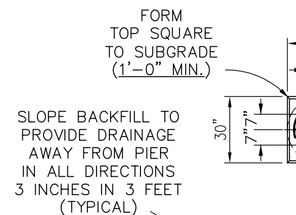
ELEVATION

* SEE FOUNDATION PLAN FOR T.O.C. ELEVATION

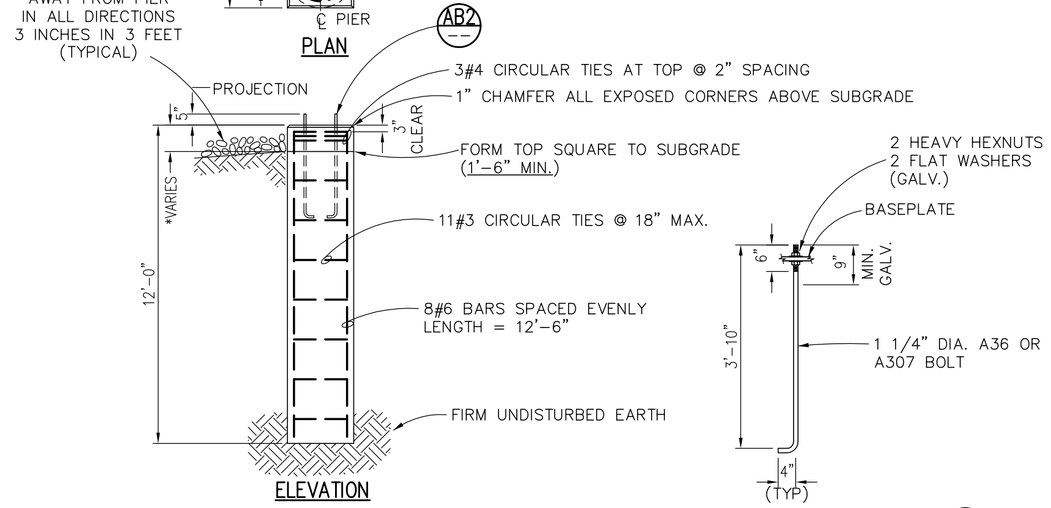
FOUNDATION (LM FD01)

0 1 2 3 4 5

MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	2.6 c.y.	PER SPEC.
REBAR #6 #3	 150 lb. 29 lb.	PER SPEC.
ANCHOR BOLTS AB2	4	FURNISHED AND INSTALLED BY CONTRACTOR



PLAN



ELEVATION

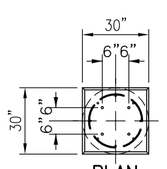
ANCHOR BOLT DETAIL (AB2)
SCALE: N.T.S.

* SEE FOUNDATION PLAN FOR T.O.C. ELEVATION

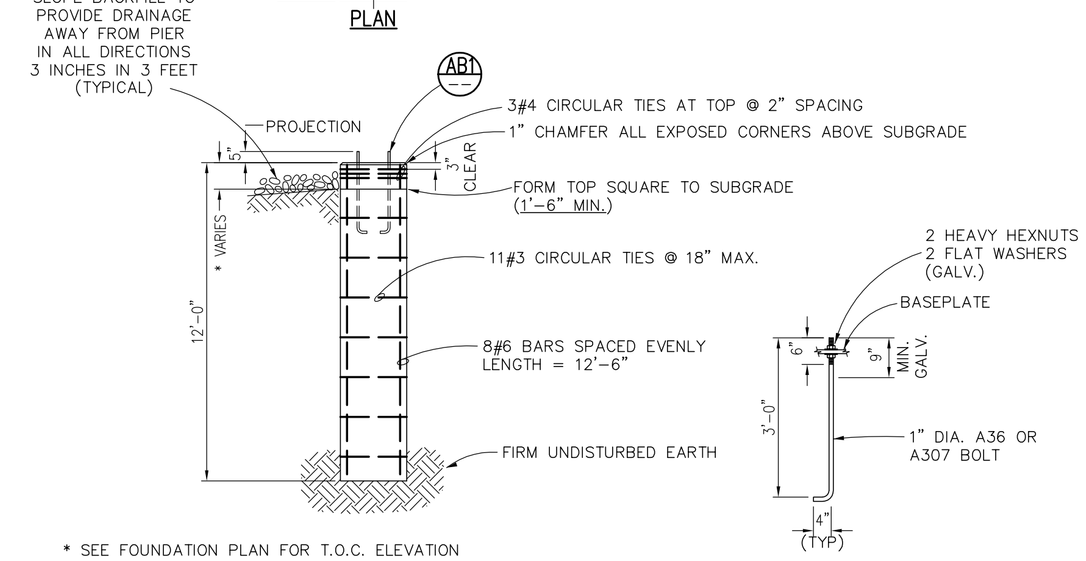
FOUNDATION (A FD01)

0 1 2 3 4 5

MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	2.6 c.y.	PER SPEC.
REBAR #6 #3	 150 lb. 29 lb.	PER SPEC.
ANCHOR BOLTS AB1	4	FURNISHED AND INSTALLED BY CONTRACTOR



PLAN



* SEE FOUNDATION PLAN FOR T.O.C. ELEVATION

ANCHOR BOLT DETAIL (AB1)
SCALE: N.T.S.

ELEVATION

FOUNDATION (B FD01)

0 1 2 3 4 5

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
⚠1	06-21-07	REVISED FOUNDATION DETAILS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

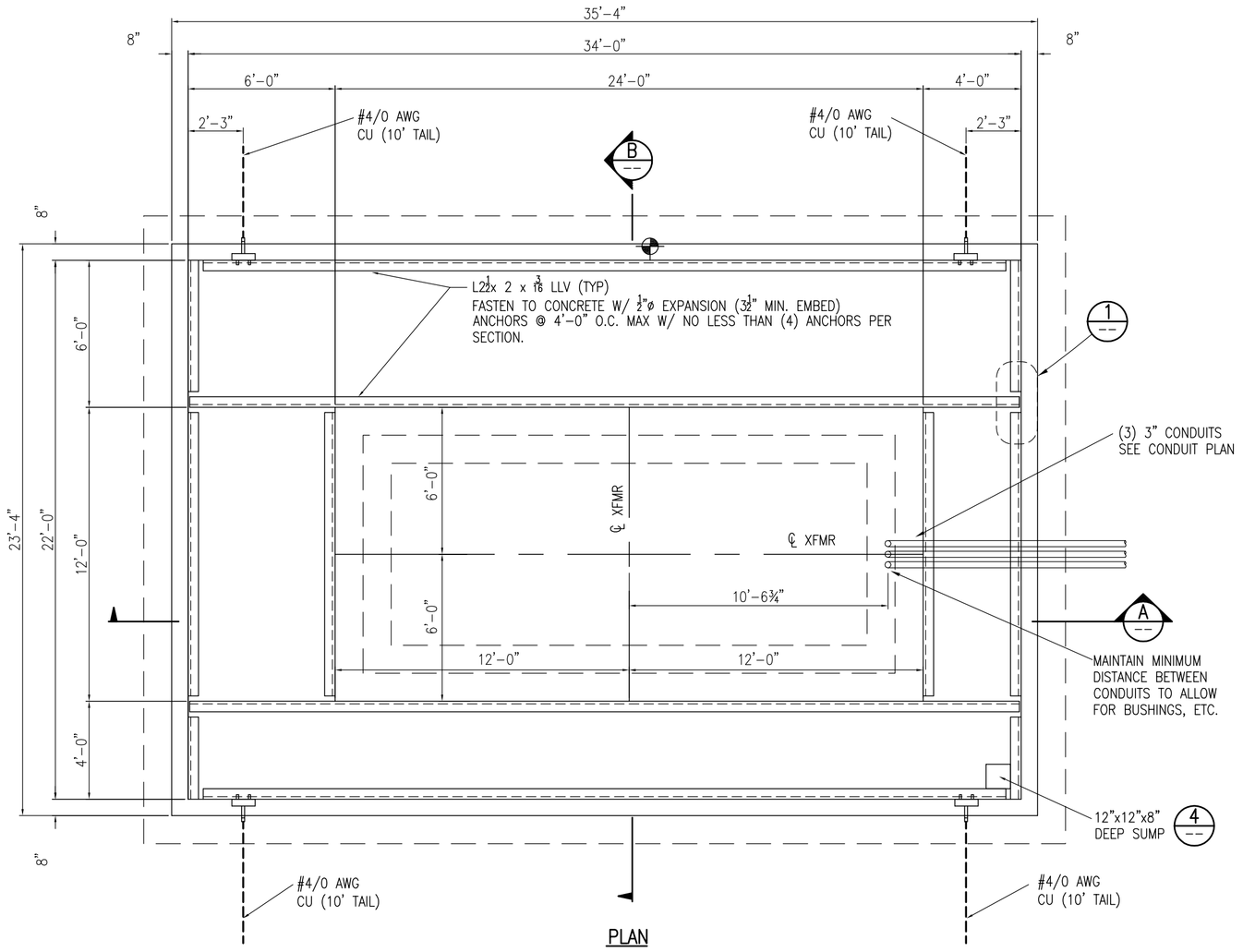
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION FOUNDATION DETAILS

0 1" 2"

FILENAME	TWESD-FD-02
SCALE	NONE

SHEET **FD-02**



PLAN

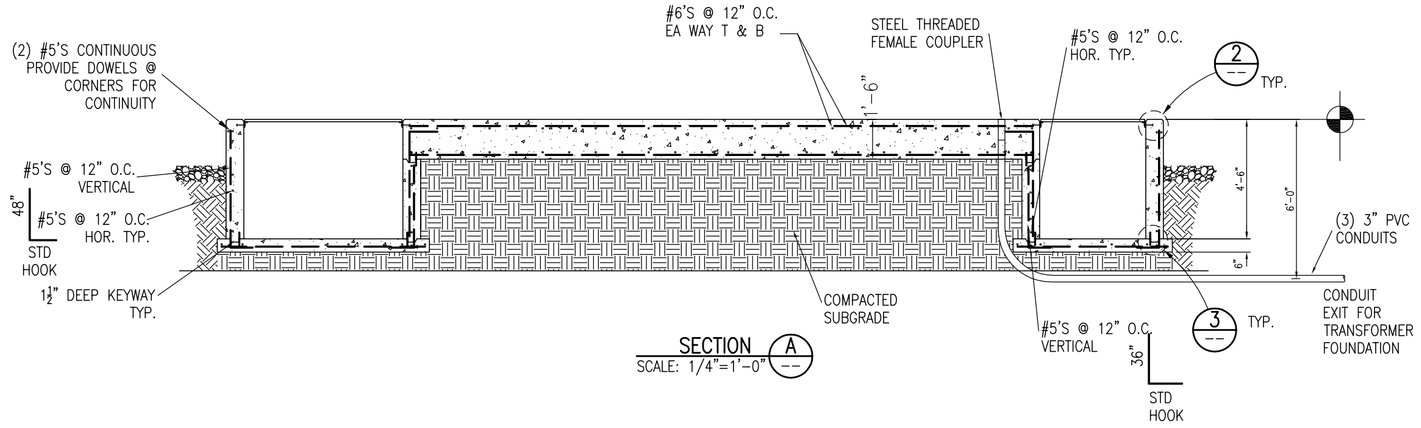
MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	72.1 C.Y.	PER SPEC.
REBAR	4127.4 LBS 1676.2 LBS	#5 ASTM A615 GRADE 60 #6 ASTM A615 GRADE 60
GND PAD	4	BURNDY YGF29-4N

FOUNDATION TF
230-34.5kV TRANSFORMER FOUNDATION

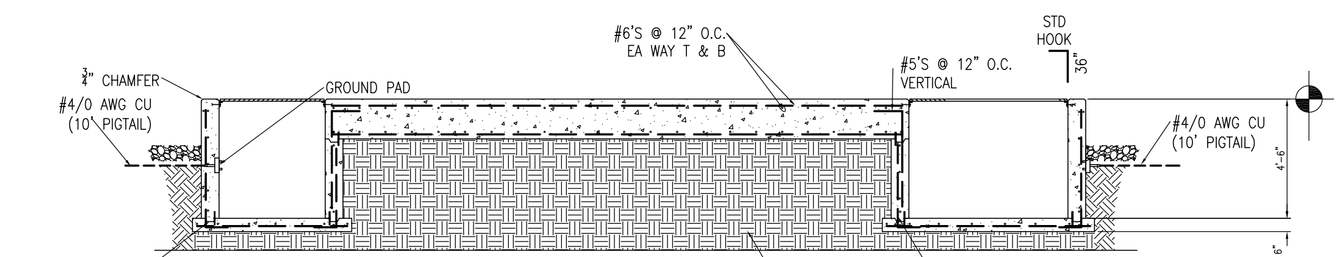
2 REQUIRED

NOTES

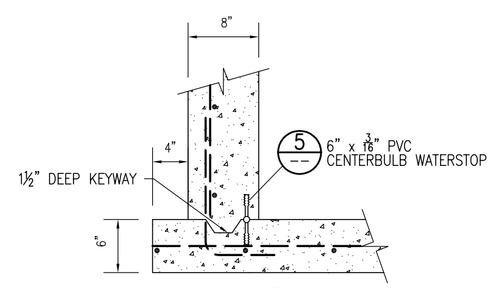
1. SPACE REBAR 3" FROM ALL OUTSIDE SURFACES, UNLESS NOTED OTHERWISE.
2. EXCAVATION, BACKFILL, GRAVEL, CONCRETE SHALL BE IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS.
3. DETAILS SHOWN INDICATE TYPICAL CONSTRUCTION REQUIREMENTS FOR DEPTH OF EXCAVATION AND ABOVE GRADE FORMING. ACTUAL REQUIREMENTS SHALL BE DETERMINED FROM FOUNDATION TOP ELEVATIONS AS SHOWN ON THE "FOUNDATION PLAN".
4. GROUT IS NOT REQUIRED BETWEEN STEEL BASEPLATE AND TOP OF FOUNDATION. PLACE ALL STRUCTURES ON LEVELING NUTS.
5. CHAMFER ALL EXPOSED EDGES 1".



SECTION A
SCALE: 1/4"=1'-0"

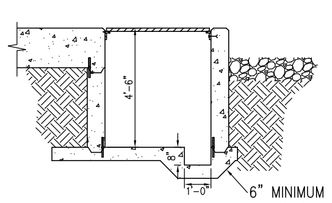


SECTION B
SCALE: 1/4"=1'-0"

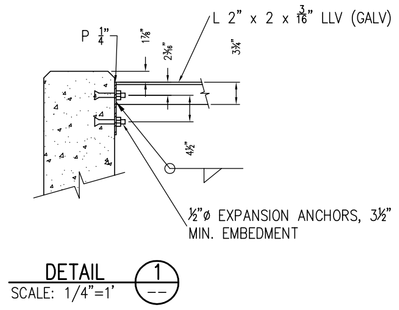


DETAIL 3
SCALE: 1"=1'-0"

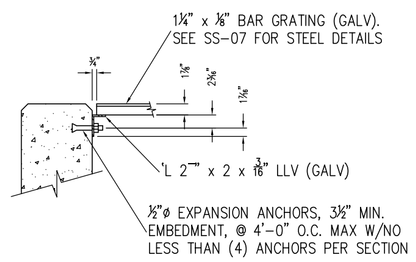
FOUNDATION TF
SCALE: 1/4"=1'-0" FD01



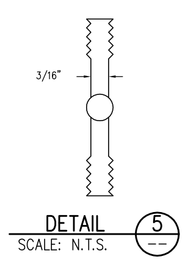
SUMP DETAIL 4
SCALE: 1/4"=1'-0"



DETAIL 1
SCALE: 1/4"=1'



DETAIL 2
SCALE: 1/4"=1'



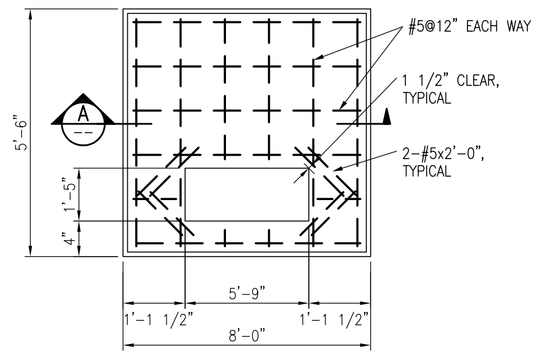
DETAIL 5
SCALE: N.T.S.

3/16" x 6" CENTER BULB THERMOPLASTIC RUBBER GREEN STREAK #780 WATERSTOP OR EQUAL

MATERIALS (1 FDN)		
ITEM	QTY.	REMARKS
CONCRETE	0.90 CY	PER SPEC.
REBAR	95 LBS	#5 ASTM A 615 GR. 60

FOUNDATION STA AUX

2 REQUIRED



PLAN

SECTION A
SCALE: 1/4"=1'-0"

FOUNDATION AUX
SCALE: 1/2"=1'-0" FD01

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
2	07-16-07	ADDED CONDUIT NOTE
1	06-21-07	REVISED FOUNDATION DETAILS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

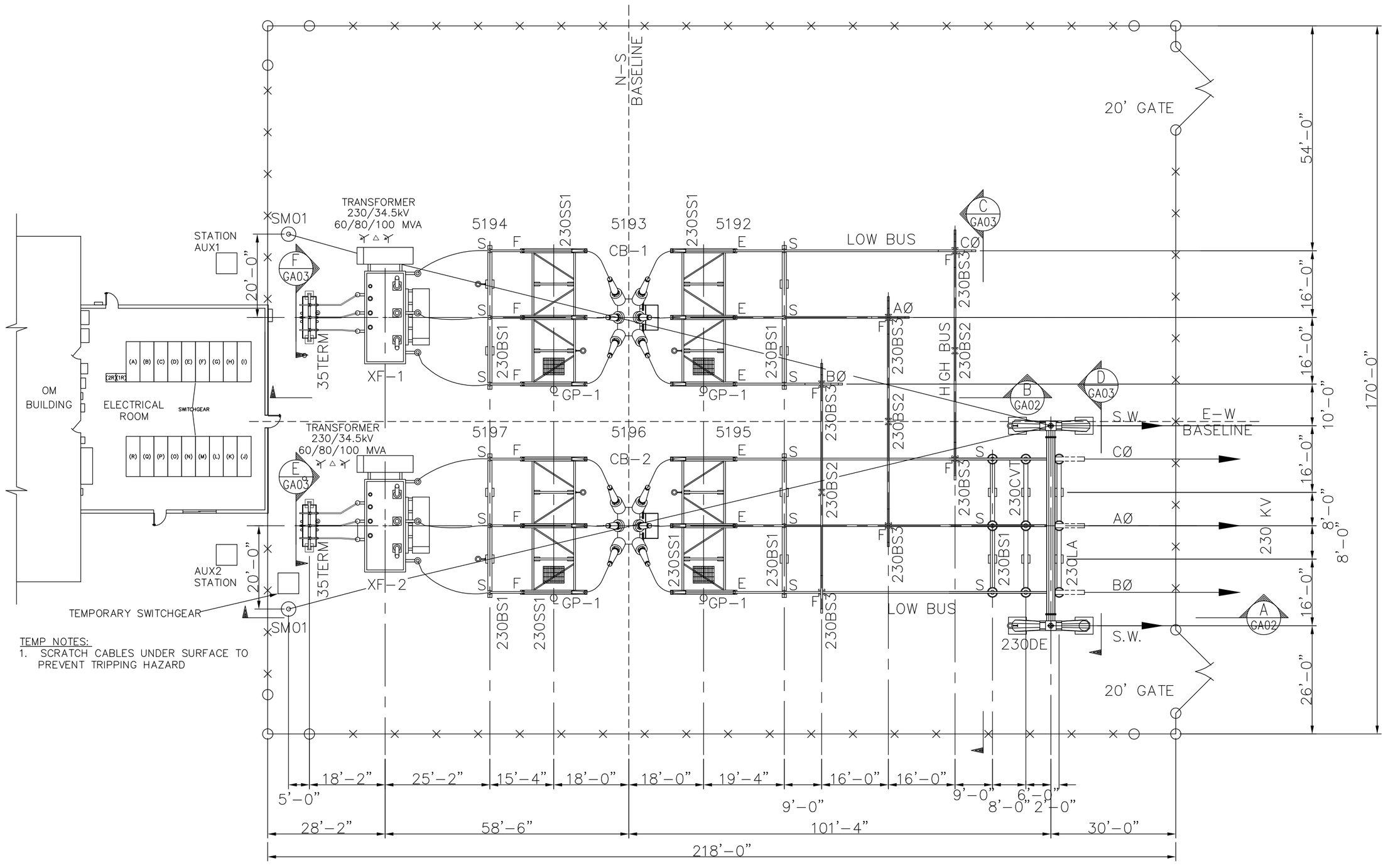
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION FOUNDATION DETAILS

0 1" 2"

FILENAME	TWESD-FD-03
SCALE	NONE

SHEET FD-03



TEMP NOTES:
1. SCRATCH CABLES UNDER SURFACE TO PREVENT TRIPPING HAZARD

N

0' 10' 20' 30' 40'

STRUCTURAL STEEL SCHEDULE			
STRUCTURE DESIGNATION	DESCRIPTION	QTY	REF. DWG.
230SS1	230kV 3Ø SWITCH STAND (10'-6" BUS HEIGHT)	4	TWESD-SS-01
230BS1	230kV 3Ø BUS SUPPORT (11'-0" BUS HEIGHT)	5	TWESD-SS-02
230BS2	230kV 1Ø BUS SUPPORT (23'-0" BUS HEIGHT)	3	TWESD-SS-02
230BS3	230kV 1Ø BUS SUPPORT (11'-0" BUS HEIGHT)	6	TWESD-SS-02
GP-1	GROUND PLATFORM	4	TWESD-SS-03
35TERM	TERMINATION STAND	2	TWESD-SS-04
230CVT	230kV CVT SUPPORT	1	TWESD-SS-06
230LA	230kV ARRESTER SUPPORT	1	TWESD-SS-06
230DE	DEADEND TOWER	1	TWESD-SM-01
SM-01	STATIC MAST	2	TWESD-SM-01

NOTES:
1. ACTUAL 230KV BREAKER TO BE CONFIRMED.

LEGEND

A / GA02 — SECTION DETAIL NUMBER / REFER TO DRAWING FOR SECTION DETAIL

F – FIXED SUPPORT
S – SLIP SUPPORT
E – EXPANSION SUPPORT
C – APPROXIMATE COUPLER LOCATION

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
B	11-13-07	ADD MDU NAMING CONNECTION
A	10-24-07	TEMP SWGR
2	09-28-07	CONTROL ROOM CHANGES
1	09-04-07	REVISED PER MANUF. DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

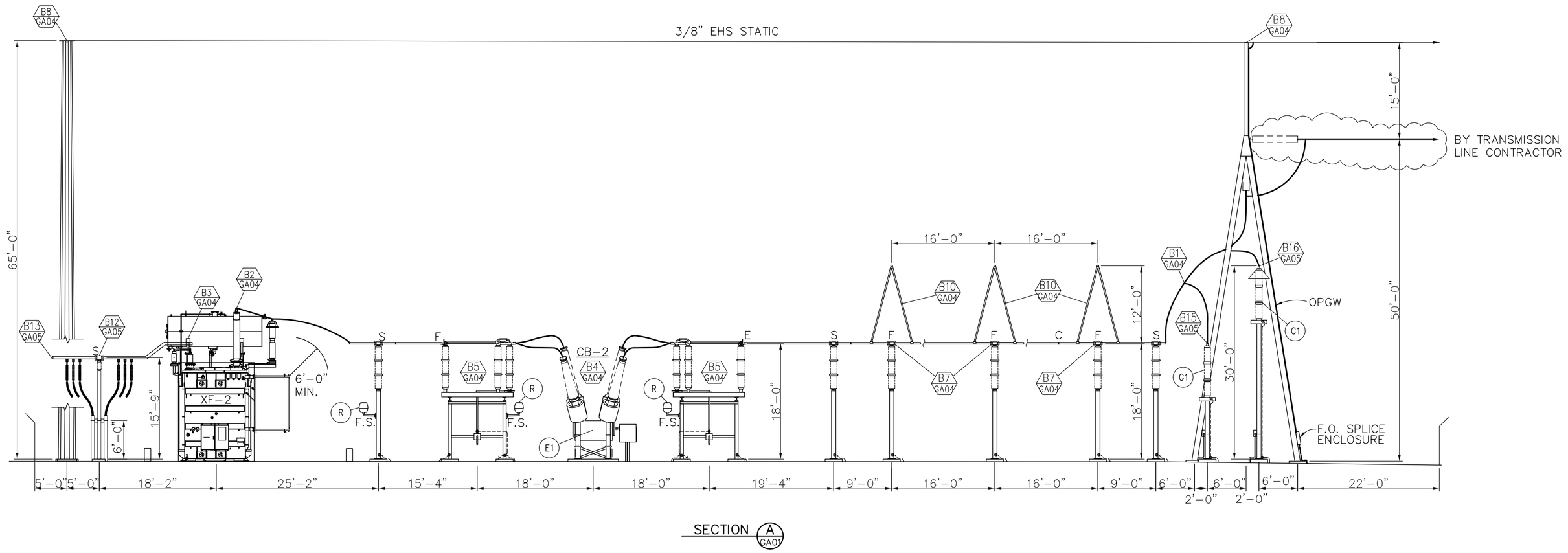
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION GENERAL ARRANGEMENT

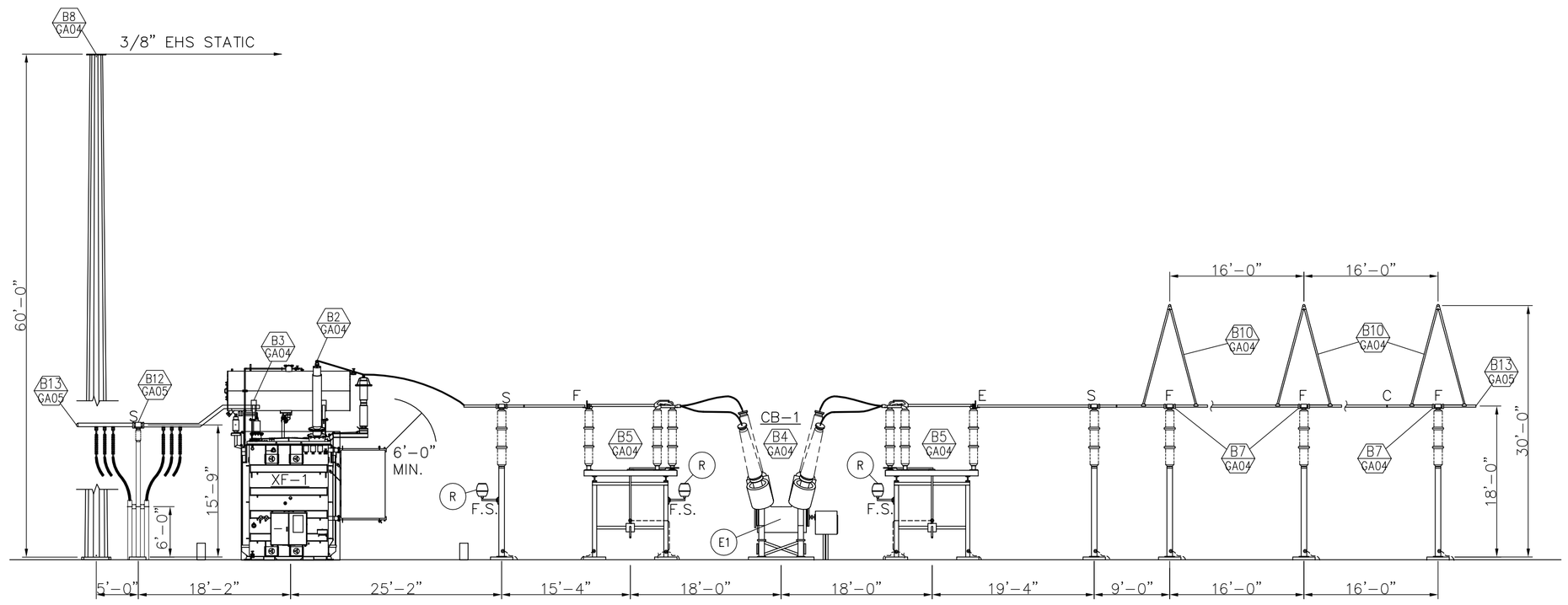
0 1" 2"

FILENAME	TWESD-GA-01
SCALE	NONE

SHEET GA-01



SECTION A CA01



SECTION B CA01

NOTES:

1. BUS HEIGHT IS FROM BOTTOM OF STEEL BASEPLATE TO CENTER-LINE OF BUS.
2. T.O.C. IS 'TOP OF CONCRETE'
3. ACTUAL 230KV BREAKER TO BE CONFIRMED.

LEGEND:

B4 CA04 ——— BUS CONNECTION DETAIL NUMBER
——— REFER TO DRAWING TWESD-GA-04

H1 ——— BILL OF MATERIAL ITEM NUMBER
REFER TO DRAWING TWESD-GA-06

S – SLIP
F – FIXED
E – EXPANSION
C – APPROXIMATE LOCATION OF COUPLER
F.O. – FIBER OPTIC
F.S. – FAR SIDE

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	11-06-07	REVISED PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

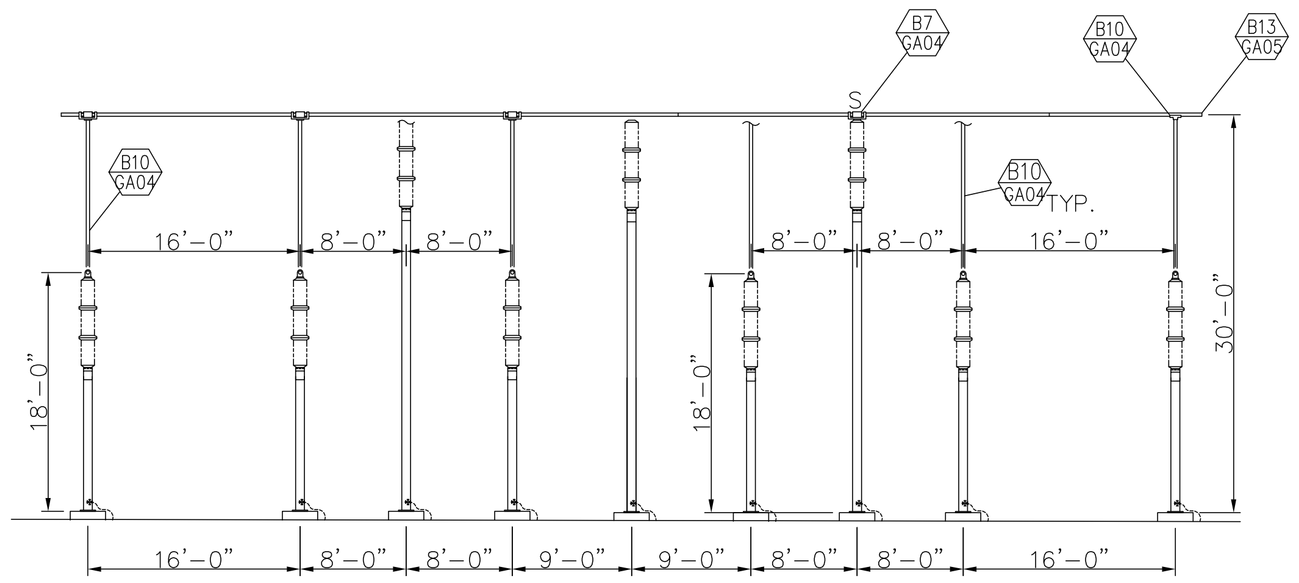
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION GENERAL ARRANGEMENT SECTION A & B

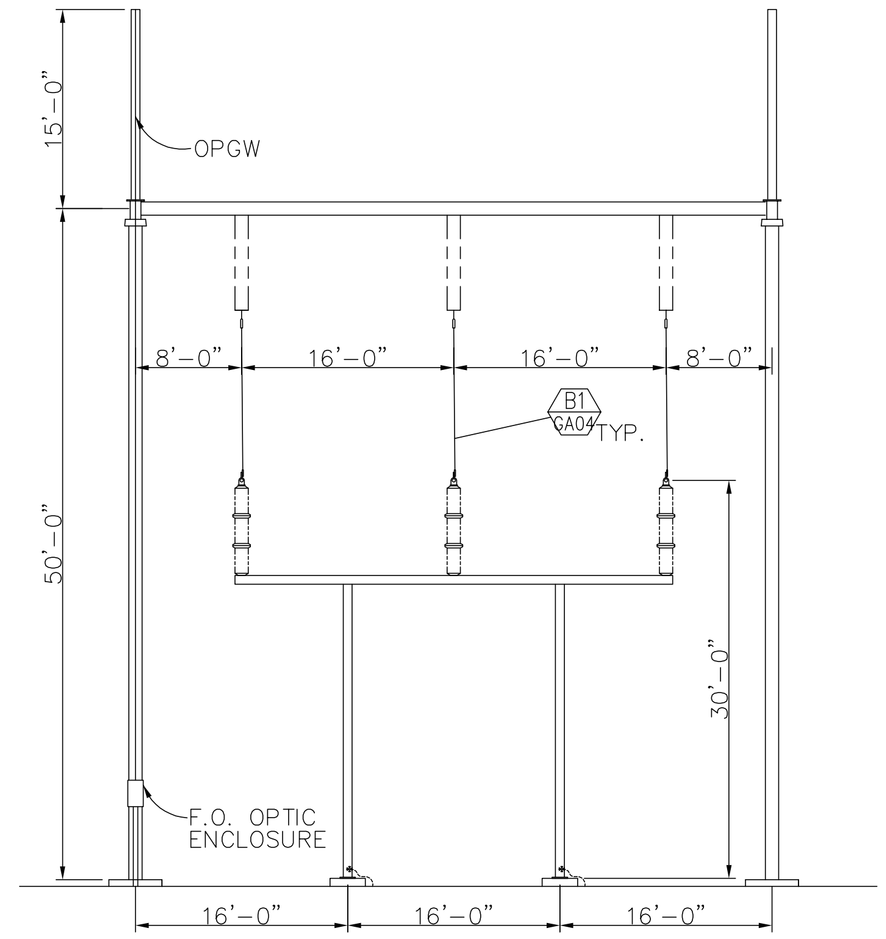
0 1" 2"

FILENAME	TWESD-GA-02
SCALE	3/32" = 1'

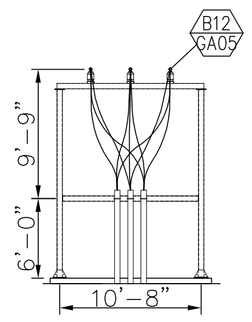
SHEET **GA-02**



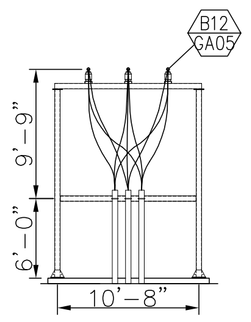
SECTION C GA01



SECTION D GA01



SECTION E GA01



SECTION F GA01

NOTES

1. BUS HEIGHT IS FROM BOTTOM OF STEEL BASEPLATE TO CENTER–LINE OF BUS.
2. T.O.C. IS 'TOP OF CONCRETE'

LEGEND

B1 / GA04 ——— BUS CONNECTION DETAIL NUMBER
——— REFER TO DRAWING TWESD–GA–01

S – SLIP
F – FIXED
E – EXPANSION
C – APPROXIMATE COUPLER LOCATION
F.O. – FIBER OPTIC

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

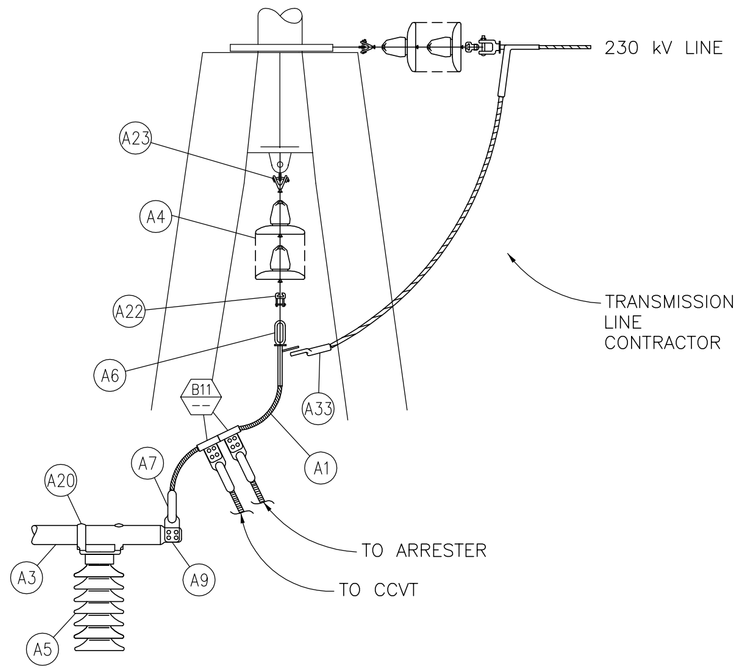
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
GENERAL ARRANGEMENT SECTIONS C, D, E & F

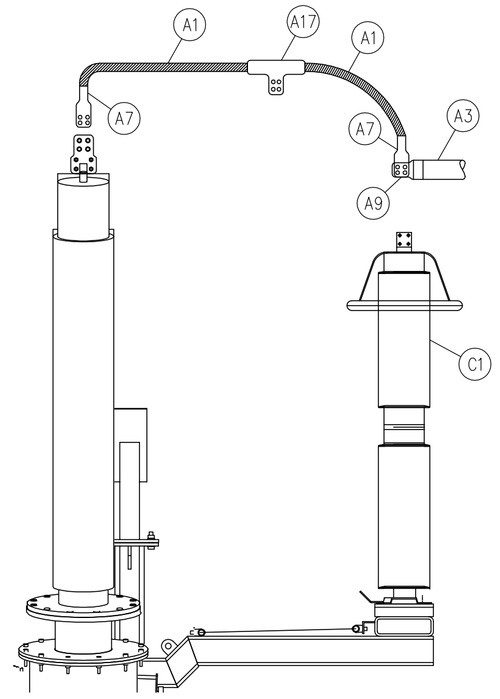
0 1" 2"

FILENAME	TWESD–GA–03
SCALE	1/8" = 1'

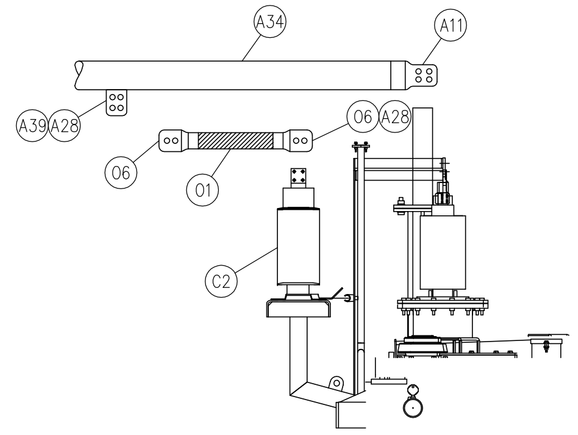
SHEET **GA-03**



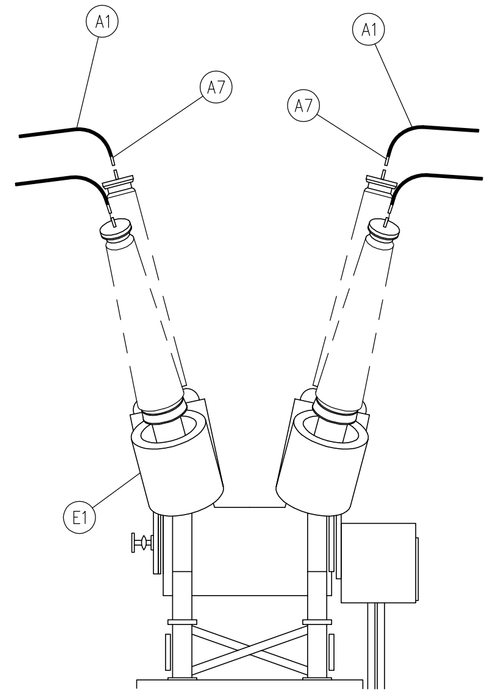
B1
230kV TAKEOFF STRUCTURE LINE ATTACHMENT DETAIL



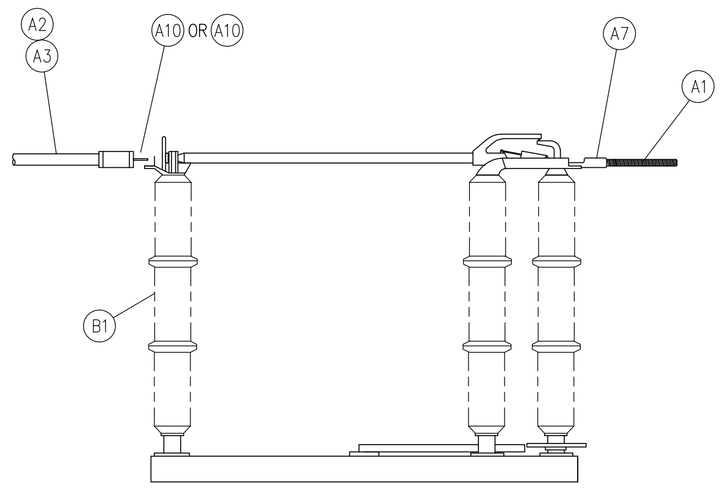
B2
TRANSFORMER 230kV BUSHING/LA DETAIL



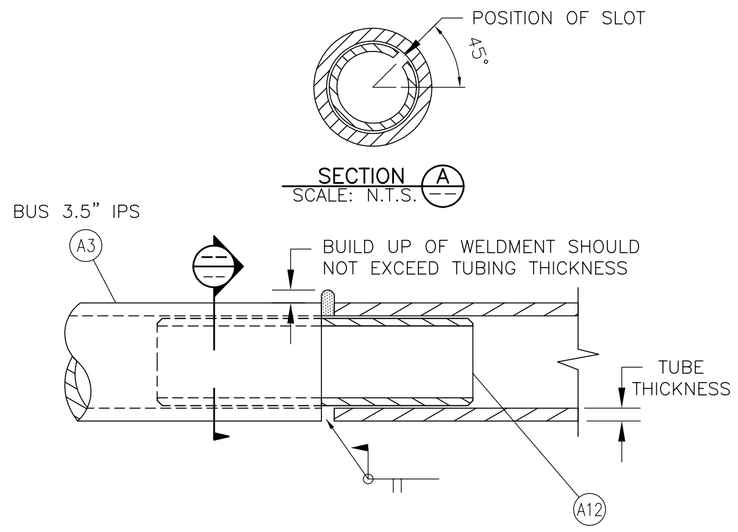
B3
TRANSFORMER 34.5kV BUSHING/LA DETAIL



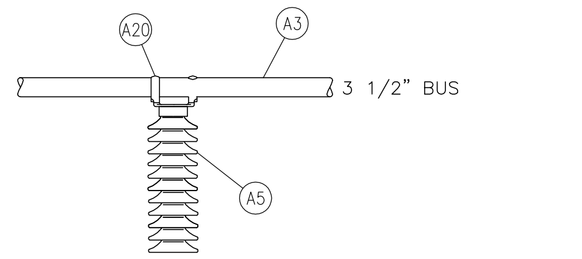
B4
230kV BREAKER DETAIL



B5
230kV DISCONNECT SWITCH CONNECTION DETAIL



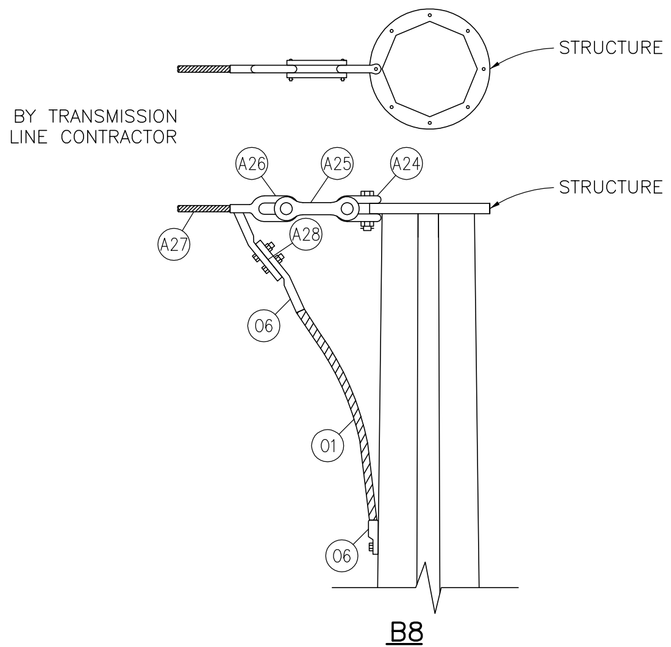
B6
230kV BUS COUPLER JOINT



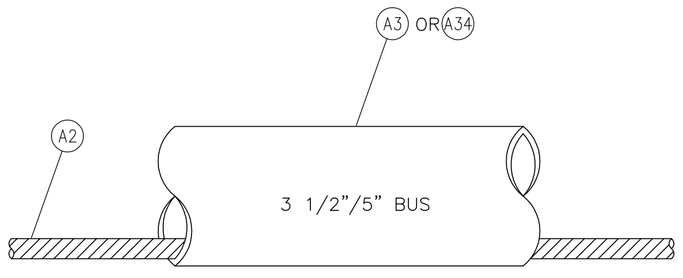
S – "SLIP" SUPPORT
A20 NOT WELDED TO BUS.

F – "FIXED" SUPPORT
A20 WELDED TO BUS.

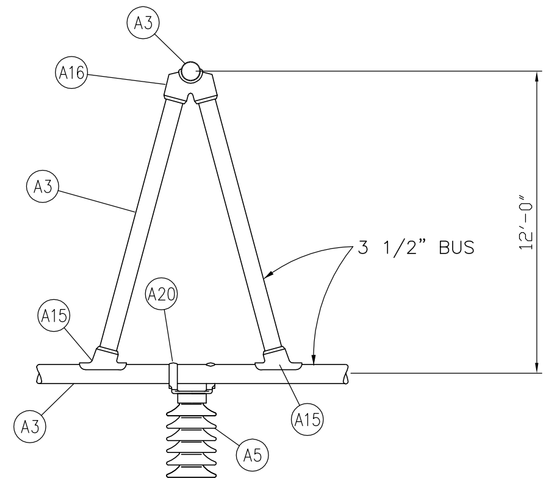
B7
230kV BUS SUPPORT DETAIL



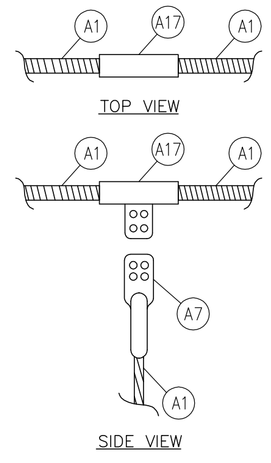
B8
STATIC CONNECTION DETAIL



B9
TYPICAL DAMPING CABLE DETAIL



B10
230kV A–FRAME BUS SUPPORT ASSEMBLY DETAIL



B11
230kV STRAND BUS TAP

LEGEND:
B4 / A04 — BUS CONNECTION DETAIL NUMBER REFER TO DRAWING TWESD–GA–04
A7 — BILL OF MATERIAL ITEM NUMBER REFER TO DRAWING TWESD–GA–06

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
A	11–06–07	REVISED PER VENDOR DRAWINGS
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

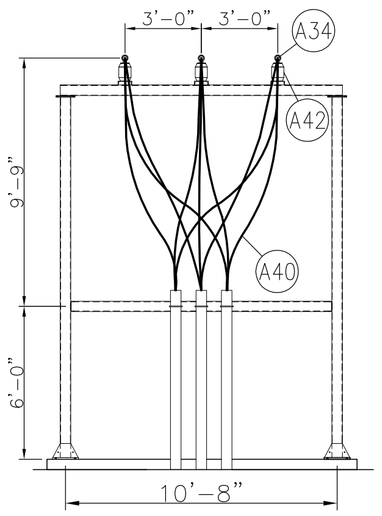
TATANKA WIND ENERGY

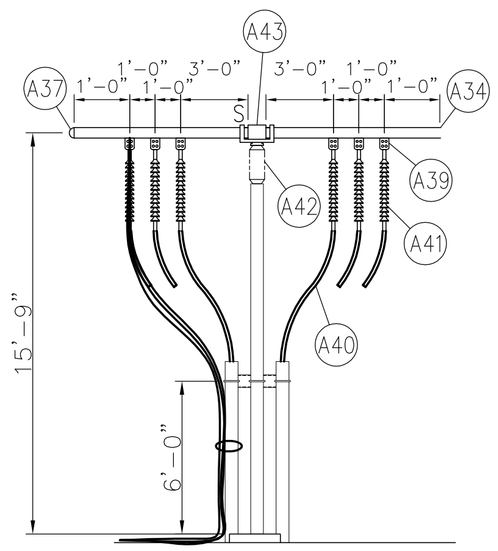
230/34.5kV PROJECT SUBSTATION BUS DETAILS B1 THROUGH B11

0 1" 2"

FILENAME	TWESD–GA–04
SCALE	NONE

SHEET GA-04

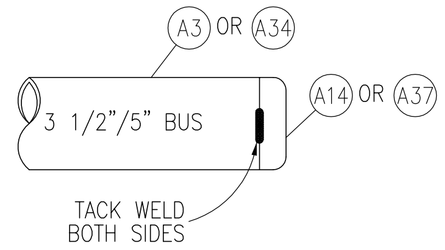




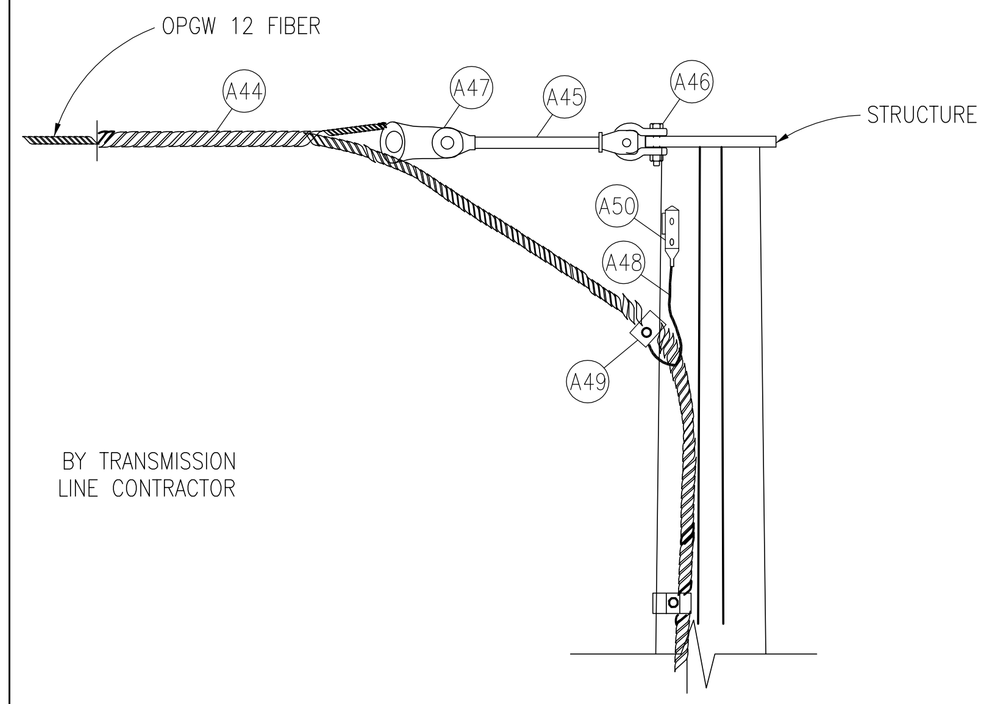
NOTE:

SPLIT PHASES BETWEEN ALL 3 CONDUITS, BOTH SIDES OF STRUCTURE.

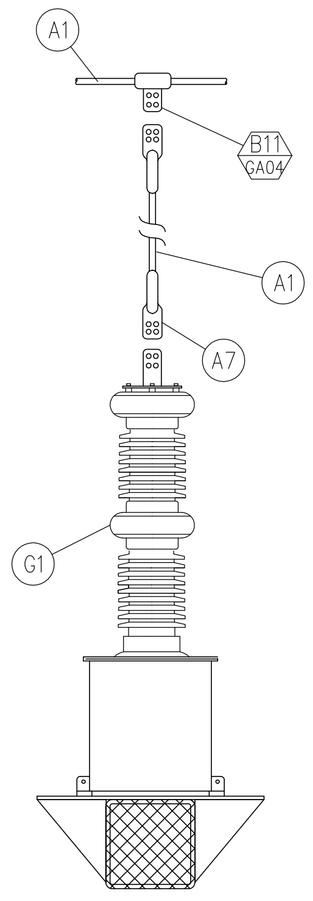
B12
CABLE TERMINATOR DETAIL



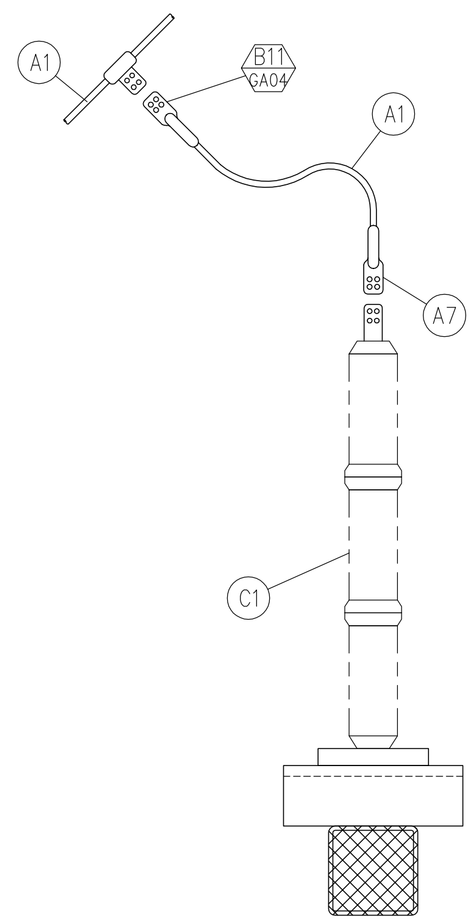
B13
END CAP DETAIL



B14
FIBER OPTIC OPGW ATTACHMENT



B15
230kV LINE CCVT CONNNECTION DETAIL



B16
230kV LIGHTNING ARRESTER DETAIL

LEGEND:

B4 / GA04 — BUS CONNECTION DETAIL NUMBER
REFER TO DRAWING TWESD-GA-04

H1 — BILL OF MATERIAL ITEM NUMBER
REFER TO DRAWING TWESD-GA-06

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-24-07	TEMP SWGR
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

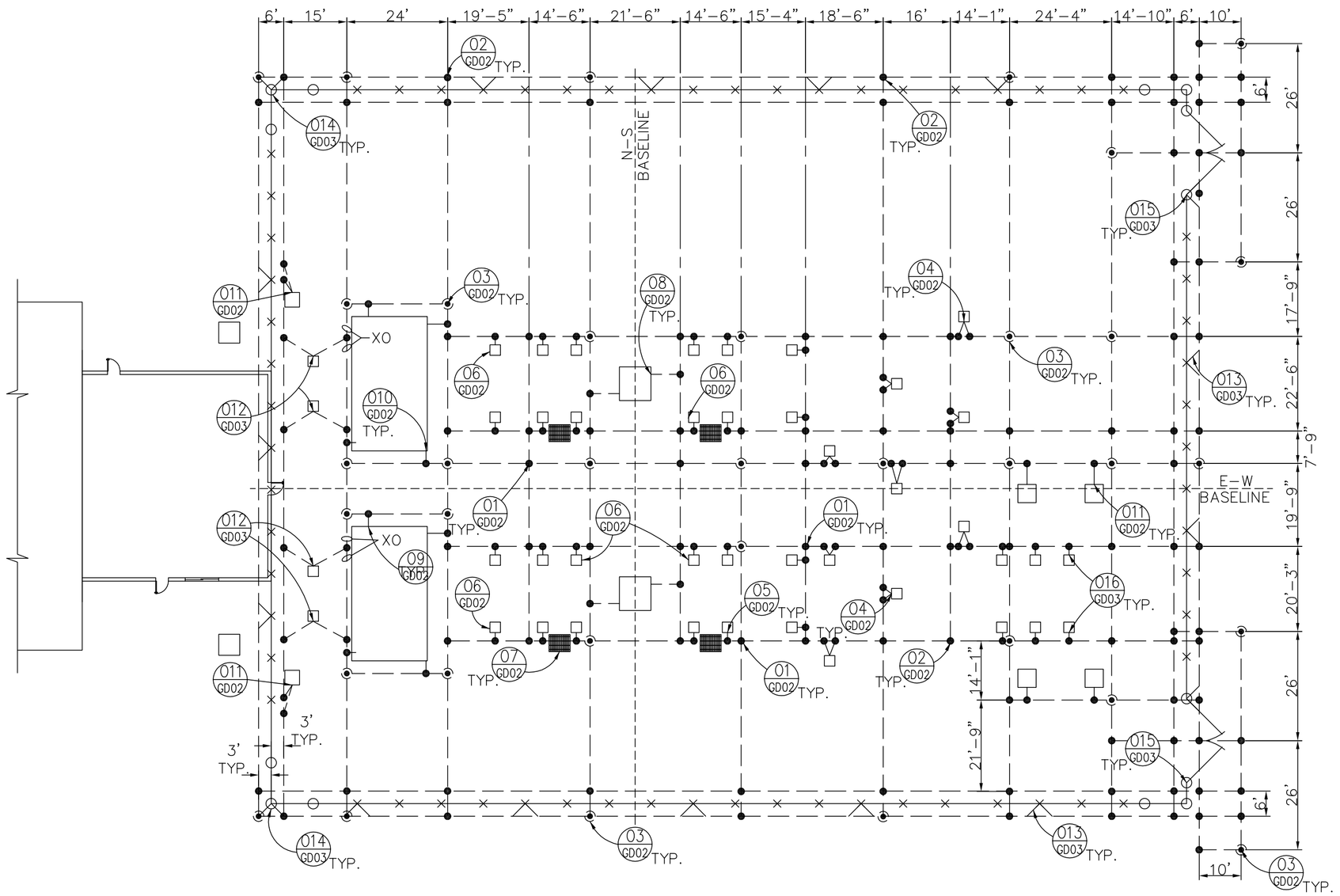
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
BUS DETAILS B12 THROUGH B16

0 1" 2"

FILENAME	TWESD-GA-05
SCALE	NONE

SHEET
GA-05



N

0' 10' 20' 30' 40'

LEGEND

- 01 / GD02 — INDICATES GROUNDING DETAIL / INDICATES DRAWING NUMBER
- EQUIPMENT OPERATORS GROUND PLATFORMS (SEE EQUIPMENT GROUNDING DETAIL FOR PLATFORM INSTALLATION)
- FOUNDATION
- NEW GROUND GRID
- #4/0 CABLE TO GROUND ROD
- #4/0 CABLE TEE

NOTES:

1. SWITCH MECHANISMS INCLUDE GROUND BRAIDS AND PIPE CLAMPS.
2. REFER TO GROUNDING PLAN FOR DETAIL LOCATIONS.
3. REFER TO MATERIAL LIST FOR RECOMMENDED MANUFACTURER'S CATALOG NUMBERS AND DESCRIPTIONS.

SUBSTATION GROUNDING NOTES

MAIN GROUND SYSTEM

1. PROVIDE A CONTINUOUS GROUND SYSTEM WITH ONE CONDUCTOR LOCATED AROUND THE PERIMETER OF THE STATION AND WITH INTERTIES AND GROUND RODS AS SHOWN ON THE GROUNDING PLAN, TO EFFECTIVELY GROUND ALL STRUCTURES AND EQUIPMENT.
2. 4/0 BARE COPPER WIRE IS TO BE USED FOR THE MAIN GROUND SYSTEM, BURIED 18 INCHES BELOW SUBGRADE.
3. GROUND RODS SHALL BE LOCATED AS SHOWN ON THE GROUNDING PLAN AND SHALL BE FULLY DRIVEN BELOW THE SURFACE OF THE EARTH. IF POSSIBLE THE TOPS OF THE RODS SHOULD BE APPROXIMATELY ONE FOOT BELOW GRADE.

CONNECTIONS TO STEEL STRUCTURES AND EQUIPMENT

1. CONNECTIONS OF GROUND CABLES TO STEEL STRUCTURES AND EQUIPMENT SHALL BE SECURELY MADE WITH MECHANICAL CONNECTORS.
2. GROUND LEADS SHALL BE RUN UP OVER THE FOOTINGS AS INDICATED, AND UP THE STRUCTURES IN A NEAT AND WORKMANLIKE MANNER.
3. HOLES NECESSARY FOR ATTACHING CONNECTORS SHALL BE FIELD DRILLED AND TAPPED IF NECESSARY, WHERE NO PLATE OR TAB FOR ATTACHMENT HAS BEEN SUPPLIED.
4. WHERE CONNECTIONS TO THE GROUND MAT ARE STUBBED OUT AT EQUIPMENT FOOTINGS IN ADVANCE OF EQUIPMENT INSTALLATION, CARE SHALL BE TAKEN THAT SUFFICIENT LENGTH OF CABLE PLUS A REASONABLE MARGIN IS LEFT, SO THE LEAD MAY BE TRAINED UP ALONG THE WALL OF THE FOOTING AND MADE TO FOLLOW ALL SURFACES CLOSELY IN ROUTING CABLE TO THE POINT OF CONNECTIONS.
5. GROUND CABLES SHALL BE SUPPORTED APPROXIMATELY EVERY FOUR FEET WHEN EXTENDED UP THE STRUCTURE.
6. SINGLE-LEG STRUCTURES SHALL HAVE 2-4/0 GROUND WIRES RUN FROM DIFFERENT LOCATIONS ATTACHED TO THE SINGLE LEG. MULTI-LEG STRUCTURES SHALL BE GROUNDED WITH 1-4/0 GROUND PER LEG.

CONNECTIONS TO EQUIPMENT COMPARTMENTS, CONDUIT & CABLES

1. ALL EQUIPMENT COMPARTMENTS SHALL BE GROUNDED.
2. ALL STEEL CONDUITS SHALL BE EFFECTIVELY GROUNDED EITHER BY DIRECT GROUNDS OR BY ATTACHMENT TO METAL ENCLOSURES WHICH ARE ADEQUATELY GROUNDED.
3. ALL METALLIC POWER CABLE SHIELDS MUST BE SOLIDLY GROUNDED.

FENCE GROUNDING

1. ALL METALLIC FENCING SHALL BE SECURELY TIED TO MAIN GROUND SYSTEM AT EACH FENCE CORNER, AND AT INTERMEDIATE INTERVALS OF 40 FEET AS DETAILED ON THE GROUNDING PLAN.
2. THE PERIPHERAL CONDUCTOR OF THE MAIN GROUND GRID SHALL BE 4/0 BARE COPPER & LOCATED 3 FEET OUTSIDE OF, AND PARALLEL TO, THE FENCE AND SHALL BE BURIED 18 INCHES BELOW SUBGRADE.
3. EVERY 4TH FENCE POST SHALL BE CONNECTED TO THE MAIN GROUND GRID.
4. GROUND RODS SHALL BE DRIVEN ALONG THE CONDUCTOR AND BONDED TO EACH FENCE CORNER AND AT INTERVALS SHOWN ON THE GROUNDING PLAN.

SWITCH CONTROL HANDLES AND GROUND MATS

1. ALL GROUP-OPERATED SWITCH CONTROL HANDLES SHALL BE GROUNDED AND PROVIDED WITH A PROTECTIVE SWITCH PLATFORM.
2. SWITCH PLATFORMS SHALL BE CENTERED UNDER THE SWITCH CONTROL ROD AND PLACED ON THE CRUSHED ROCK SURFACE.
3. ALL GROUND CONNECTIONS TO PLATFORMS SHALL BE MADE ABOVE GROUND WITH ALL CABLE EXPOSED

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
1	09-28-07	CONTROL ROOM CHANGES
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

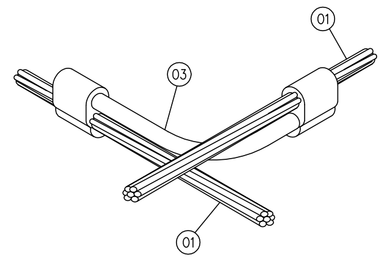
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION GROUNDING PLAN

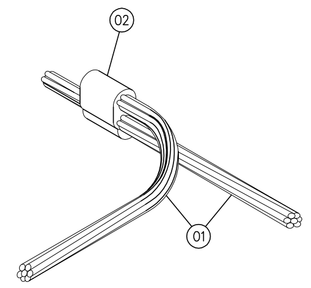
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FILENAME	TWESD-GD-01
SCALE	NONE

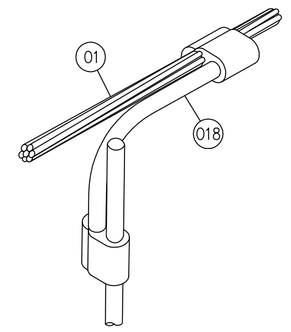
SHEET **GD-01**



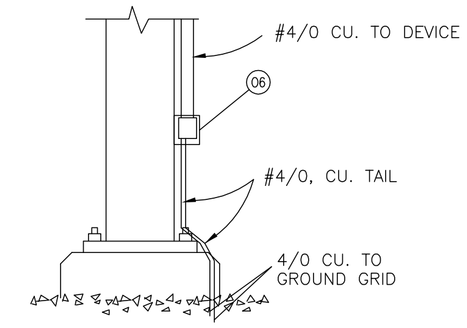
HORIZONTAL X CONNECTION (01 GD01)
N.T.S.



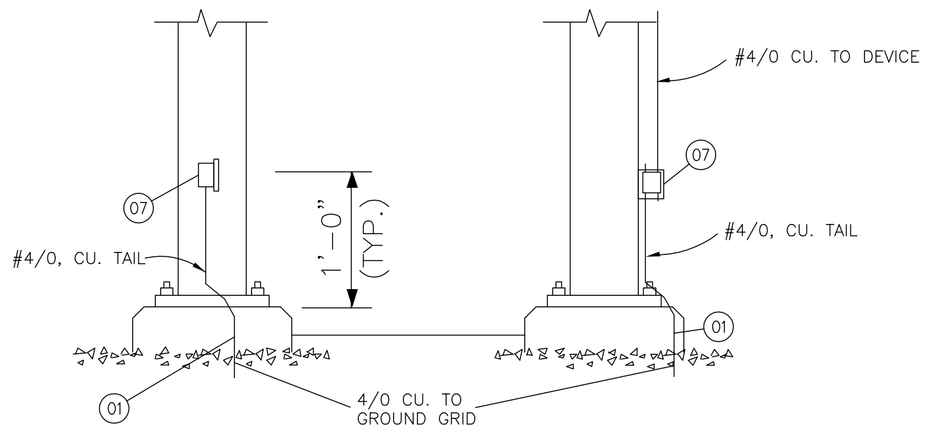
HORIZONTAL T CONNECTION (02 GD01)
N.T.S.



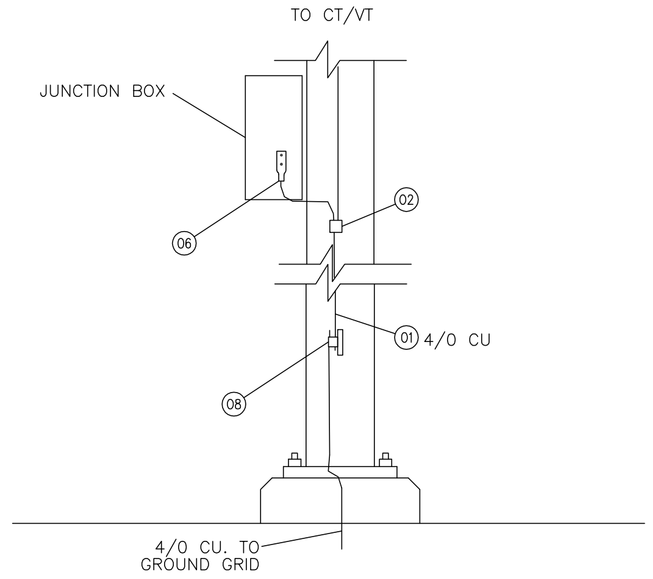
CABLE TO GROUND ROD CONNECTION (03 GD01)
N.T.S.



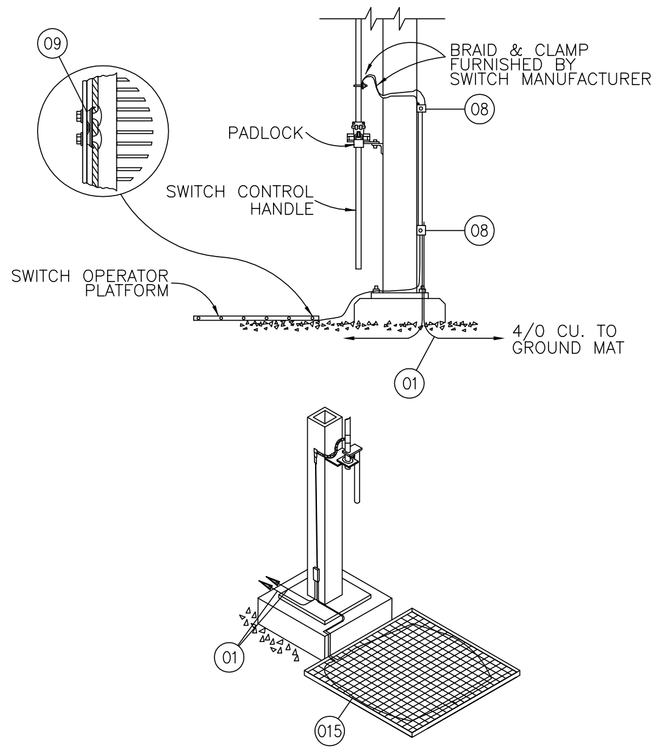
SINGLE – LEG STRUCTURE GROUNDING (04 GD01)
N.T.S.



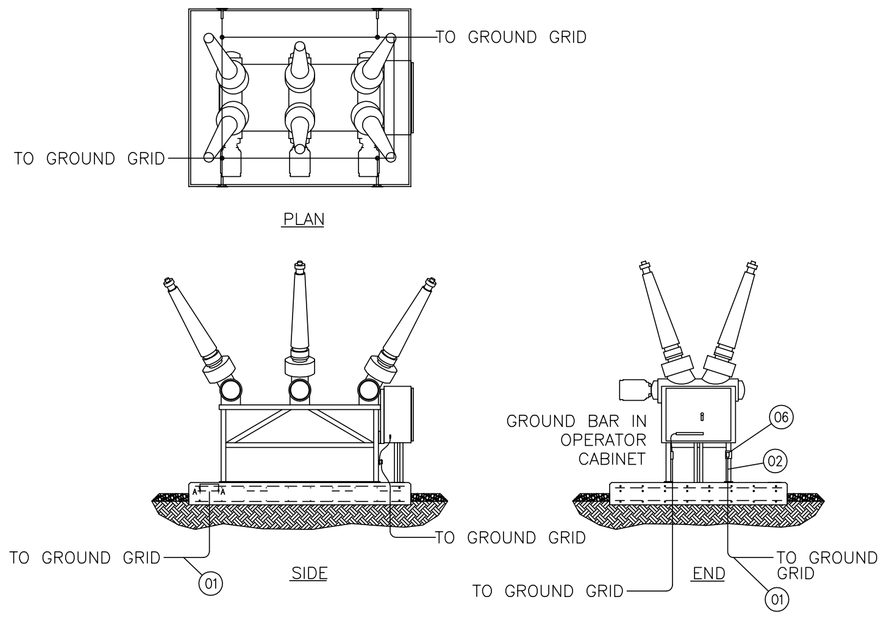
MULTI–LEG STRUCTURE GROUNDING (05 GD01)
N.T.S.



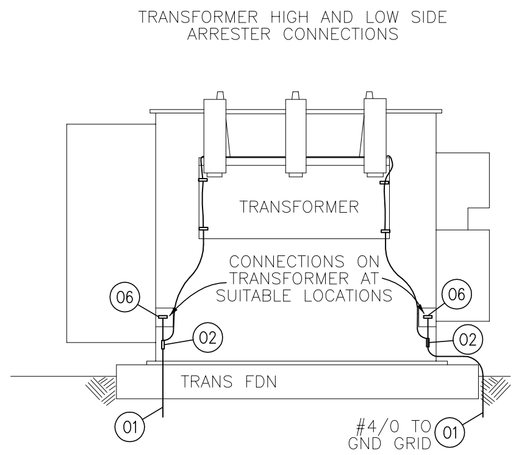
TYPICAL J–BOX GROUNDING (06 GD01)
N.T.S.



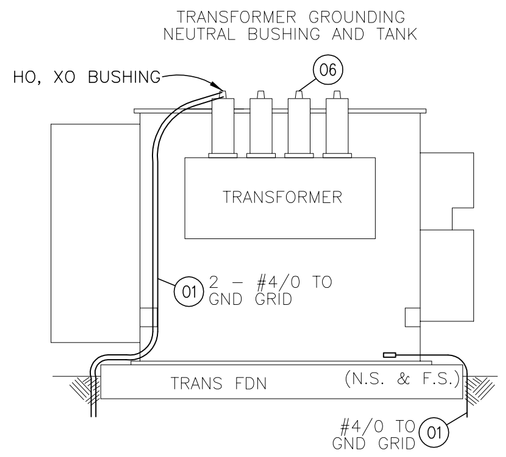
OPERATORS SWITCHING GROUND MAT (07 GD01)
N.T.S.



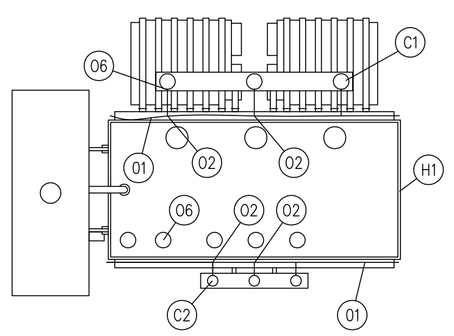
CIRCUIT BREAKER GROUNDING (08 GD01)
N.T.S.



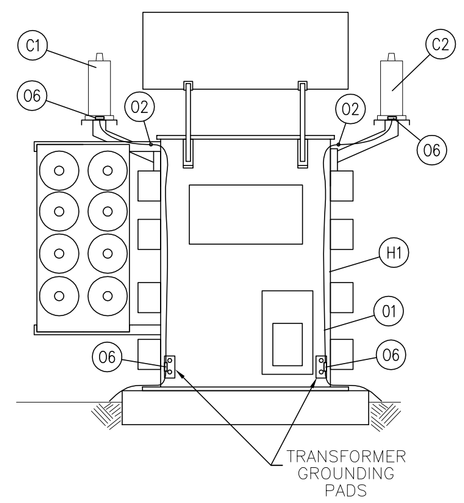
TRANSFORMER GROUNDING DETAIL (09 GD01)
N.T.S.



SIDE VIEW

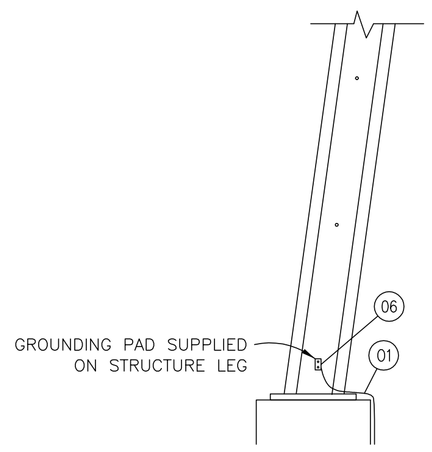


PLAN VIEW



END VIEW

TRANSFORMER GROUNDING DETAIL (010 GD01)
N.T.S.



TUBULAR STEEL STRUCTURE GROUNDING (011 GD01)
N.T.S.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07–07–08	AS BUILT
0	03–30–07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

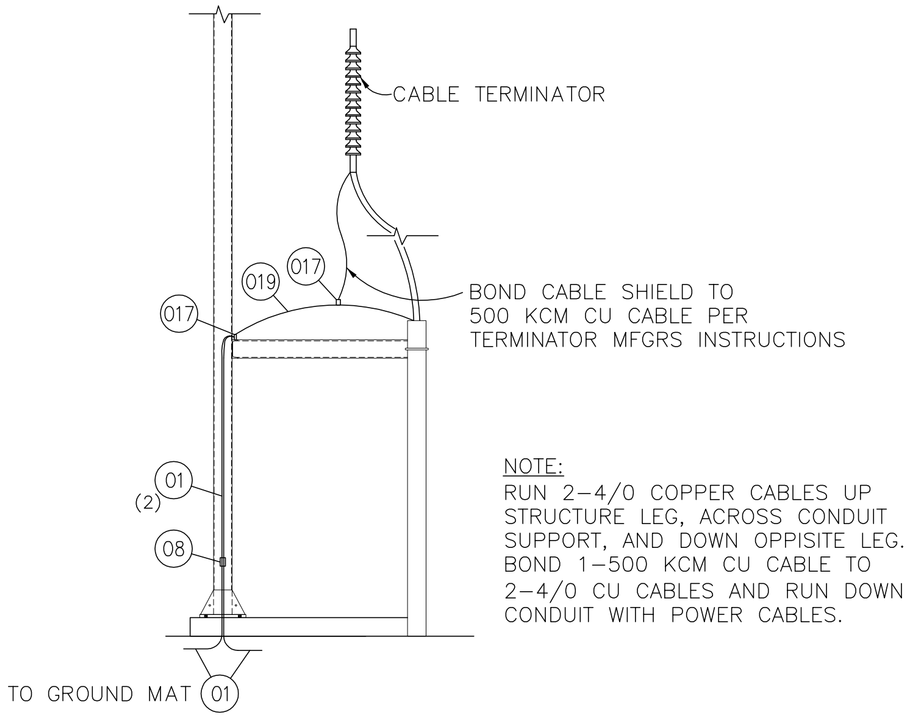
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION GROUNDING DETAILS O1 THROUGH O11

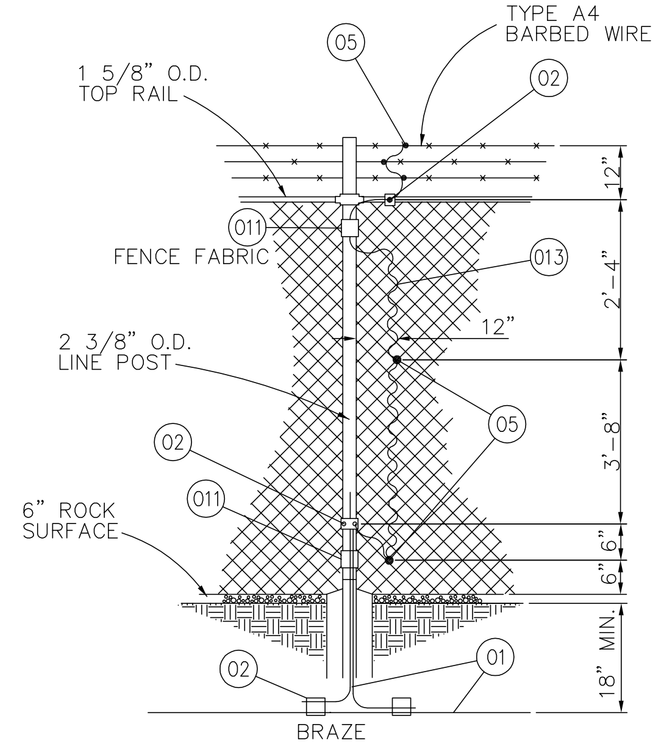
0 1" 2"

FILENAME	TWESD–GD–02
SCALE	NONE

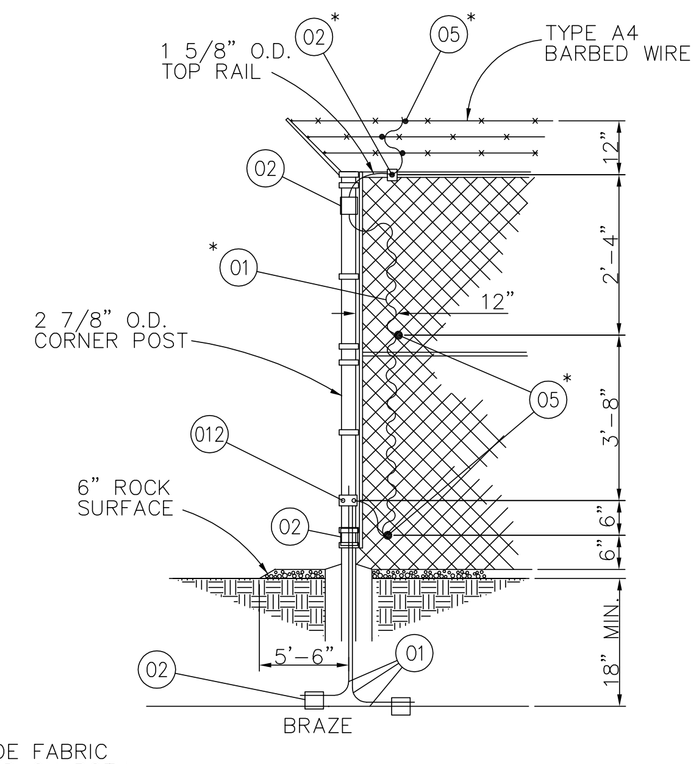
SHEET **GD-02**



CABLE TERMINATION GROUNDING 012 GD01
N.T.S.

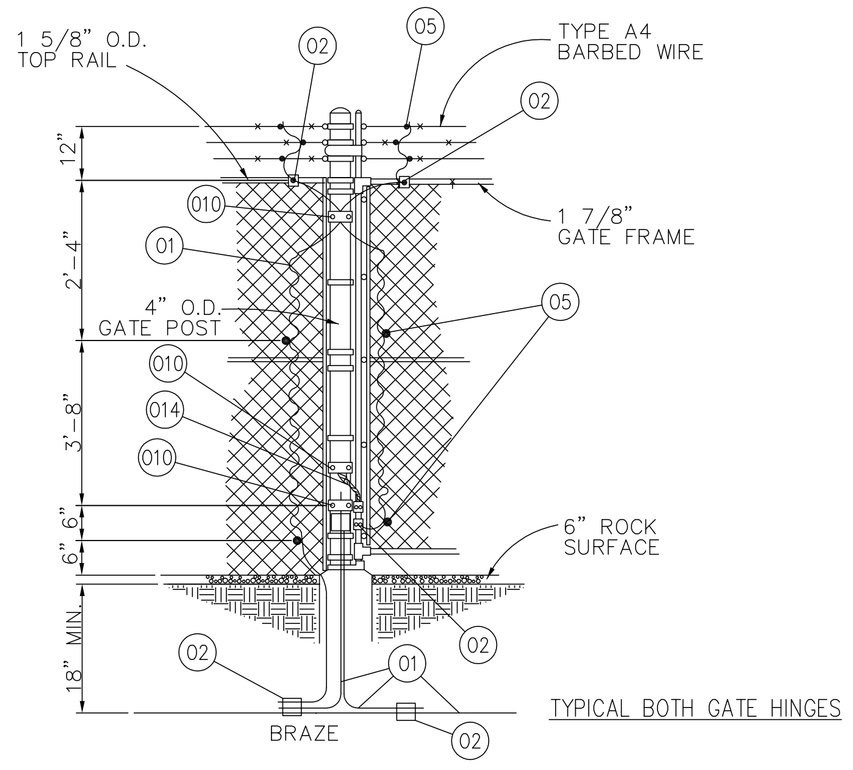


FENCE LINE POST GROUNDING 013 GD01
N.T.S.



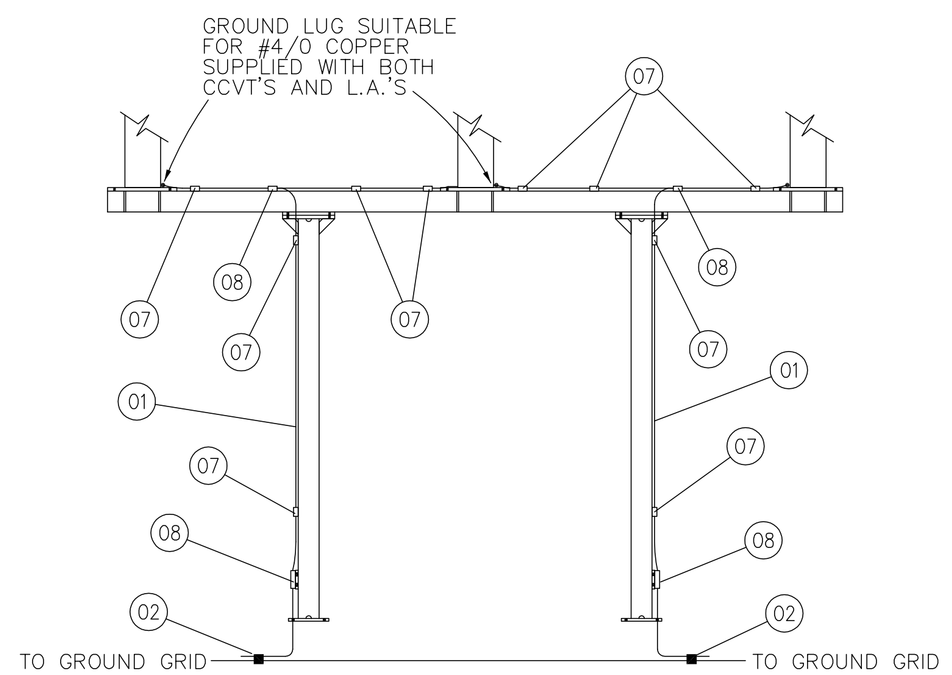
*PROVIDE FABRIC GROUND ON BOTH SIDES OF CORNER POST.

FENCE CORNER POST GROUNDING 014 GD01
N.T.S.



TYPICAL BOTH GATE HINGES

LARGE GATE GROUNDING 015 GD01
N.T.S.



230kV CCVT & LIGHTNING ARRESTOR GROUNDING DETAIL 016 GD01
N.T.S.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

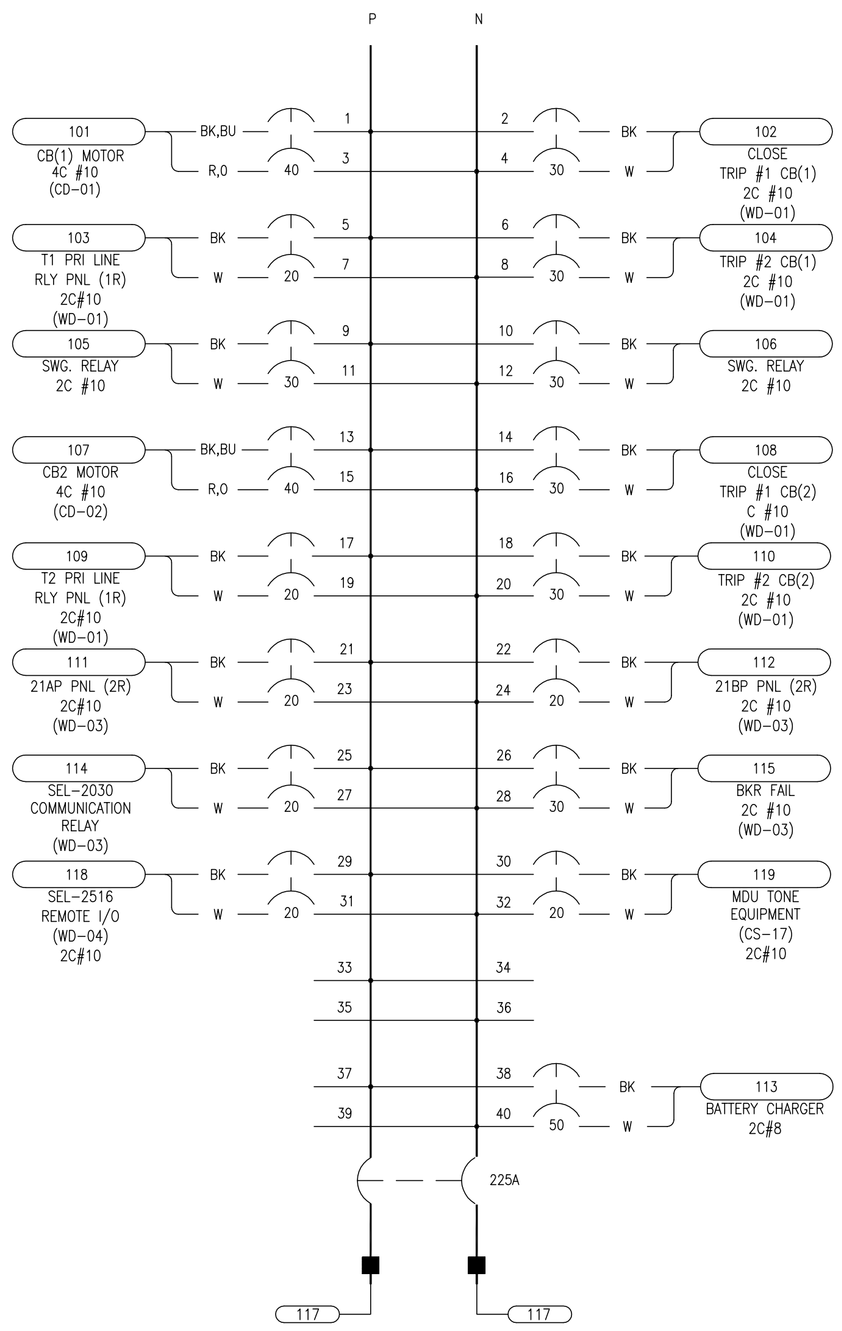
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
GROUNDING DETAILS O12 THROUGH O16

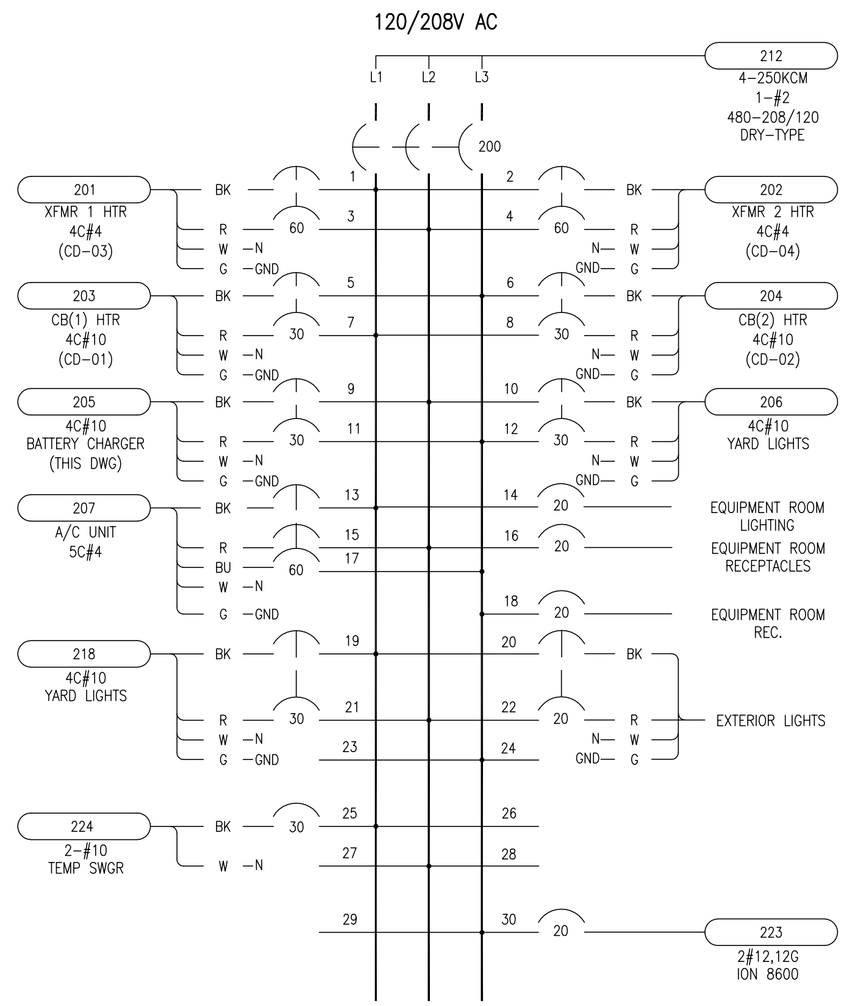
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FILENAME	TWESD-GD-03
SCALE	NONE

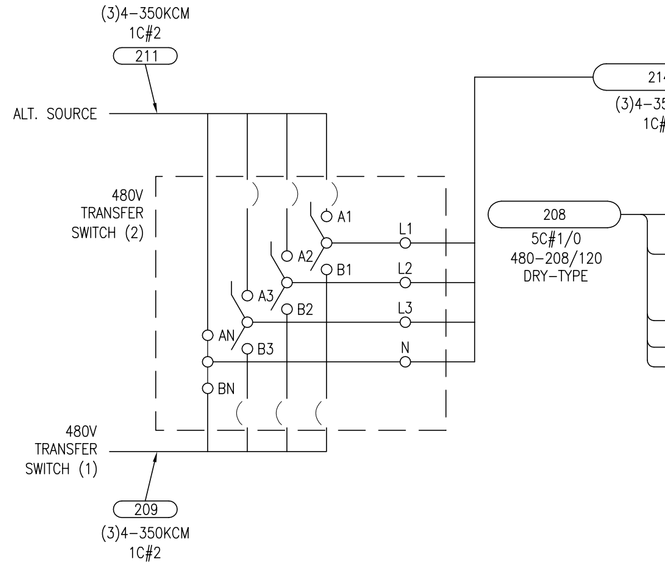
SHEET **GD-03**

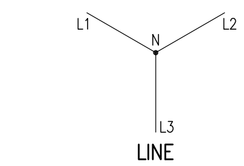


D.C. PANEL BOARD-1 (DCPB1)
(225A PANEL)

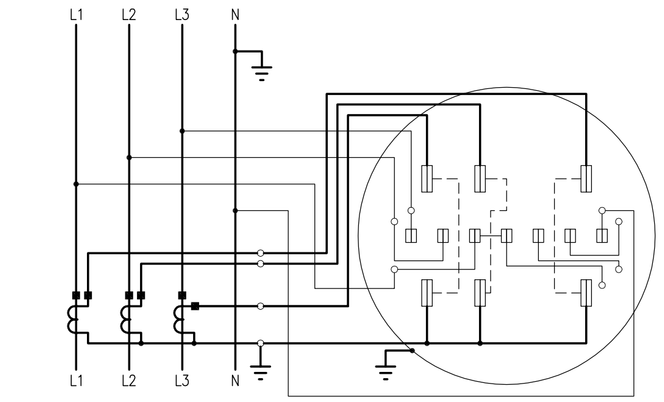


A.C. PANEL BOARD (ACPB1)
(200A PANEL)



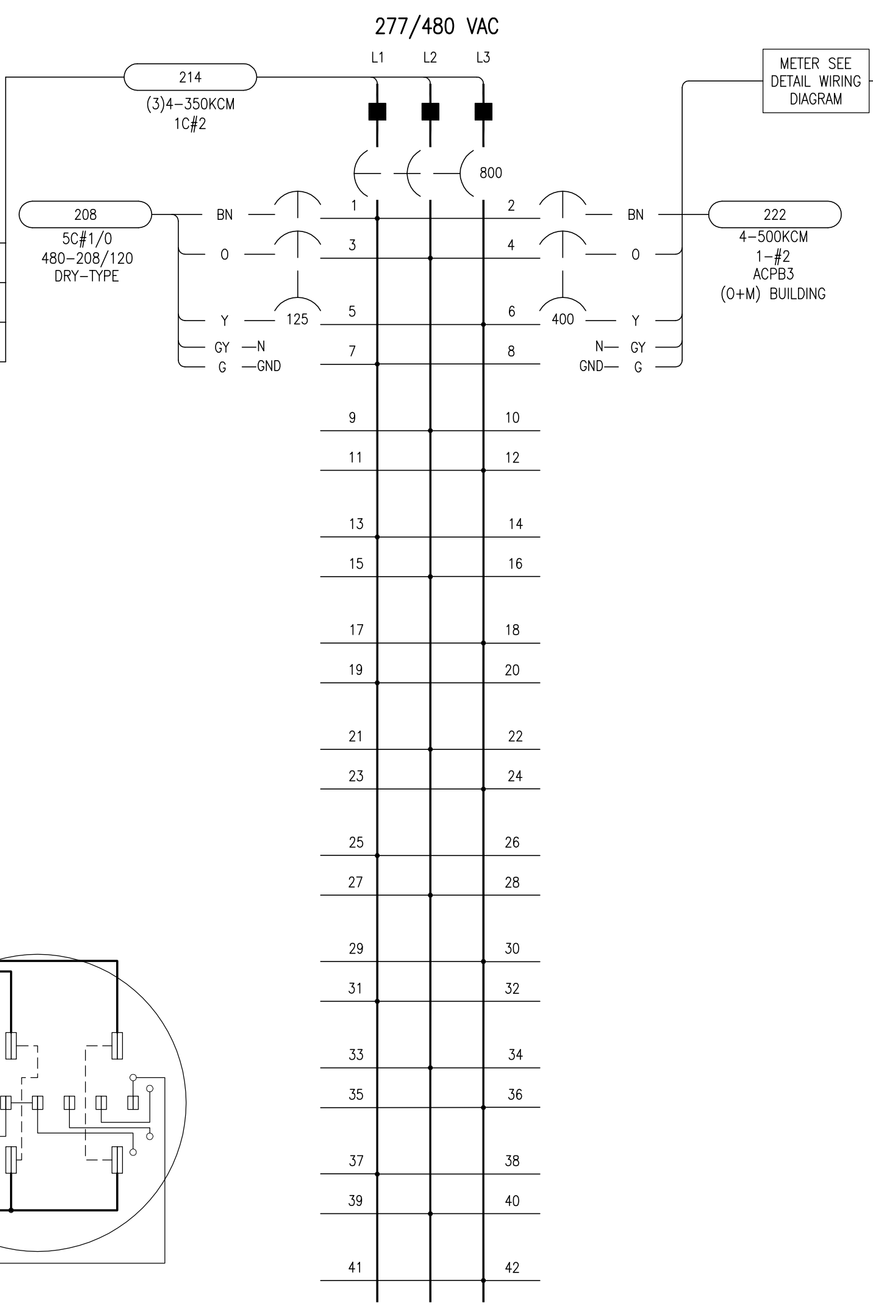


LINE

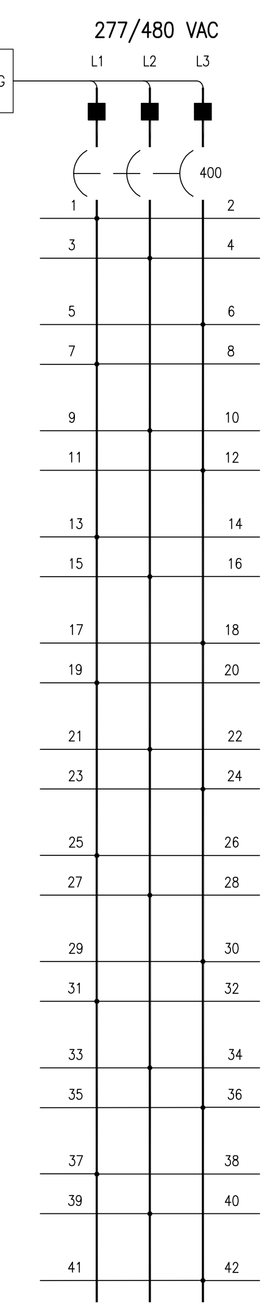


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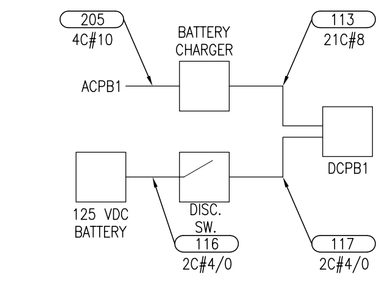
METER SOCKET WIRING DIAGRAM
N.T.S.



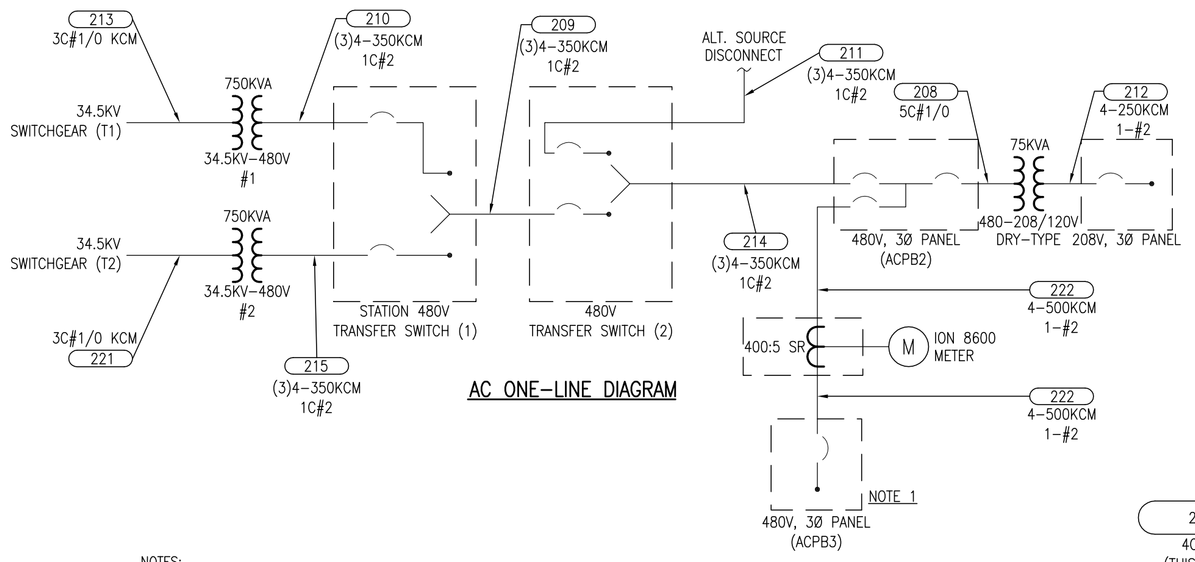
A.C. PANEL BOARD (ACPB2)
(800A PANEL)



A.C. PANEL BOARD (ACPB3)
(400A PANEL)
NOTE 1

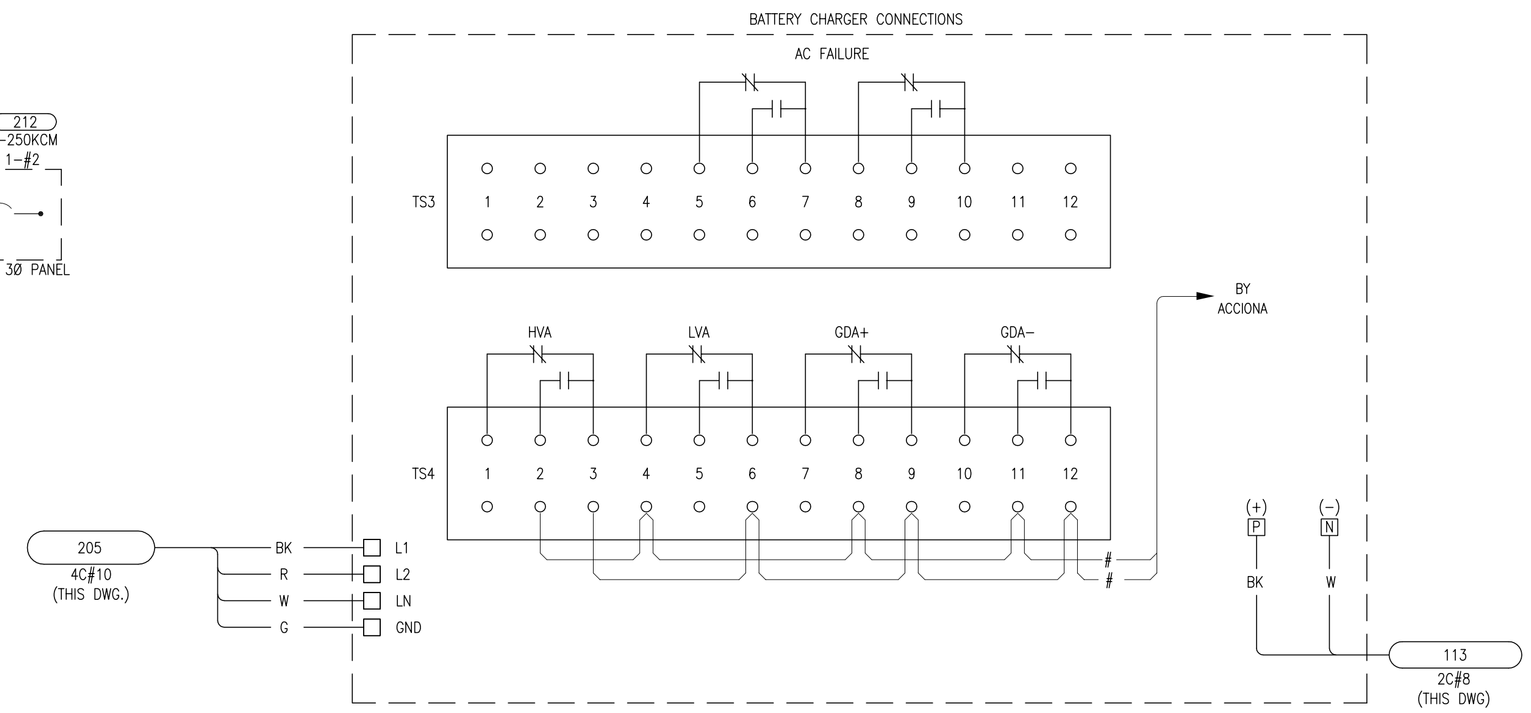


125 VDC ONE-LINE DIAGRAM



AC ONE-LINE DIAGRAM

NOTES:
1. PANELBOARD ACPB3 WILL BE LOCATED IN THE SCADA/ELECTRICAL ROOM.



			PROJECT MANAGER: WEB
			PROJECT ENGINEER: RWC
			DRAWN: GDS
	07-07-08	AS BUILT	
A	10-24-07	ISSUED FOR REVIEW-TEMP SWGR	
A	09-19-07	ISSUED FOR REVIEW - SPS UPGRADE	
1	09-04-07	ADD NEW METERED FDR&PANEL FOR O+M BUILDING	
0	03-30-07	ISSUED FOR CONSTRUCTION	
ISSUE	DATE	DESCRIPTION	PROJECT NUMBER: 48049

MORTENSON®

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION (AC1 & DC1) AC AND DC PANEL BOARDS

0 1" 2"

FILENAME: TWESD-LC-01
SCALE: NONE

SHEET
LC-01

CIRCUIT BREAKER

CABINET LIGHT

COIL

CONTACT, NORMALLY CLOSED

CONTACT, NORMALLY OPEN

CONNECTOR

DENSITY MONITOR

DOOR SWITCH

FUSE BLOCK

FUSE BLOCK, SLUGGED

FUSED DISCONNECT

FUSED DISCONNECT, SLUGGED

FUSE PULLOUT

FUSE PULLOUT, SLUGGED

INDICATOR LIGHT

KNIFE SWITCH

MOTOR

PUSHBUTTON

RESISTOR/ HEATER

TERMINAL BLOCK

TERMINAL BLOCK (AUXILIARY)

THERMOSTAT

THERMAL OVERLOAD

TOGGLE SWITCH

TRANSFORMER

STANDARD ANSI DESIGNATIONS

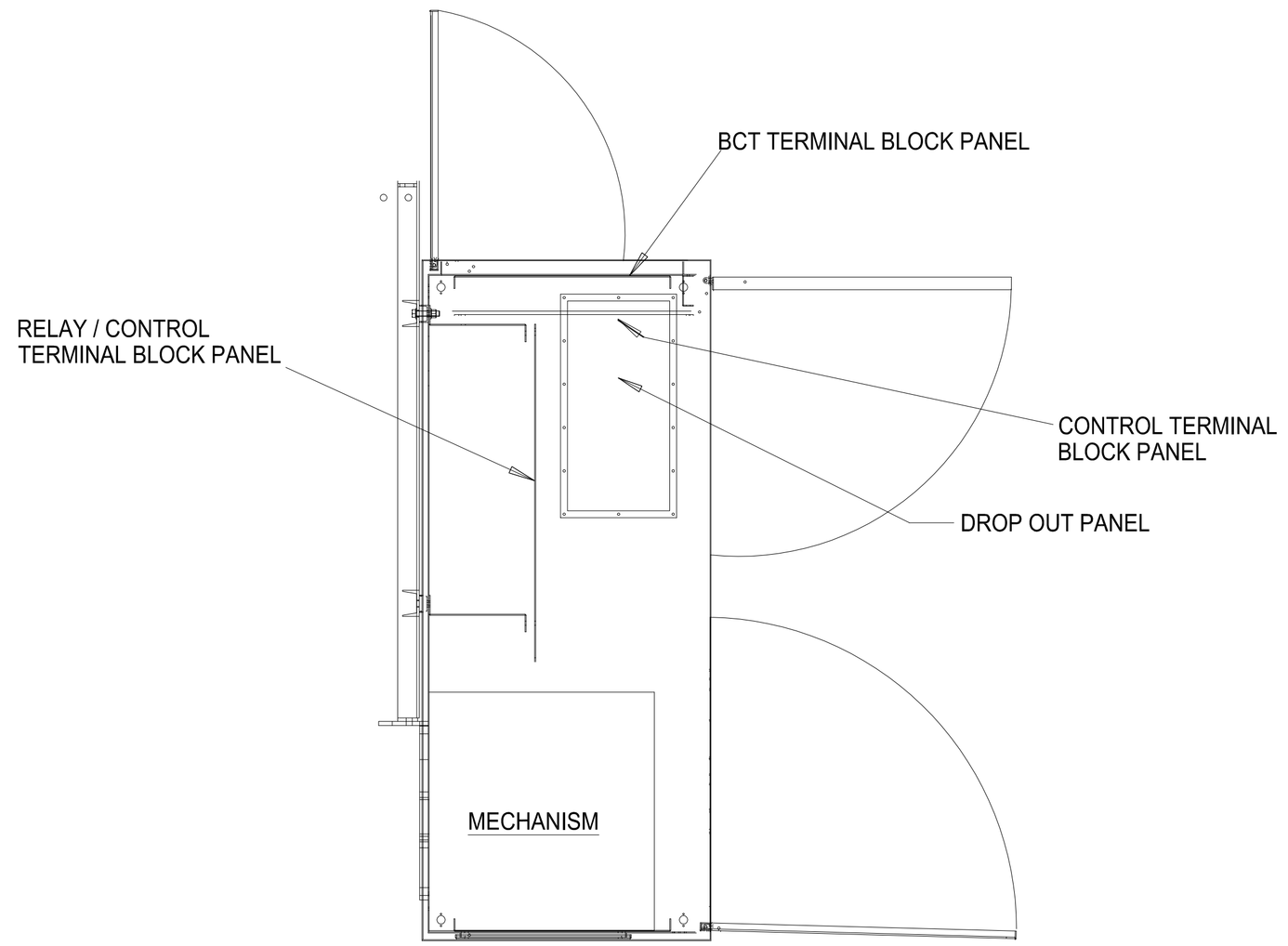
01CS BREAKER CONTROL SWITCH
23 THERMOSTAT
23X HEATER CONTACTOR
27X LOSS OF POWER RELAY
30 ANNUNCIATOR
37 UNDERCURRENT ALARM
43L/R LOCAL REMOTE TRANSFER SWITCH
49 MOTOR THERMAL OVERLOAD
52a,b BREAKER AUXILIARY SWITCH
52C CLOSE PUSHBUTTON
52CC BREAKER CLOSE COIL
52T TRIP PUSHBUTTON
52TC BREAKER TRIP COIL
52X CLOSING RELAY
52Y ANTIPUMP RELAY
52-MON BREAKER CONDITION MONITOR
63G SF6 PRESSURE / DENSITY GAUGE
63GX SF6 PRESSURE / DENSITY RELAY
69 PERMISSIVE CONTROL SWITCH
69-KI KEY INTERLOCK
74CC CLOSE COIL MONITOR
74TC TRIP COIL MONITOR
79X RECLOSE DELAY RELAY
83X MOTOR TRANSFER CONTACTOR
88 MOTOR
88F MOTOR FAILURE ALARM
88LS MOTOR LIMIT SWITCH
AIL AMBER INDICATOR LIGHT
GIL GREEN INDICATOR LIGHT
HTR HEATER
RIL RED INDICATOR LIGHT

28 /ES:14 /ES:A1

- 28: SOURCE PIN NUMBER
- /ES: DESTINATION DEVICE DESIGNATION
- 14: DESTINATION PIN NUMBER
- /ES:A1: SECOND DESTINATION IF APPLICABLE

WIRING KEY

TOP VIEW OF CONTROL CABINET



REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

LEGEND

G. Muchesko	D. Muetzel	05/03/07
DRAWN	CHECKED	DATE

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 1 OF 14

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

acciona

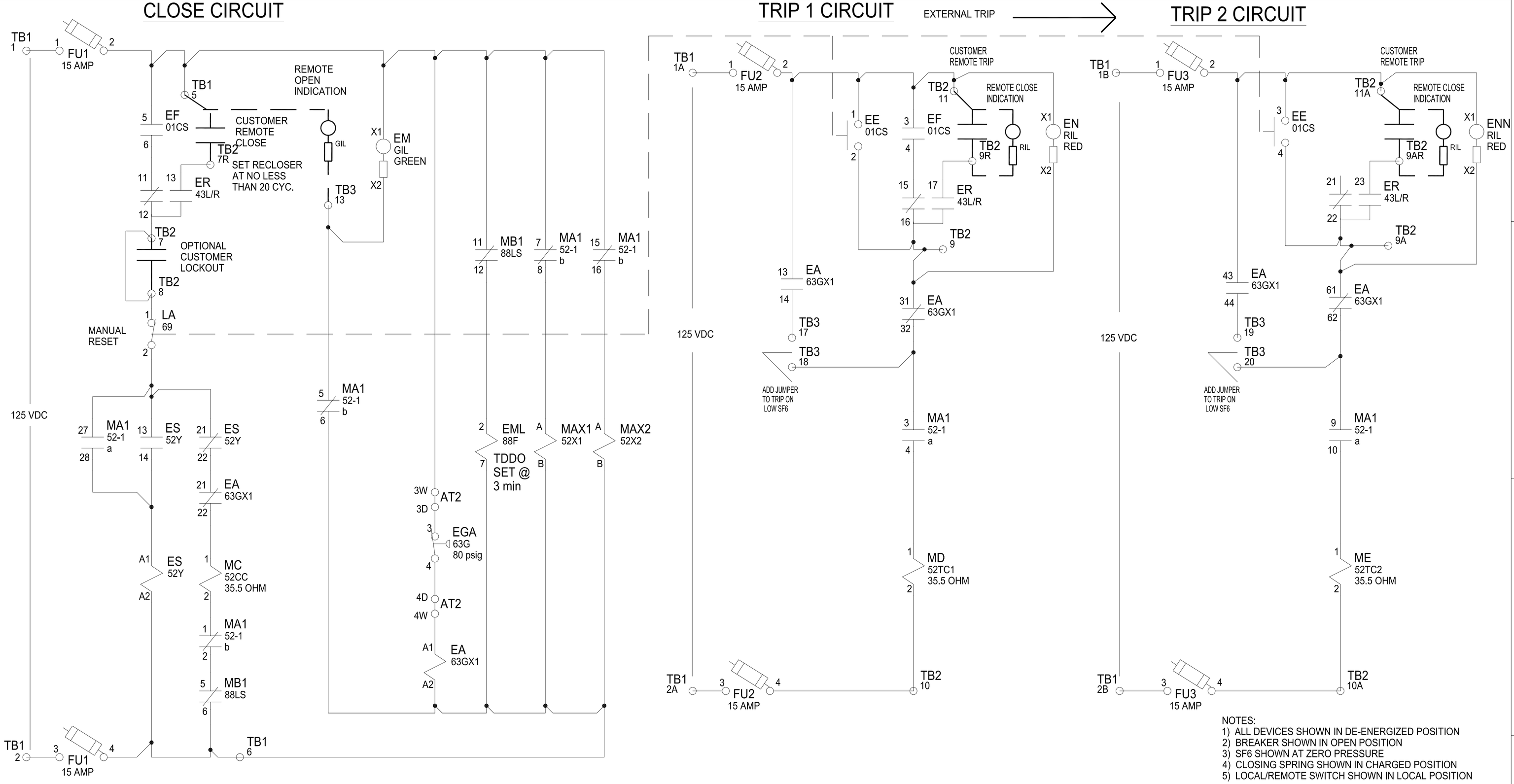
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
LEGEND

0 1" 2"

FILENAME	TWESD-MD-01.DWG
SCALE	NONE

SHEET **MD-01**



NOTES:
1) ALL DEVICES SHOWN IN DE-ENERGIZED POSITION
2) BREAKER SHOWN IN OPEN POSITION
3) SF6 SHOWN AT ZERO PRESSURE
4) CLOSING SPRING SHOWN IN CHARGED POSITION
5) LOCAL/REMOTE SWITCH SHOWN IN LOCAL POSITION

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

CONTROL SCHEMATICS

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

SHT 2 OF 14

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

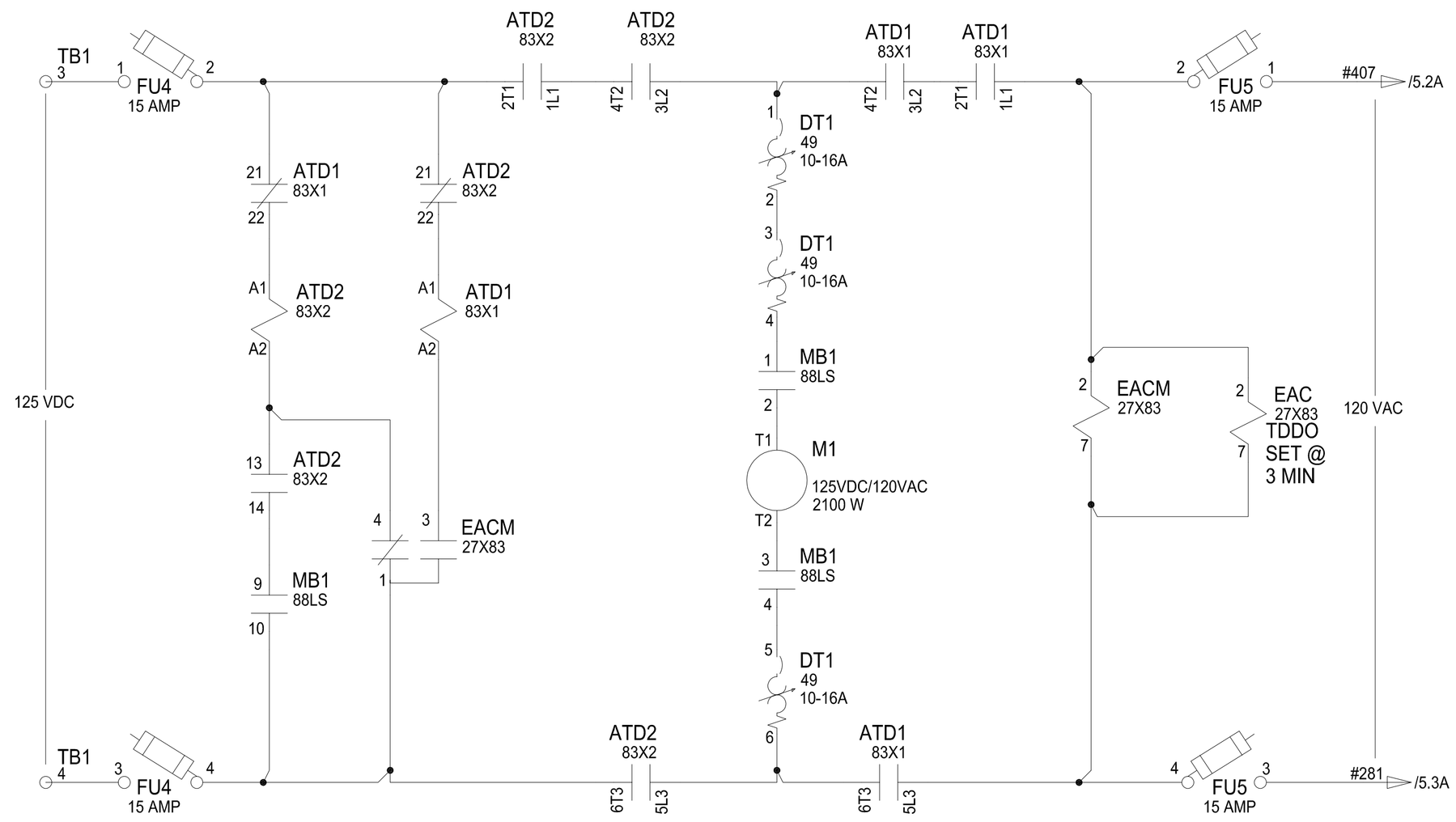
230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
CONTROL SCHEMATIC

0 1" 2"

FILENAME	TWESD-MD-02.DWG
SCALE	NONE

SHEET
MD-02

MOTOR CIRCUIT



NOTES:
1) ALL DEVICES SHOWN IN DE-ENERGIZED POSITION
2) BREAKER SHOWN IN OPEN POSITION
3) SF6 SHOWN AT ZERO PRESSURE
4) CLOSING SPRING SHOWN IN CHARGED POSITION
5) LOCAL/REMOTE SWITCH SHOWN IN LOCAL POSITION

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

CONTROL SCHEMATICS

	DRAWN	CHECKED	DATE
	G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 3 OF 14

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

acciona

TATANKA WIND ENERGY

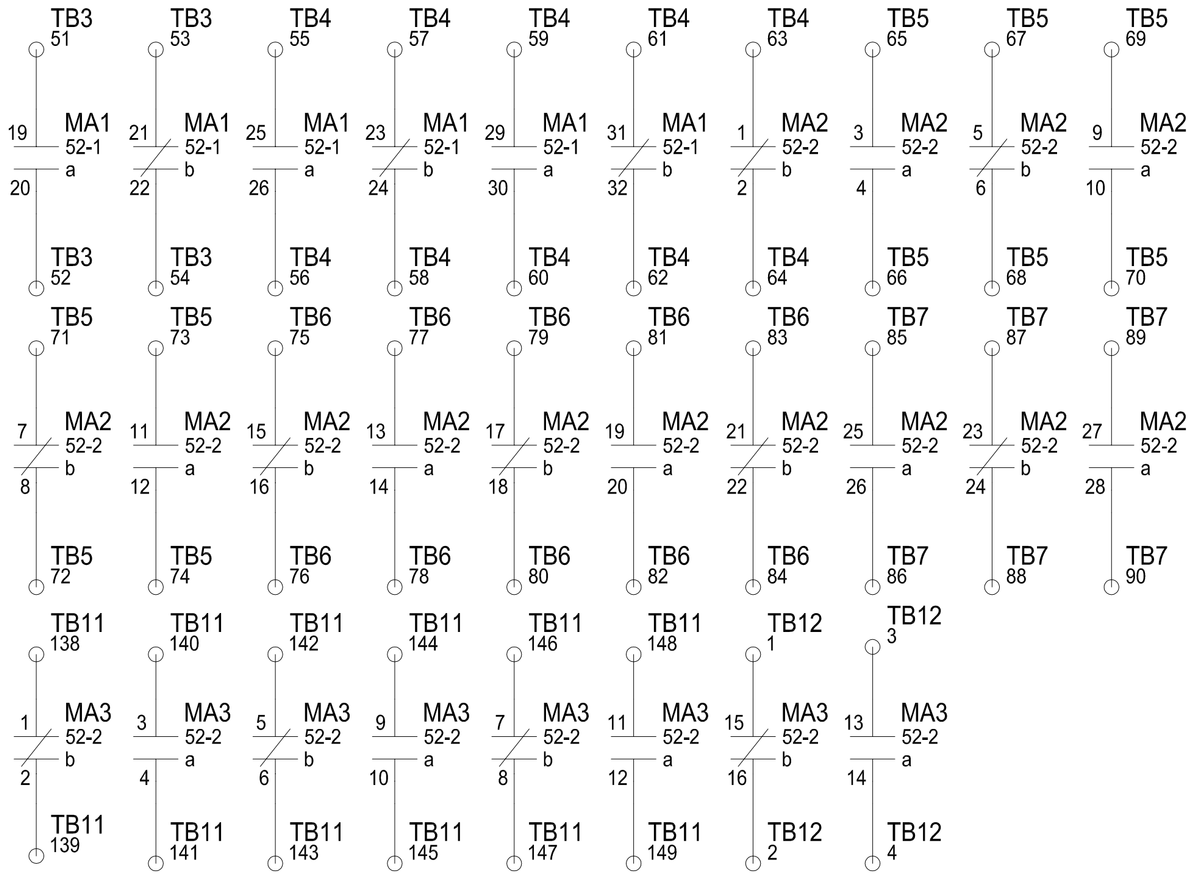
230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
CONTROL SCHEMATIC

0 1" 2"

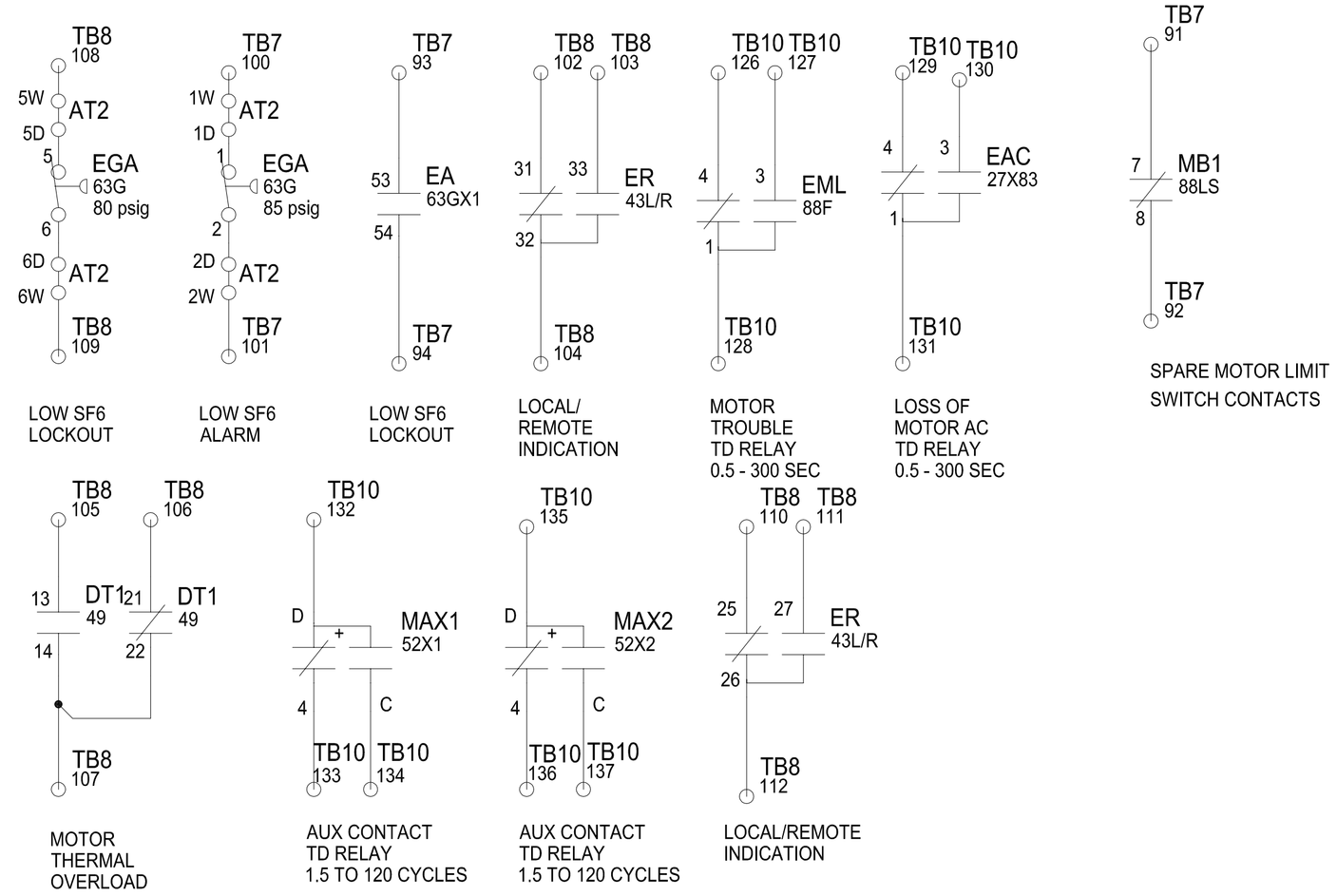
FILENAME: TWESD-MD-03.DWG
SCALE: NONE

SHEET
MD-03

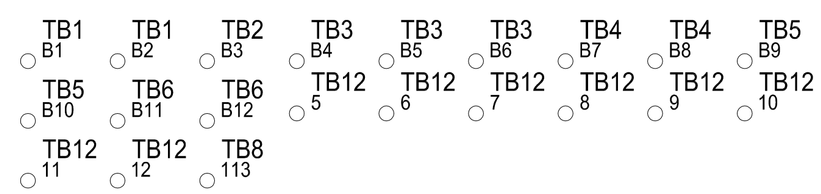
SPARE AUXILIARY SWITCHES FOR CUSTOMER USE



CUSTOMER ALARMS



SPARE TERMINAL BLOCKS FOR CUSTOMER USE



REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

BILL OF MATERIALS — G. Muchesko / D. Muetzel / 05/03/07 (DRAWN / CHECKED / DATE)

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB # J12789 J12791

AREVA ORDER # CX04111, CX04112

SHT 4 OF 14

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

MORTENSON

HDR Engineering, Inc.

acciona

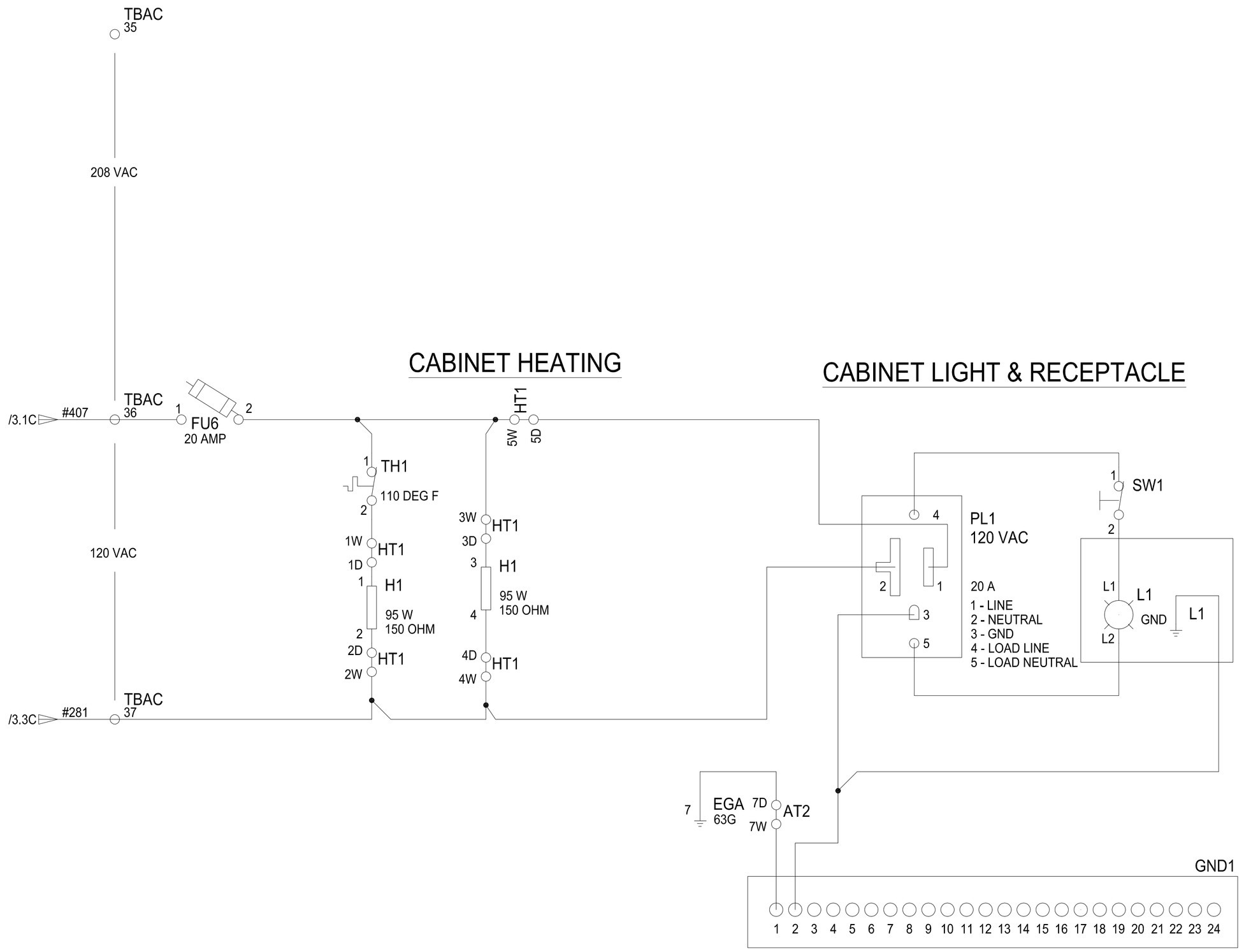
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
AUX SWITCH & CUSTOMER ALARMS

0 1" 2"

FILENAME: TWESD-MD-04.DWG
SCALE: NONE

SHEET: MD-04



REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

SF6 GAS PIPING/RATING NAMEPLATE

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

SHT 5 OF 14

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
CABINET HEATING

FILENAME	TWESD-MD-05.DWG
SCALE	NONE

SHEET
MD-05

RELAY PANEL WIRING
TERMINAL BLOCKS

TB1

	1	FU1:1
	2	FU1:3
	1A	FU2:1
	2A	FU2:3
	1B	FU3:1
	2B	FU3:3
	3	FU4:1
	4	FU4:3
	5	EM:X1,EF:5
	6	MB1:6,MAX2:B
	B1	
	B2	

TB2

	7	TB2:8,ER:12
	7R	ER:13
	8	LA:1,TB2:7
	9	ER:16,EA:31
	9R	ER:17
	9A	ER:22,EA:61
	9AR	ER:23
	10	FU2:4,MD:2
	10A	ME:2,FU3:4
	11	EN:X1,EF:3
	11A	EE:3,ENN:X1
	B3	

TB3

	13	EM:X2,MA1:5
	17	EA:14
	18	EA:32
	19	EA:44
	20	EA:62
	B4	
	51	MA1:19
	52	MA1:20
	53	MA1:21
	54	MA1:22
	B5	
	B6	

TB4

	55	MA1:25
	56	MA1:26
	57	MA1:23
	58	MA1:24
	59	MA1:29
	60	MA1:30
	61	MA1:31
	62	MA1:32
	63	MA2:1
	64	MA2:2
	B7	
	B8	

TBAC

	35	
FU6:1,FU5:1	36	
HT1:2W,FU5:3	37	

TERMINAL BLOCK PANEL
WIRING (CONTROL)

TB5

MA2:3	65	
MA2:4	66	
MA2:5	67	
MA2:6	68	
MA2:9	69	
MA2:10	70	
MA2:7	71	
MA2:8	72	
MA2:11	73	
MA2:12	74	
	B9	
	B10	

TB8

	102	ER:31
	103	ER:33
	104	ER:32
	105	DT1:13
	106	DT1:21
	107	DT1:14
	108	AT2:5W
	109	AT2:6W
	110	ER:25
	111	ER:27
	112	ER:26
	113	

TB6

MA2:15	75	
MA2:16	76	
MA2:13	77	
MA2:14	78	
MA2:17	79	
MA2:18	80	
MA2:19	81	
MA2:20	82	
MA2:21	83	
MA2:22	84	
	B11	
	B12	

TB9

	114	
	115	
	116	
	117	
	118	
	119	
	120	
	121	
	122	
	123	
	124	
	125	

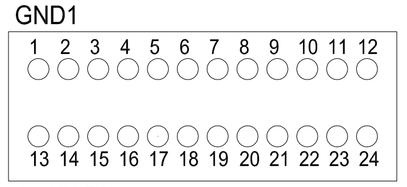
TB7

MA2:25	85	
MA2:26	86	
MA2:23	87	
MA2:24	88	
MA2:27	89	
MA2:28	90	
MB1:7	91	
MB1:8	92	
EA:53	93	
EA:54	94	
AT2:1W	100	
AT2:2W	101	

TB10

	126	EML:4
	127	EML:3
	128	EML:1
	129	EAC:4
	130	EAC:3
	131	EAC:1
	132	MAX1:D
	133	MAX1:4
	134	MAX1:C
	135	MAX2:D
	136	MAX2:4
	137	MAX2:C

GND1



1 AT2:7W
2 PL1:3,L1:GND

MECHANISM PANEL

TB11

MA3:1	138	
MA3:2	139	
MA3:3	140	
MA3:4	141	
MA3:5	142	
MA3:6	143	
MA3:9	144	
MA3:10	145	
MA3:7	146	
MA3:8	147	
MA3:11	148	
MA3:12	149	

TB12

MA3:15	1	
MA3:16	2	
MA3:13	3	
MA3:14	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	

NOTES:
1) ALL 120VAC WIRES ARE TO BE GRAY 12GA SIS. AND AC GROUND WIRES ARE TO BE GREEN 12GA SIS.
2) ALL 125VDC/120VAC MOTOR CIRCUIT WIRES ARE TO BE GRAY 12GA SIS.
3) ALL 208VAC WIRES ARE TO BE GRAY 10GA SIS.
4) ALL CONTROL WIRING IS TO BE GRAY 14GA SIS VW1.
5) WIRE MARKERS ARE TO BE SHRINK-TYPE AND ARE TO SHOW OPPOSITE END / SAME END DESIGNATION.
6) ALL WIRE LUGS TO BE INSULATED RING-TYPE (EXCEPT FOR DEVICES THAT DO NOT ACCEPT RING-TYPE TERMINALS).
7) ALL CT SECONDARY WIRING TO BE 10GA SIS.

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

WIRING DIAGRAM

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07
DRAWN	CHECKED	DATE

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 6 OF 14

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
WIRING DIAGRAM

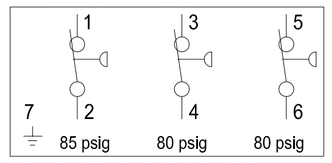
0 1" 2"

FILENAME	TWESD-MD-06.DWG
SCALE	NONE

SHEET
MD-06

MECHANISM WIRING

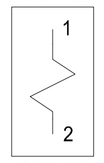
EGA 63G



1 AT2:1D
2 AT2:2D
3 AT2:3D
4 AT2:4D
5 AT2:5D
6 AT2:6D
7 AT2:7D

STANDARD CABLE COLORS
1 - BLK 4 - ORA 7 - GRN
2 - RED 5 - WHT
3 - BLU 6 - WHT/BLK or BRN

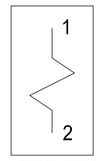
MC 52CC



1 EA:22
2 MA1:1

COIL VOLTAGE - 125 VDC
COIL RESISTANCE - 35.5 OHM

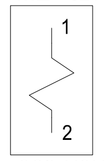
MD 52TC1



1 MA1:4
2 TB2:10

COIL VOLTAGE - 125 VDC
COIL RESISTANCE - 35.5 OHM

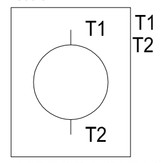
ME 52TC2



1 MA1:10
2 TB2:10A

COIL VOLTAGE - 125 VDC
COIL RESISTANCE - 35.5 OHM

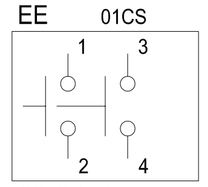
M1



T1 MB1:2
T2 MB1:3

MOTOR VOLTAGE - 125VDC/120VAC
WATTAGE - 2100 W

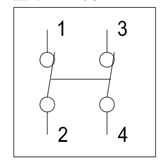
EE 01CS



1 EA:13,EF:3
2 ER:16
3 EA:43,TB2:11A
4 ER:22

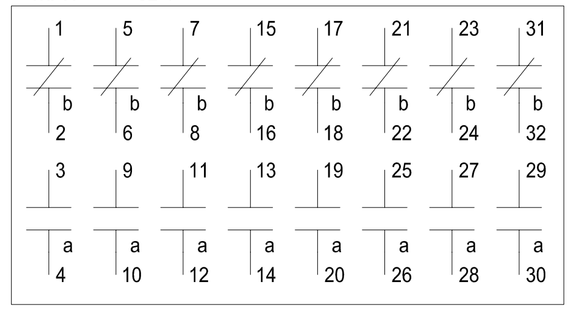
COLOR - BLK

LA 69



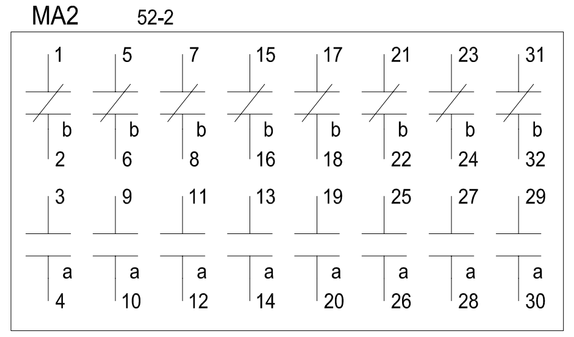
1 TB2:8
2 ES:13,MA1:27

MA1 52-1



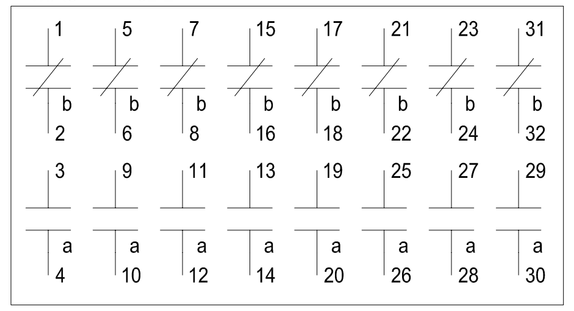
1 MC:2
2 MB1:5
3 EA:32
4 MD:1
5 TB3:13
6 EA:A2
9 EA:62
10 ME:1
7 MB1:11,MA1:15
8 MAX1:A
15 MA1:7
16 MAX2:A
19 TB3:51
20 TB3:52
21 TB3:53
22 TB3:54
25 TB4:55
26 TB4:56
23 TB4:57
24 TB4:58
27 LA:2
28 ES:A1
31 TB4:61
32 TB4:62
29 TB4:59
30 TB4:60

MA2 52-2



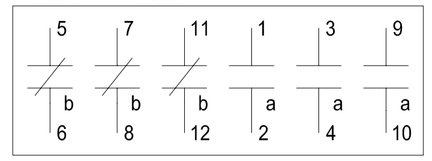
1 TB4:63
2 TB4:64
3 TB5:65
4 TB5:66
5 TB5:67
6 TB5:68
9 TB5:69
10 TB5:70
7 TB5:71
8 TB5:72
11 TB5:73
12 TB5:74
15 TB6:75
16 TB6:76
13 TB6:77
14 TB6:78
17 TB6:79
18 TB6:80
19 TB6:81
20 TB6:82
21 TB6:83
22 TB6:84
25 TB7:85
26 TB7:86
23 TB7:87
24 TB7:88
27 TB7:89
28 TB7:90

MA3 52-2



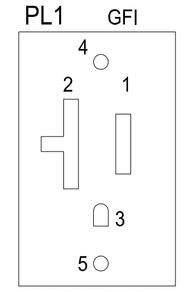
1 TB11:138
2 TB11:139
3 TB11:140
4 TB11:141
5 TB11:142
6 TB11:143
9 TB11:144
10 TB11:145
7 TB11:146
8 TB11:147
11 TB11:148
12 TB11:149
15 TB12:1
16 TB12:2
13 TB12:3
14 TB12:4

MB1 88LS



5 MA1:2
6 TB1:6,ES:A2
7 TB7:91
8 TB7:92
11 AT2:3W,MA1:7
12 EML:2
1 DT1:4
2 M1:T1
3 M1:T2
4 DT1:5
9 ATD2:14
10 FU4:4

PL1 GFI



1 HT1:5D
2 HT1:4W
3 GND1:2
4 SW1:1
5 L1:L2

1 - LINE
2 - NEUTRAL
3 - GND
4 - LOAD LINE
5 - LOAD NEUTRAL

VOLTAGE - 120 VAC
AMP RATING -20 A

NOTES:
1) ALL 120VAC WIRES ARE TO BE GRAY 12GA SIS. AND AC GROUND WIRES ARE TO BE GREEN 12GA SIS.
2) ALL 125VDC/120VAC MOTOR CIRCUIT WIRES ARE TO BE GRAY 12GA SIS.
3) ALL 208VAC WIRES ARE TO BE GRAY 10GA SIS.
4) ALL CONTROL WIRING IS TO BE GRAY 14GA SIS VW1.
5) WIRE MARKERS ARE TO BE SHRINK-TYPE AND ARE TO SHOW OPPOSITE END / SAME END DESIGNATION.
6) ALL WIRE LUGS TO BE INSULATED RING-TYPE (EXCEPT FOR DEVICES THAT DO NOT ACCEPT RING-TYPE TERMINALS).
7) ALL CT SECONDARY WIRING TO BE 10GA SIS.

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

WIRING DIAGRAM

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 7 OF 14

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
WIRING DIAGRAM

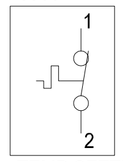
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FILENAME	TWESD-MD-07.DWG
SCALE	NONE

SHEET
MD-07

RELAY PANEL WIRING

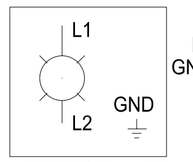
TH1



1 FU6:2
2 HT1:1W

TEMP SETTING -110 DEG F

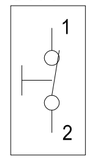
L1



L1 SW1:2
L2 PL1:5
GND GND1:2

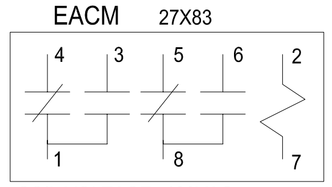
WATTAGE - 40 W

SW1



1 PL1:4
2 L1:L1

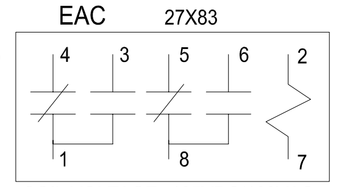
EACM 27X83



2 EAC:2,ATD1:1L1
7 EAC:7,ATD1:5L3
4 ATD2:A2
1 ATD2:6T3,FU4:4
3 ATD1:A2

COIL VOLTAGE -120VAC
COIL RESISTANCE - 2,250 OHMS

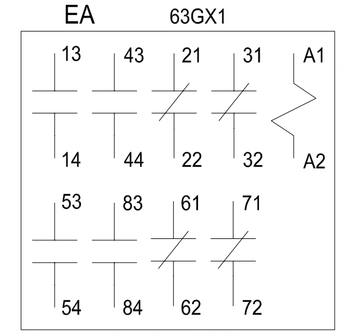
EAC 27X83



2 EACM:2
7 EACM:7
4 TB10:129
1 TB10:131
3 TB10:130

COIL VOLTAGE -125VDC/120VAC
COIL RESISTANCE - SOLID STATE

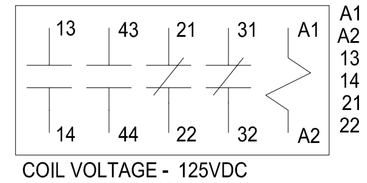
EA 63GX1



A1 AT2:4W
A2 MA1:6,EML:7
13 FU2:2,EE:1
14 TB3:17
21 ES:22
22 MC:1
31 TB2:9,EN:X2
32 MA1:3,TB3:18
43 FU3:2,EE:3
44 TB3:19
53 TB7:93
54 TB7:94
61 TB2:9A,ENN:X2
62 MA1:9,TB3:20

COIL VOLTAGE - 125VDC
COIL RESISTANCE - 4524 ohm

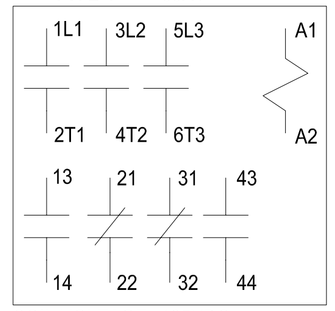
ES 52Y



A1 MA1:28,ES:14
A2 FU1:4,MB1:6
13 ES:21,LA:2
14 ES:A1
21 ES:13
22 EA:21

COIL VOLTAGE - 125VDC
COIL RESISTANCE - 4524 ohm

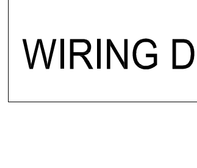
ATD1 83X1



A1 ATD2:22
A2 EACM:3
1L1 EACM:2,FU5:2
2T1 ATD1:3L2
3L2 ATD1:2T1
4T2 DT1:1
5L3 EACM:7,FU5:4
6T3 DT1:6
21 FU4:2
22 ATD2:A1

COIL VOLTAGE -125VDC
COIL RESISTANCE -2900 Ohm

H1



1 HT1:1D
2 HT1:2D
3 HT1:3D
4 HT1:4D

WATTAGE - 2X 95 W
RESISTANCE - 2X 150 OHM

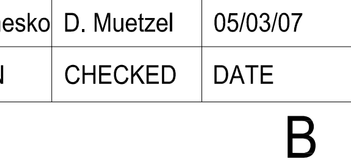
MAX1 52X1



A MA1:8
B MAX2:B,EML:7
D TB10:132
4 TB10:133
C TB10:134

COIL VOLTAGE -125VDC/120VAC
COIL RESISTANCE -SOLID STATE

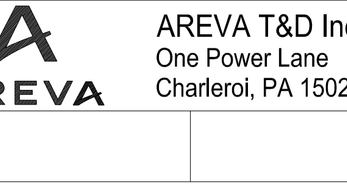
MAX2 52X2



A MA1:16
B TB1:6,MAX1:B
D TB10:135
4 TB10:136
C TB10:137

COIL VOLTAGE -125VDC/120VAC
COIL RESISTANCE -SOLID STATE

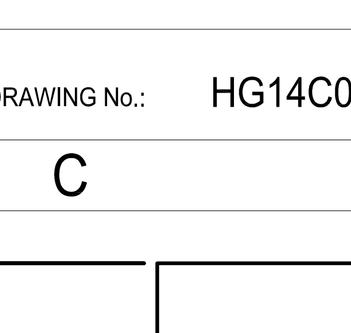
EML 88F



2 MB1:12
7 EA:A2,MAX1:B
4 TB10:126
1 TB10:128
3 TB10:127

COIL VOLTAGE -125VDC/120VAC
COIL RESISTANCE - SOLID STATE

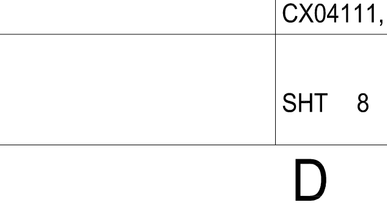
ATD2 83X2



A1 ATD1:22
A2 EACM:4,ATD2:13
1L1 ATD2:4T2
2T1 FU4:2,ATD2:21
3L2 DT1:1
4T2 ATD2:1L1
5L3 DT1:6
6T3 EACM:1
13 ATD2:A2
14 MB1:9
21 ATD2:2T1
22 ATD1:A1

COIL VOLTAGE -125VDC
COIL RESISTANCE -2900 Ohm

DT1 49



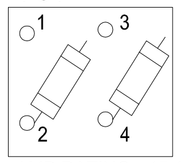
1 ATD1:4T2,ATD2:3L2
2 DT1:3
3 DT1:2
4 MB1:1
5 MB1:4
6 ATD1:6T3,ATD2:5L3
13 TB8:105
14 DT1:22,TB8:107
21 TB8:106
22 DT1:14

AMP RATING - 10-16A

HT1

H1:1	1D	TH1:2
H1:2	2D	TBAC:37,HT1:4W
H1:3	3D	HT1:5W
H1:4	4D	PL1:2,HT1:2W
PL1:1	5D	HT1:3W,FU6:2
	6D	
	1W	
	2W	
	3W	
	4W	
	5W	
	6W	

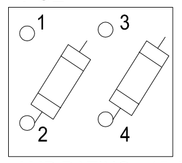
FU1



1 TB1:1
2 EF:5
3 TB1:2
4 ES:A2

AMP RATING - 15 AMP

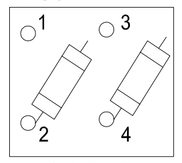
FU2



1 TB1:1A
2 EA:13
3 TB1:2A
4 TB2:10

AMP RATING - 15 AMP

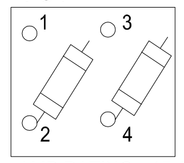
FU3



1 TB1:1B
2 EA:43
3 TB1:2B
4 TB2:10A

AMP RATING - 15 AMP

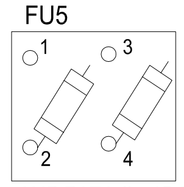
FU4



1 TB1:3
2 ATD2:2T1,ATD1:21
3 TB1:4
4 MB1:10,EACM:1

AMP RATING - 15 AMP

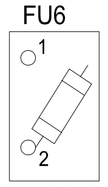
FU5



1 TBAC:36
2 ATD1:1L1
3 TBAC:37
4 ATD1:5L3

AMP RATING - 15 AMP

FU6



1 TBAC:36
2 TH1:1,HT1:5W

AMP RATING - 20 AMP

NOTES:
1) ALL 120VAC WIRES ARE TO BE GRAY 12GA SIS. AND AC GROUND WIRES ARE TO BE GREEN 12GA SIS.
2) ALL 125VDC/120VAC MOTOR CIRCUIT WIRES ARE TO BE GRAY 12GA SIS.
3) ALL 208VAC WIRES ARE TO BE GRAY 10GA SIS.
4) ALL CONTROL WIRING IS TO BE GRAY 14GA SIS VW1.
5) WIRE MARKERS ARE TO BE SHRINK-TYPE AND ARE TO SHOW OPPOSITE END / SAME END DESIGNATION.
6) ALL WIRE LUGS TO BE INSULATED RING-TYPE (EXCEPT FOR DEVICES THAT DO NOT ACCEPT RING-TYPE TERMINALS).
7) ALL CT SECONDARY WIRING TO BE 10GA SIS.

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

WIRING DIAGRAM

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

SHT 8 OF 14

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

MORTENSON

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
WIRING DIAGRAM

0 1" 2"

FILENAME: TWESD-MD-08.DWG
SCALE: NONE

SHEET
MD-08

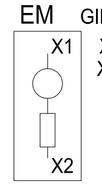
RELAY PANEL WIRING

EF 01CS

DECK	CONTACTS FRONT END	SWITCH POSITION PTL	TRIP	NORM	CLOSE
1	1		X	X	X
	2		X	X	X
2	3		X		
	4		X		
3	5				X
	6				X

3 EE:1,TB2:11
4 ER:15
5 TB1:5,FU1:2
6 ER:11

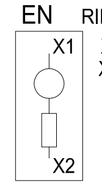
EM GIL



X1 AT2:3W,TB1:5
X2 TB3:13

VOLTAGE - 125V
RESISTANCE - 6250 OHM
COLOR - GREEN

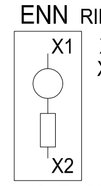
EN RIL



X1 TB2:11
X2 EA:31

VOLTAGE - 125V
RESISTANCE - 6250 OHM
COLOR - RED

ENN RIL



X1 TB2:11A
X2 EA:61

VOLTAGE - 125V
RESISTANCE - 6250 OHM
COLOR - RED

ER 43L/R

DECK	CONTACTS FRONT END	SWITCH POSITION LOCAL	REMOTE
1	12 – 11	X	
	13		X
	16 – 15	X	
	17		X
2	22 – 21	X	
	23		X
	26 – 25	X	
	27		X
3	32 – 31	X	
	33		X
	36 – 35	X	
	37		X

11 EF:6
12 TB2:7
13 TB2:7R
15 EF:4
16 TB2:9,EE:2
17 TB2:9R
22 TB2:9A,EE:4
23 TB2:9AR
25 TB8:110
26 TB8:112
27 TB8:111
31 TB8:102
32 TB8:104
33 TB8:103

AT2

EGA:1	1D	1W	TB7:100
EGA:2	2D	2W	TB7:101
EGA:3	3D	3W	EM:X1,MB1:11
EGA:4	4D	4W	EA:A1
EGA:5	5D	5W	TB8:108
EGA:6	6D	6W	TB8:109
EGA:7	7D	7W	GND1:1

NOTES:
1) ALL 120VAC WIRES ARE TO BE GRAY 12GA SIS. AND AC GROUND WIRES ARE TO BE GREEN 12GA SIS.
2) ALL 125VDC/120VAC MOTOR CIRCUIT WIRES ARE TO BE GRAY 12GA SIS.
3) ALL 208VAC WIRES ARE TO BE GRAY 10GA SIS.
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REV.	DESCRIPTION	DRAWN	CHECKED	DATE
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7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

WIRING DIAGRAM	DRAWN	CHECKED	DATE
	G. Muchesko	D. Muetzel	05/03/07

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

SHT 9 OF 14

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

MORTENSON

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
WIRING DIAGRAM

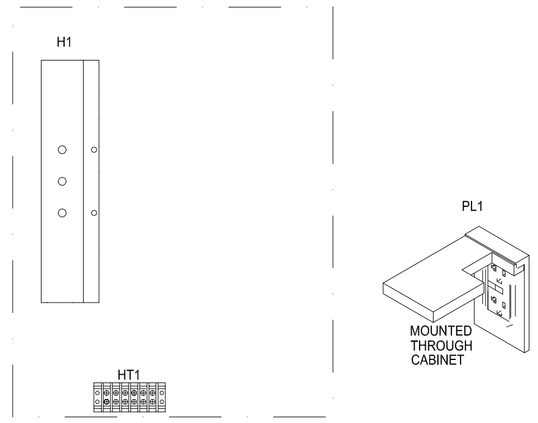
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SCALE: NONE

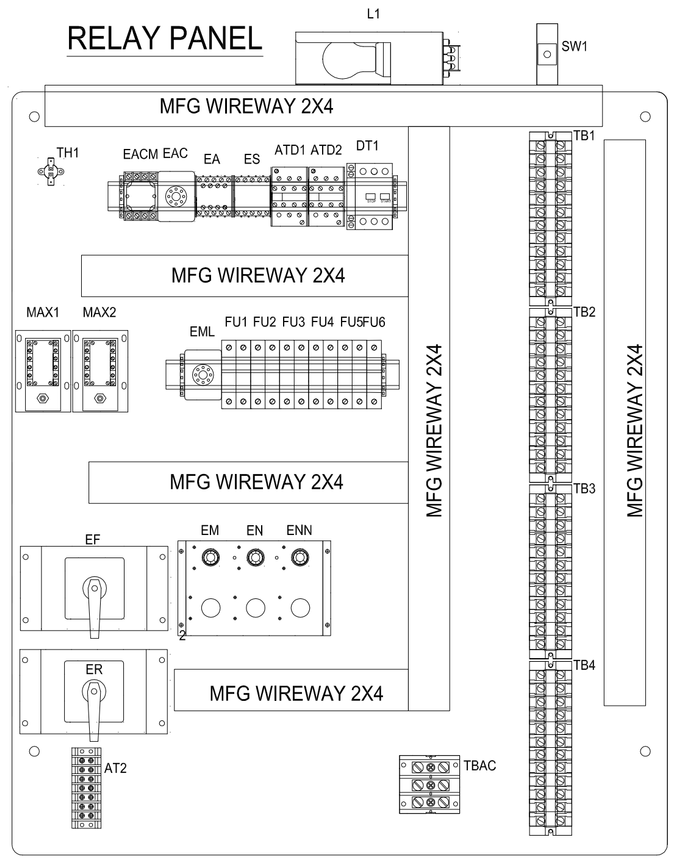
SHEET
MD-09

MFG. NOTES:
1) SEE 1-415-881 FOR DIN RAIL SPECIFICATIONS.

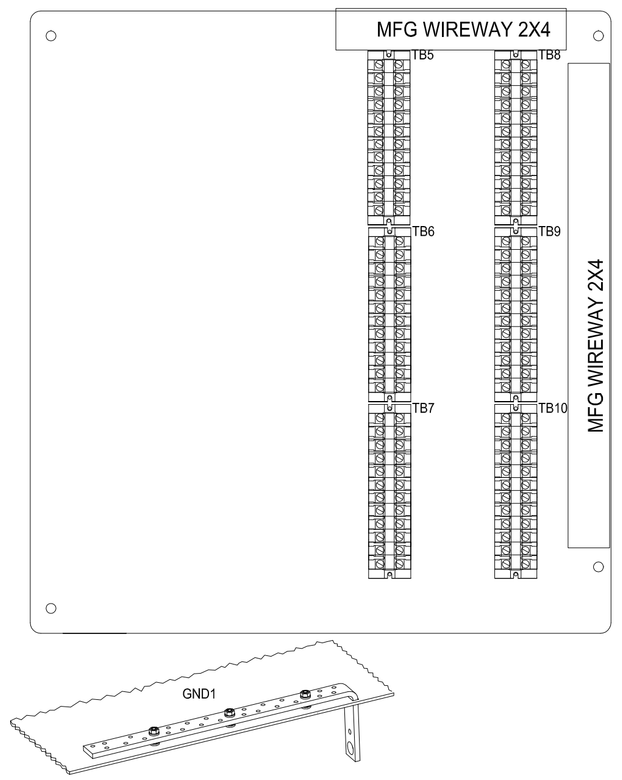
MOUNTED TO CABINET FLOOR
CLEAR OF WIRING



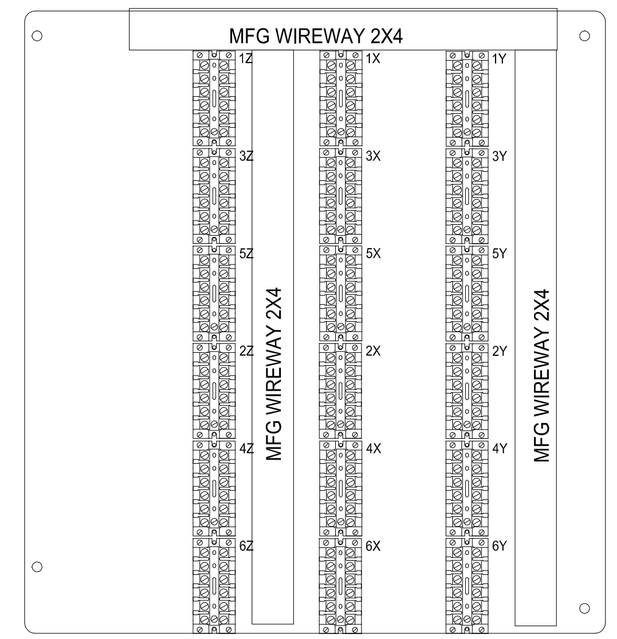
RELAY PANEL



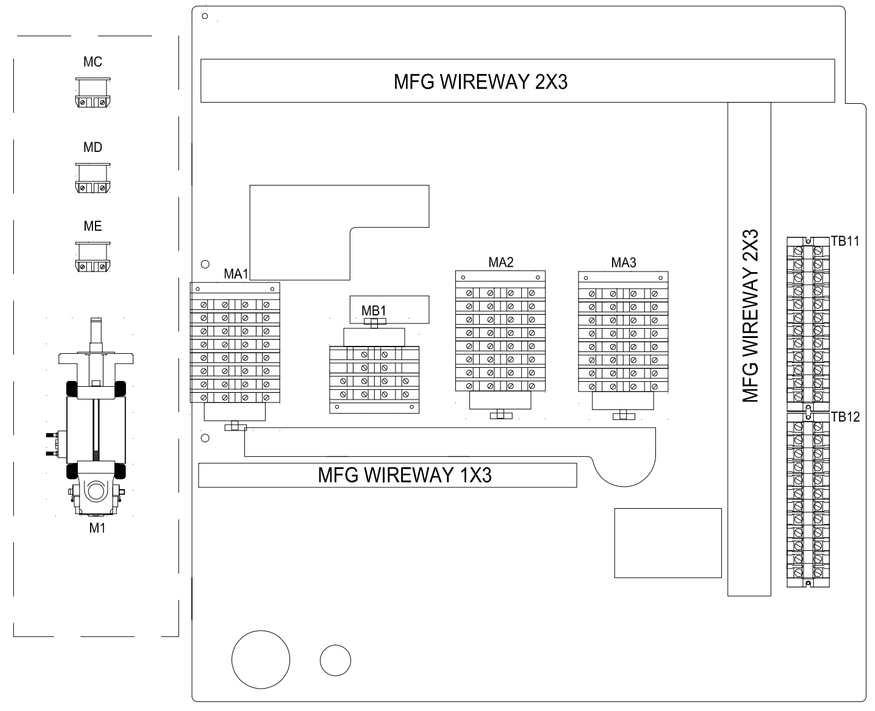
TERMINAL BLOCK PANEL (CONTROL)

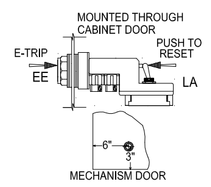


TERMINAL BLOCK PANEL (BCT)

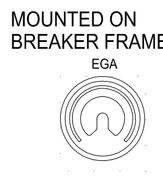


MECHANSM PANEL

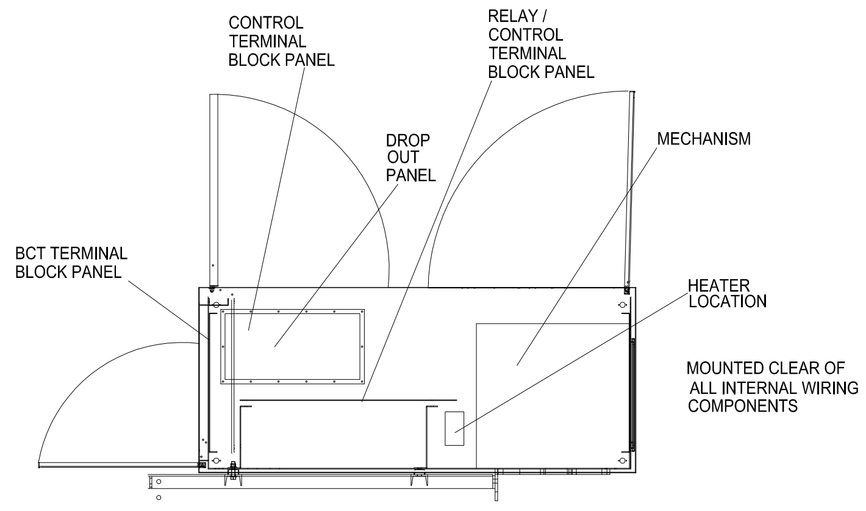




MOUNTED ON
BREAKER FRAME



TOP VIEW OF CONTROL CABINET



REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

PANEL LAYOUT

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 10 OF 14

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON®

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
PANEL LAYOUT

0 1" 2"

FILENAME	TWESD-MD-10.DWG
SCALE	NONE

SHEET
MD-10

ITEM	QTY	AREVA #	MFR #	MFR	DESCRIPTION	DEVICE ID
001	001	13.102.164-01	13.102.164-01	AREVA	MOTOR LIMIT SWITCH	MB1
002	001	13.102.194-01	13.102.194-01	AREVA	AUXILIARY SWITCH	MA3
003	002	13.102.194-01	13.102.194-01	AREVA	AUXILIARY SWITCH	MA1, MA2
004	005	1_410_504_P5	MAR1512STD73796	MARATHON	TERMINAL BLOCK 12PT	TB11, TB12, TB5, TB6, TB7
005	007	1_410_504_P5	MAR1512STD73796	MARATHON	TERMINAL BLOCK 12PT	TB1, TB10, TB2, TB3, TB4, TB8, TB9
006	001	1_410_508_P6	CR104	GENERAL ELECTRIC	CONTACT BLOCK	EE
007	001	1_410_629_P11	24203D 10D2L24A	ELECTROSWITCH	CONTROL SWITCH, LOCAL/REMOTE 3 STAGE	ER
008	001	1_410_629_P53	SB1	GE	CONTROL SWITCH, TRIP-OFF-CLOSE -PTL	EF
009	002	1_410_630_P50	MRL125DL48R-MPLLRD	C3CONTROLS	LED INDICATOR LIGHT, RED, 125V	EN, ENN
010	001	1_410_630_P53	MRL125DL48G-MPLLGN	C3CONTROLS	LED INDICATOR LIGHT, GREEN, 125V	EM
011	001	1_410_632_P19	1-410-632-P19	AREVA	CABINET LIGHT	L1
012	001	1_417_123_P1	E69-30A	CHERRY	DOOR SWITCH	SW1
013	001	1_410_634_P7	STO-110	STANCOR	THERMOSTAT 110F	TH1
014	001	1_410_636_P2	7360K8	CUTLER HAMMER	PERMISSIVE CONTROL SWITCH	LA
015	001	1_410_640_P19	IH3-1	THOMAS & BETTS / RED DOT	RECEPTACLE, ENCLOSURE	PL1
016	001	1_410_640_P4	WPFS26	HUBBELL	RECEPTACLE, WEATHERPROOF COVER	PL1
017	001	1_410_640_P5	GF5352A OR =	HUBBELL	RECEPTACLE, GFI, 120VAC, 20A	PL1
018	004	1_410_641_P73	CLIPFIX35-5	PHOENIX	END CLAMP	END4, END5, END6, END7
019	010	1_410_650_P10	1-410-650-P10	AREVA	FUSE, 15A, CLASS TFNQ	FU1, FU1, FU2, FU2, FU3, FU3, FU4, FU4, FU5, FU5
020	001	1_410_650_P11	1-410-650-P11	AREVA	FUSE, 20A, CLASS TFNQ	FU6
021	001	1_410_651_P11	CF120-400-101	ITC	FUSED DISCONNECT 1 POLE 20A	FU6
022	005	1_410_651_P12	CF120-400-102	ITC	FUSED DISCONNECT 2 POLE 15A	FU1, FU2, FU3, FU4, FU5
023	002	1_410_655_P51	3RT1325-1BG40	SIEMENS	CONTACTOR 125VDC	ATD1, ATD2
024	001	1_410_748_P10	1423123	MARATHON	TERMINAL BLOCK 3PT 200A	TBAC
025	001	1_410_748_P11	CC1423	MARATHON	TERMINAL BLOCK COVER	TBAC
026	001	1_410_749_P101	CS4C-22Z-110D	SPRECHER + SCHUH	CONTROL RELAY 2NO 2NC (125 VDC)	ES
027	001	1_410_749_P101	CS4C-22Z-110D	SPRECHER + SCHUH	CONTROL RELAY 4NO 4NC (125 VDC)	EA
028	001	1_410_749_P108	CS4-P22	SPRECHER + SCHUH	AUXILIARY CONTACT	EA
029	001	1_410_749_p18	KRP11-AG-120	POTTER AND BRUMFIELD	CONTROL RELAY, 2 FORM "C", 120VAC	EACM
030	003	1_410_749_P25	27E-891	POTTER & BRUMFIELD	RELAY SOCKET, 8 PIN	EAC, EACM, EML
031	001	1_410_906	1_410_906	AREVA	E-TRIP / 69 BLOCK	LA
032	002	1_411_074_P7	TDT-120-AKA-300	DIVERSIFIED	TIME DELAY RELAY 2 FORM "C", DIVERSIFIED TDT	EAC, EML
033	018	1_411_107_p3	1506 SC	MARATHON	TERMINAL BLOCK 6PT, SHORTING	2X, 2Y, 2Z, 3X, 3Y, 3Z, 4X, 4Y, 4Z, 5X, 1X, 5Y
						5Z, 6X, 6Y, 6Z, 1Y, 1Z
034	001	1_412_182	1-412-182	AREVA	HGF MECHANISM PANEL (40KA)	PAN10
035	002	1_412_952	1-412-952	AREVA	CONTROL SWITCH BRACKET - 8.5"	1, 3
036	002	1_413_652_P2	1017SP7-B-4-B	KANSON	TIME DELAY RELAY, 2 FORM "C", 125V, 1.5-120 CYC	MAX1, MAX2
037	001	1_413_999_G4	CIR409NYXX 120VAC	CHROMALOX	ANTICONDENSATION HEATER ASSY 120VAC	H1
038	001	1_415_866	1-415-866	AREVA	PUSH BUTTON / IND LITE BRACKET - HORIZONTAL	2
039	001	1_415_890	1-415-890	AREVA	HGF TERMINAL BLOCK PANEL	PAN5
040	001	1_415_891	1-415-891	AREVA	HGF RELAY PANEL	PAN6
041	001	1_416_202_P11	1-416-202-P11	WIKA	DENSITY MONITOR (98,85,80) COLOR SCALE	EGA
042	001	1_417_056_P1	1-417-056-P1	AREVA	SWITCH BRACKET	SW1
043	001	1_417_125_P1	GEL 40A15/120V 15199	GE	LIGHT BULB 40W 120VAC	L1
044	001	1_417_485_G1	1-417-485-G1	AREVA	ASSY FOR THIRD AUX SW. HGF 40KA	MA3
045	001	1_966_957	MBS 25	AEG	THERMAL OVERLOAD 10-16A	DT1
046	001	2_990_245_G1	2-990-245-G1	AREVA	HGF PANEL MOUNTING ASSY	PAN10
047	001	1_410_508_P1	CR104PBG10B1	GENERAL ELECTRIC	PUSHBUTTON, BLACK, 2NO	EE
048	001	1_410_748_P1	TB206	BUSSMAN	AUX. TERMINAL BLOCK, 6 PT	HT1
049	001	1_410_748_P3	TB207	BUSSMAN	AUX. TERMINAL BLOCK, 7 PT	AT2
050	001	48.127.121-00-02	49.101.018-02	GROSHOPP	SPRING CHARGE MOTOR	M1
051	003	49.102.110-20	49.102.110-20	AREVA	COIL (125 VDC)	MC, MD, ME
052	001		GROUND_BAR	AREVA	GROUND BAR, 24PT	GND1

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
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7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

BILL OF MATERIALS

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14

CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 11 OF 14

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
BILL OF MATERIALS

0 1" 2"

FILENAME	TWESD-MD-11.DWG
SCALE	NONE

SHEET
MD-11

BCT WIRING

1Z	
	1Z1	1Z-X1
	1Z2	1Z-X2
	1Z3	1Z-X3
	1Z4	1Z-X4
	1Z5	1Z-X5
	GND	GND

1X		
1X-X1	1X1	
1X-X2	1X2	
1X-X3	1X3	
1X-X4	1X4	
1X-X5	1X5	
GND	GND	

1Y	
1Y1	1Y-X1
1Y2	1Y-X2
1Y3	1Y-X3
1Y4	1Y-X4
1Y5	1Y-X5
GND	GND

3Z	
3Z1	3Z-X1
3Z2	3Z-X2
3Z3	3Z-X3
3Z4	3Z-X4
3Z5	3Z-X5
GND	GND

3X		
3X-X1	3X1	
3X-X2	3X2	
3X-X3	3X3	
3X-X4	3X4	
3X-X5	3X5	
GND	GND	

3Y	
3Y1	3Y-X1
3Y2	3Y-X2
3Y3	3Y-X3
3Y4	3Y-X4
3Y5	3Y-X5
GND	GND

5Z	
5Z1	5Z-X1
5Z2	5Z-X2
5Z3	5Z-X3
5Z4	5Z-X4
5Z5	5Z-X5
GND	GND

5X		
5X-X1	5X1	
5X-X2	5X2	
5X-X3	5X3	
5X-X4	5X4	
5X-X5	5X5	
GND	GND	

5Y	
5Y1	5Y-X1
5Y2	5Y-X2
5Y3	5Y-X3
5Y4	5Y-X4
5Y5	5Y-X5
GND	GND

2Z	
2Z1	2Z-X1
2Z2	2Z-X2
2Z3	2Z-X3
2Z4	2Z-X4
2Z5	2Z-X5
GND	GND

2X		
2X-X1	2X1	
2X-X2	2X2	
2X-X3	2X3	
2X-X4	2X4	
2X-X5	2X5	
GND	GND	

2Y	
2Y1	2Y-X1
2Y2	2Y-X2
2Y3	2Y-X3
2Y4	2Y-X4
2Y5	2Y-X5
GND	GND

4Z	
4Z1	4Z-X1
4Z2	4Z-X2
4Z3	4Z-X3
4Z4	4Z-X4
4Z5	4Z-X5
GND	GND

4X		
4X-X1	4X1	
4X-X2	4X2	
4X-X3	4X3	
4X-X4	4X4	
4X-X5	4X5	
GND	GND	

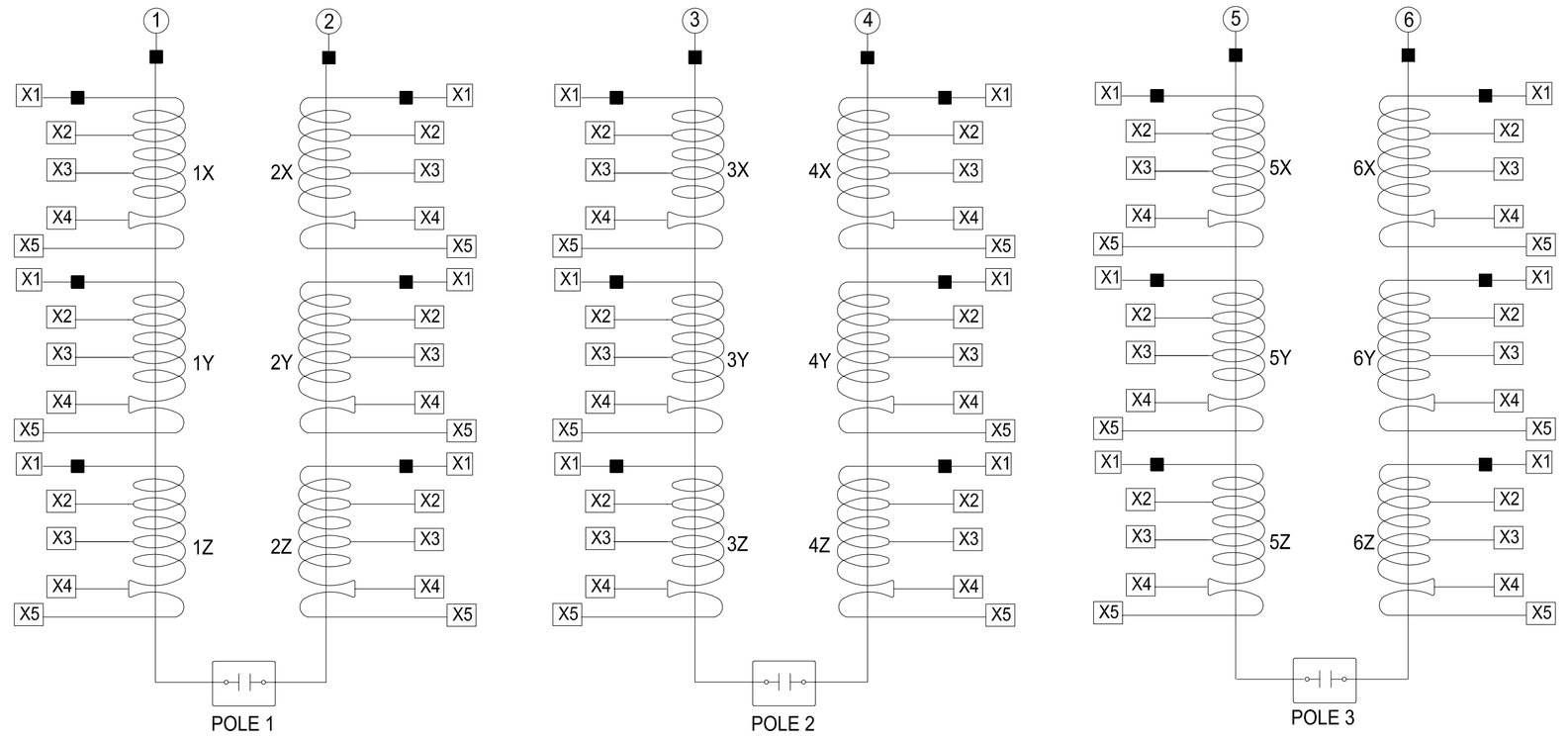
4Y	
4Y1	4Y-X1
4Y2	4Y-X2
4Y3	4Y-X3
4Y4	4Y-X4
4Y5	4Y-X5
GND	GND

6Z	
6Z1	6Z-X1
6Z2	6Z-X2
6Z3	6Z-X3
6Z4	6Z-X4
6Z5	6Z-X5
GND	GND

6X		
6X-X1	6X1	
6X-X2	6X2	
6X-X3	6X3	
6X-X4	6X4	
6X-X5	6X5	
GND	GND	

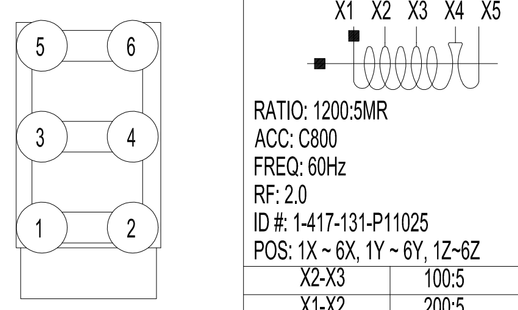
6Y	
6Y1	6Y-X1
6Y2	6Y-X2
6Y3	6Y-X3
6Y4	6Y-X4
6Y5	6Y-X5
GND	GND

CT WIRING NOTES:
1) LEADS TO BE TERMINATED WITH UNINSULATED TYPE LUGS.
2) ALL CT LEADS ARE TO BE SHORTED BEFORE SHIPMENT WHT-BLK-GND. (IF LEADS ARE NOT COLOR CODED SHORT THE FIRST LEAD-THE LAST LEAD-GROUND)
3) ALL BCT LEADS ARE 10GA WIRE.
4) ALL GROUND WIRES ARE 10GA GREEN SIS WIRE.



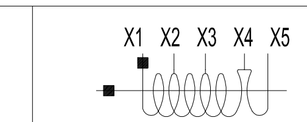
BCT NAMEPLATE

BCT NAMEPLATE NOTES:
1) MATERIAL: ALUMINUM
2) MOUNTED: INTERNALLY
3) NAMEPLATE DIMENSIONS AS SHOWN ON AREVA FABRICATION DRAWING 1_416_218_P3/P4



CT MFG: MERAMEC

BUSHING	1	2	3	4	5	6
UPPER	X	X	X	X	X	X
MIDDLE	Y	Y	Y	Y	Y	Y
LOWER	Z	Z	Z	Z	Z	Z



RATIO: 1200:5MR
ACC: C800
FREQ: 60Hz
RF: 2.0
ID #: 1-417-131-P11025
POS: 1X ~ 6X, 1Y ~ 6Y, 1Z~6Z

X2-X3	100:5
X1-X2	200:5
X1-X3	300:5
X4-X5	400:5
X3-X4	500:5
X2-X4	600:5
X1-X4	800:5
X3-X5	900:5
X2-X5	1000:5
X1-X5	1200:5

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
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8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

BCT WIRING / NAMEPLATE

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 12 OF 14

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER	WEB
PROJECT NUMBER	48069

MORTENSON

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

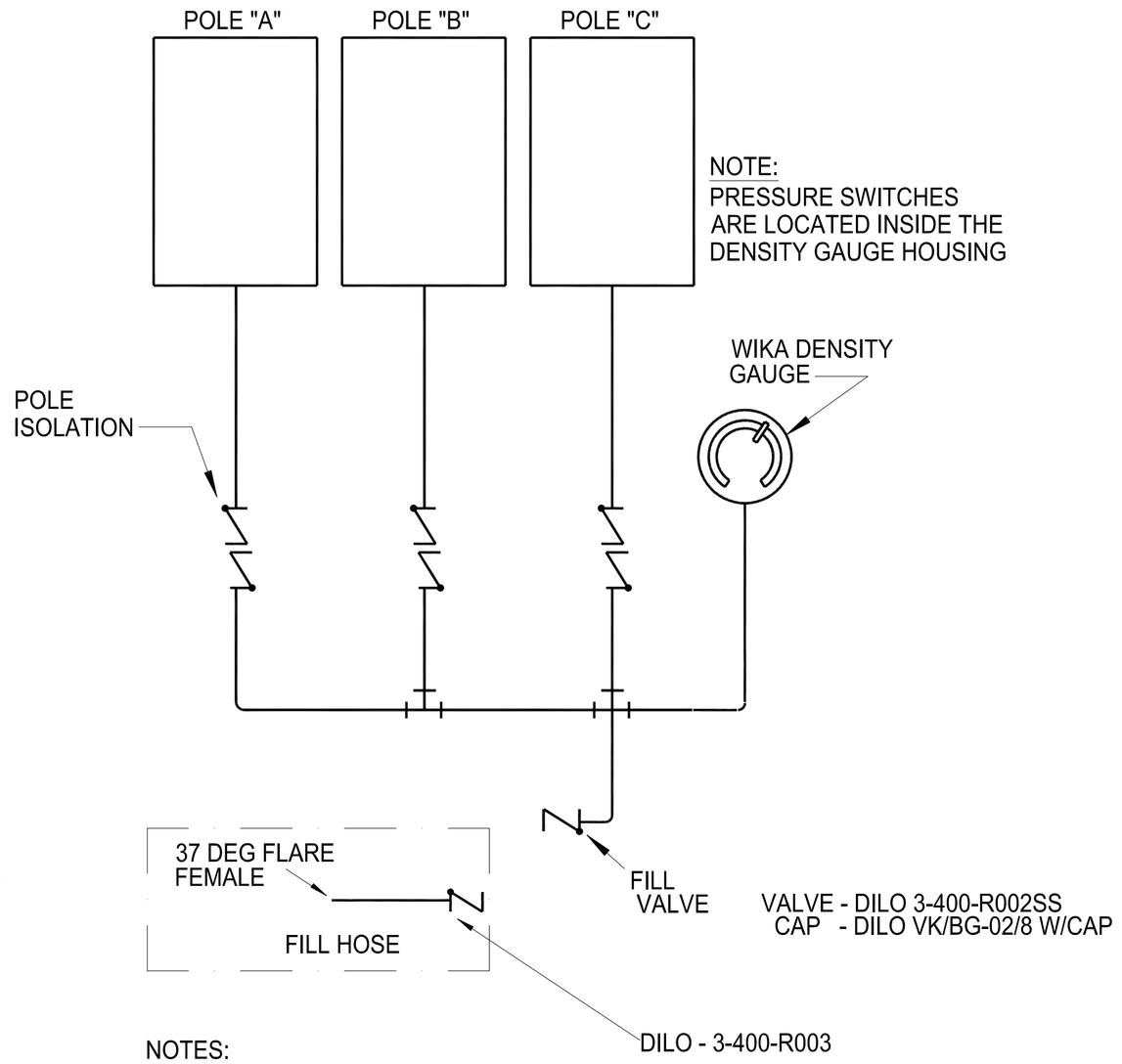
230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
BCT WIRING/NAMEPLATE

0 1" 2"

FILENAME	TWESD-MD-12.DWG
SCALE	NONE

SHEET
MD-12

GAS SCHEMATIC



NOTES:
1) ALL TUBING IS 3/8" STAINLESS.
2) GAS SAMPLING CAN BE DONE THROUGH FILL VALVE.
3) POLE ISOLATION VALVES USED TO ISOLATE TANK FROM GAS PIPING.

98.6 psig - NORMAL
85 psig - ALARM
80 psig - LOCKOUT

AREVA GAUGE No.
1_416_202_P11

RATINGS NAMEPLATE

AREVA

	TYPE: HGF 1014	CUSTOMER P.O.: XXXXXX
	SERIAL NUMBER: XXXXX-HG14	ORDER NUMBER: CX0XXXX
	MANUFACTURE DATE:	INSTRUCTION BOOK No.: HG12-IM
		PARTS LIST No.: HG14A0399
		WIRING DIAGRAM: HG14C0399
RATED MAXIMUM VOLTAGE 245 kV	RATED INTERRUPTING TIME 3.0 CYCLES	SF6 PRESSURE (@ 20° C / 68° F) RELATIVE PRESSURE
RATED VOLTAGE RANGE FACTOR (K) 1.0	RATED SHORT CIRCUIT CURRENT -TERMINAL FAULT 40 kA	-NORMAL OPERATING PRESSURE 98.6 psig
RATED FREQUENCY 60 Hz	-90% SLF WITH 0nFL_g CAPACITANCE (WITHIN 100m) 40 kA	-LOW PRESSURE ALARM 85 psig
DUTY CYCLE O-0.3s-C0-15s-C0	-CLOSE & LATCH 108 kA	-MINIMUM PRESSURE 80 psig
RATED CONTINUOUS CURRENT 1200 A	TEMPERATURE RANGE -30° C to +40° C	WEIGHT OF GAS 206 lb
CAPACITANCE CURRENT SWITCHING	SHORT TIME CURRENT DURATION 2.57s	TOTAL WEIGHT 12494 lb
-OVERVOLTAGE FACTOR 2.0	% DC COMPONENT	MECHANISM TYPE FKF 2-9 SPRING
-LINE CHARGING 200 A	FULL WAVE IMPULSE WITHSTAND 900 kV	CONTROL VOLTAGE
-ISOLATED BANK 400 A	SWITCHING IMPULSE WITHSTAND	-CLOSING 125VDC, 3.1A
-BACK-TO-BACK 400 A	-TERMINAL-TO-GROUND N/A	-TRIPPING (EACH) 125VDC, 3.1A
-INRUSH PEAK 20 kA	-TERMINAL-TO-TERMINAL N/A	-MOTOR 120VAC / 125VDC, 2100W
-INRUSH FREQUENCY 4250 Hz		-SPACE HEATER 120VAC, 190W
OUT-OF-PHASE SWITCHING 10 kA		
AREVA T&D INC., HIGH VOLTAGE SWITCHGEAR ONE POWER LANE - CHARLEROI, PA 15022		MADE IN THE USA

RATINGS NAMEPLATE NOTES:
1) MATERIAL: ANODIZED ALUMINUM
2) NAMEPLATE TO BE MOUNTED: EXTERNALLY
3) NAMEPLATE DIMENSIONS AS SHOWN ON AREVA FABRICATION DRAWING 1_416_218_P1/P2
4) SERIAL No., MANUFACTURE DATE, CUSTOMER PO, & ORDER NUMBER TO BE FILLED IN PRIOR TO ENGRAVING. (SEE TABLE FOR SERIAL No., CUSTOMER PO, & ORDER NUMBER)

SERIAL NUMBER	CUSTOMER PO	ORDER NUMBER
12789A-HG14	002713	CX04111
12789B-HG14	002713	CX04111
12789C-HG14	002713	CX04111
12791A-HG14	002714	CX04112
12791B-HG14	002714	CX04112

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

SF6 GAS PIPING / RATING NAMEPLATE

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQ. No.:

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

SHT 13 OF 14

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
SF6 GAS PIPING/RATING NAMEPLATE

0 1" 2"

FILENAME: TWESD-MD-13.DWG
SCALE: NONE

SHEET
MD-13

AT2	ATD1 83X1	ATD2 83X2	DT1 49	EA 63GX1	EACM 27X83	EE 01CS	EF 01CS	EM GIL	EML 88F
EN RIL	ENN RIL	ER 43L/R	ES 52Y	FU1 15 AMP	FU2 15 AMP	FU3 15 AMP	FU4 15 AMP	FU5 15 AMP	FU6 20 AMP
H1 2X 95 W	HT1	L1	LA 69	M1	MA1 52-1	MA2 52-2	MA3 52-2	TH1	EAC 27X83
MAX1 52X1	MAX2 52X2	MB1 88LS	MC 52CC	MD 52TC1	ME 52TC2	PL1 GFI	SW1		

DEVICE TAG NOTES:
1) TAG MATERIAL: PLASTIC - BLACK WITH WHITE LETTERS
2) TAG DIMENSIONS AS SHOWN ABOVE

TB1	TB2	TB3	TB4	TB5	TB6	TB7	TB8	TB9	TB10	TB11	TB12	
1	7	13	55	65	75	85	102	114	126	138	1	
2	7R	17	56	66	76	86	103	115	127	139	2	
1A	8	18	57	67	77	87	104	116	128	140	3	
2A	9	19	58	68	78	88	105	117	129	141	4	
1B	9R	20	59	69	79	89	106	118	130	142	5	
2B	9A	B4	60	70	80	90	107	119	131	143	6	
3	9AR	51	61	71	81	91	108	120	132	144	7	
4	10	52	62	72	82	92	109	121	133	145	8	TBAC 35
5	10A	53	63	73	83	93	110	122	134	146	9	36
6	11	54	64	74	84	94	111	123	135	147	10	
B1	11A	B5	B7	B9	B11	100	112	124	136	148	11	37
B2	B3	B6	B8	B10	B12	101	113	125	137	149	12	
P4	P4	P4	P4	P4	P4	P4	P4	P4	P4	P4	P4	P10

TERMINAL MARKER STRIP NOTES:
1) STRIP MATERIAL: PLASTIC - BLACK WITH WHITE LETTERS
2) STRIP DIMENSIONS AS SHOWN ON AREVA FABRICATION DRAWING 1_417_376_P... (SEE P#'S FOR EACH STRIP)

REV.	DESCRIPTION	DRAWN	CHECKED	DATE
12	DELETED 1x3 WIREWAY FROM MECHANISM PANEL	W. Holt	G. Muchesko	08/10/07
11	CORRECTED SERIAL No. CHART FOR NAMEPLATE	W. Holt	G. Muchesko	08/06/07
10	UPDATED RATINGS NAMEPLATE	W. Holt	G. Muchesko	08/03/07
9	CORRECT ER 43L/R WIRING	G. Muchesko	A. Lisitsa	08/03/07
8	REVISED TDDO SETTING ON EML CONTACT	W. Holt	G. Muchesko	08/02/07
7	DELETED EXTRA SIGNALS	W. Holt	G. Muchesko	07/30/07

TERMINAL MARKER STRIPS

DRAWN	CHECKED	DATE
G. Muchesko	D. Muetzel	05/03/07

CUSTOMER: Ventus Energy
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: Tatanka Wind Farm
SERIAL No.: 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQ. No.:

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C0399

SHT 14 OF 14

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

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HDR Engineering, Inc.

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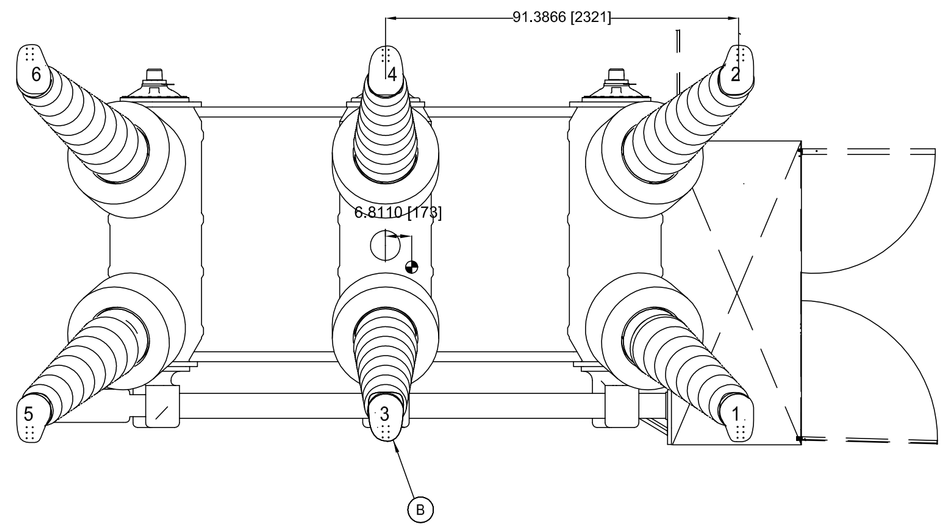
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
TERMINAL MARKER STRIPS

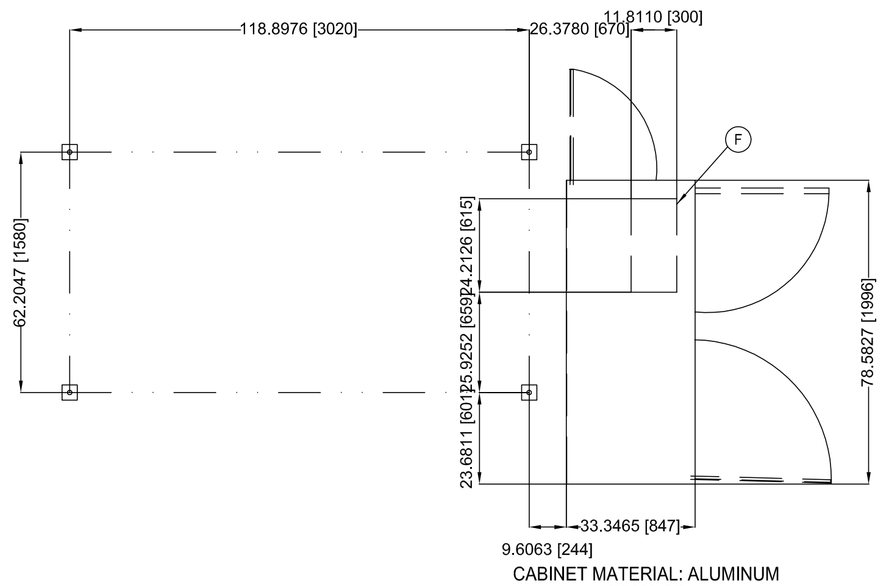
0 1" 2"

FILENAME: TWESD-MD-14.DWG
SCALE: NONE

SHEET
MD-14

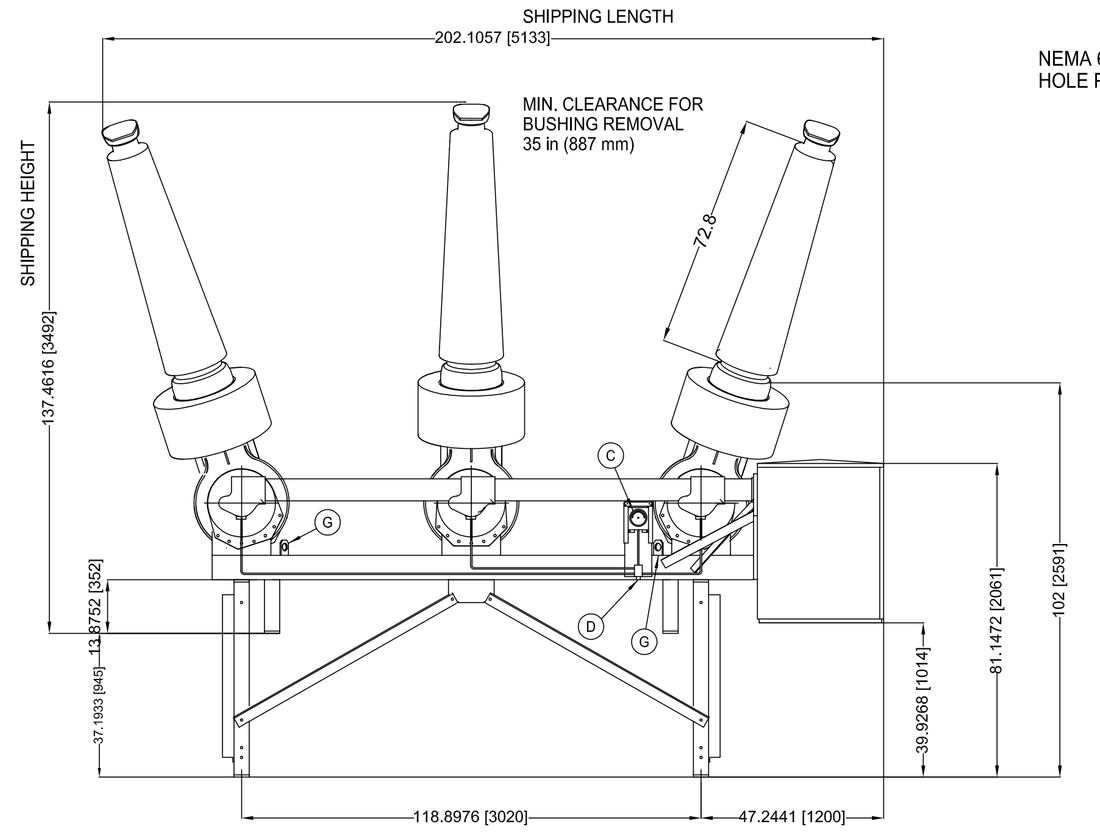


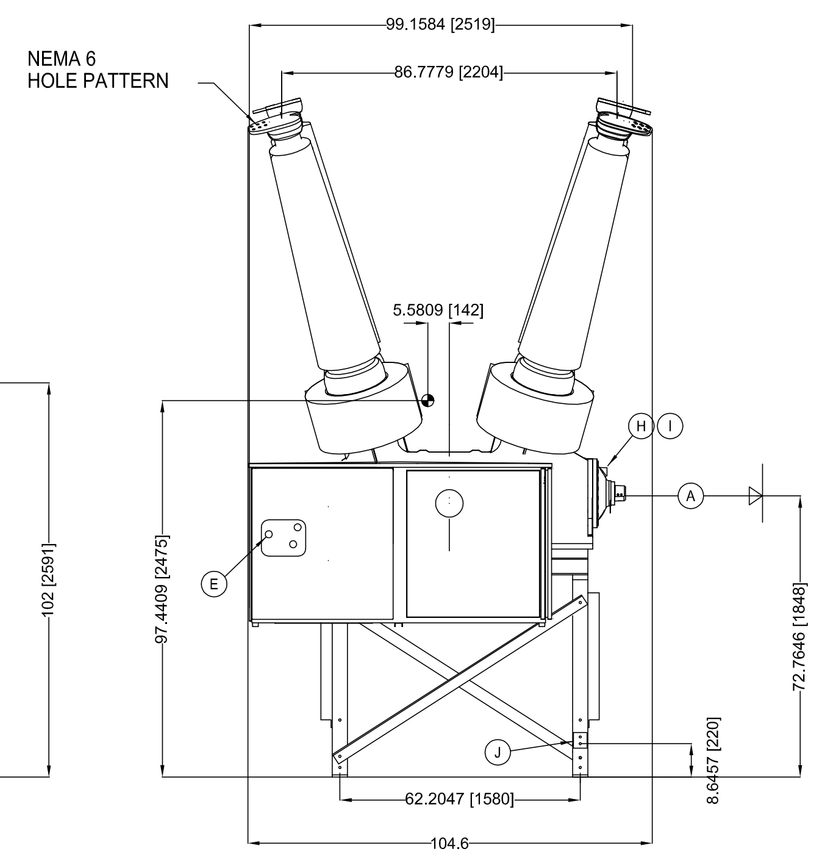
LOCATION OF DROP OUT PANELS
WITH RESPECT TO ANCHOR BOLTS



CABINET MATERIAL: ALUMINUM
NEMA 3R

FOUR (4) 1" DIAMETER ANCHOR BOLTS REQUIRED.
3.0" MINIMUM PROJECTION ABOVE FOUNDATION.
FOUNDATION TO BE LEVEL WITHIN 0.25" AT FOUR (4)
BASEPLATES. SHIM AND GROUT AS REQUIRED.
8300 lbs (3773 kg) (BREAKER WEIGHT)
+ 4194 lbs (1902 kg) (CT WEIGHT)
=12494 lbs (5675 kg) (TOTAL WEIGHT)
SEISMIC WITHSTAND CAPABILITY = 0.3 g
DYNAMIC REACTIVE FORCE PER BOLT = 15kN (3300lb)
PERMISSIBLE TERMINAL LOAD 3 kN = (660 lb) STATICALLY
PERMISSIBLE TERMINAL LOAD 4 kN = (880 lb) STATICALLY & DYNAMICALLY





LEGEND

- (A) MIN. DISTANCE FOR INTERRUPTER REMOVAL (63 inches 1608 mm)
- (B) NEMA 6 HOLE TERMINAL PAD
- (C) SF6 DENSITY MONITOR
- (D) SF6 FILL VALVE (DILO DN8)
- (E) STORED ENERGY/POSITION INDICATORS
- (F) CABLE ENTRANCE
- (G) LIFTING LUGS
- (H) PRESSURE RELIEF
- (I) MOLECULAR SIEVE
- (J) NEMA 2 GROUND PAD (DIAGONALLY OPPOSITE)

TYPE	HGF 1014
IMPULSE WITHSTAND	900 kV
MAXIMUM VOLTAGE	245kV
INTERRUPTER CURRENT RATING	40 kA
CURRENT RATING	1200 A

REV	DESCRIPTION	DRAWN	CHECKED	DATE

CUSTOMER: VENTUS ENERGY
CUSTOMER ORDER No.: 002713, 002714
SUBSTATION: TATANKA WIND FARM
SERIAL No(s): 12789A-HG14, 12789B-HG14, 12789C-HG14
12791A-HG14, 12791B-HG14
CUSTOMER EQUIPMENT No(s):

AREVA JOB #
J12789
J12791

AREVA ORDER #
CX04111, CX04112

OUTLINE DRAWING	G. Muchesko	D. Muetzel	05/03/07
	DRAWN	CHECKED	DATE

AREVA T&D Inc.
One Power Lane
Charleroi, PA 15022

DRAWING No.: HG14C1399

SHT 1 OF 1

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-12-07	ISSUED FOR REVIEW

PROJECT MANAGER: WEB
PROJECT NUMBER: 48069

MORTENSON

HDR Engineering, Inc.

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
230KV CB1 & CB2
OUTLINE DRAWING

0 1" 2"

FILENAME: TWESD-MD-15.DWG
SCALE: NONE

SHEET
MD-15

ELECTRICAL EQUIPMENT

ITEM NO.	QUANTITY REQUIRED	MANUFACTURER	CATALOG NUMBER	DESCRIPTION	REMARKS
CT1	1	COOPER B-LINE	122013	COMBINATION CT/METER ENCLOSURE FORM 9S METER SOCKET	
B1	4			DISCONNECT SWITCH,THREE PHASE, GANG OPERATED, VERTICAL BREAK, 230 KV, 1200 AMP, 900 KV BIL	
C1	9			SURGE ARRESTER, STATION CLASS, 140 KV MCOV	
C2	6			SURGE ARRESTER, STATION CLASS, 22 KV MCOV	
ACPB3	1	SQUARE D	NF SERIES	PANELBOARD, 400 AMP, 277/480V 3 PHASE, 4W, 42K A.I.C., SERIES RATED	
E1	2			POWER CIRCUIT BREAKER, SF6, 230 KV, 1200 AMP, 900 KV BIL, 40 KA INTERRUPT	
G1	3			CCVT, 230 KV, 900KV BIL, SINGLE PHASE	
G2				NOT USED	
H1	2			POWER TRANSFORMER, 230 KV-34.5 KV, 60/80/100 MVA	
M1	1	POWER MEASUREMENT		ION 8600 METER	
SG1	1			METAL-CLAD SWITCHGEAR, 35 KV, 2000 AMP MAINS, 1200 AMP UNDERGROUND FEEDERS (2-SETS OF 4 FEEDERS WITH 1-2000 AMP TIE BREAKER BETWEEN SETS OF FEEDERS). PROVISION FOR 2-15 KVA STATION SERVICE TRANSFORMERS AND 2-2000 AMP INCOMERS. LIGHTNING PROTECTION TO BE PROVIDED FOR EACH FEEDER.	
R	6	HOLOPHANE		SUBSTATION LIGHTING	

BUS MATERIAL

ITEM NO.	QUANTITY REQUIRED	MANUFACTURER	CATALOG NUMBER	DESCRIPTION	REMARKS
A1	AS REQ'D			CONDUCTOR, 1272 KCM AAC, 61 STRAND, "NARCISSUS"	
A2	AS REQ'D			CONDUCTOR, 397.5 KCM AAC, 19 STRAND, "CANNA", FOR VIBRATION DAMPING IN 3 1/2" AL BUS/5" AL BUS	
A3	AS REQ'D			CONDUCTOR, BUS, 3 1/2" IPS SCHEDULE 40 ALUMINUM, 6063-T6	
A4	42			INSULATOR, SUSPENSION, BALL-SOCKET FITTINGS, NEMA 52-5, 10", 30,000 LB, GRAY	
A5	26	LAPP	315304-70	INSULATOR, STATION POST, STANDARD STRENGTH, 230 KV, 900 KV BIL, TR-304, 5" BOLT CIRCLE, GRAY	
A6	3	ANDERSON	C011414	CONNECTOR, COMPRESSION DEADEND, FOR 1272 KCM 61 STRAND NARCISSUS, WITH VERTICAL EYE AND 4-HOLE NEMA PAD	
A7	42	ANDERSON	CCLS-1300-D	CONNECTOR, COMPRESSION TERMINAL FOR 1272 KCM 61 STRAND "NARCISSUS" TO NEMA 4 HOLE PAD	
A8	9	ANDERSON	CCL-1299-D-90	CONNECTOR, COMPRESSION TERMINAL FOR 1272 KCM 61 STRAND "NARCISSUS" TO 90 DEGREE NEMA 4 HOLE PAD	
A9	15	ANDERSON	WSTF-34-D	CONNECTOR, TERMINAL, AL, WELDED, FOR 3 1/2" IPS AL PIPE TO CENTERFORMED NEMA 4-HOLE PAD	
A10	6	ANDERSON	WSTF-334-D-CF	CONNECTOR, TERMINAL, EXPANSION, AL, WELDED, FOR 3 1/2" IPS AL PIPE TO CENTERFORMED NEMA 4-HOLE PAD	
A11	9	ANDERSON	WTSF-50-D	CONNECTOR, TERMINAL, AL ,WELDED, FOR 5" IPS AL PIPE TO CENTER FOLD NEMA 4-HOLE PAD.	
A12	AS REQ'D	ANDERSON	WCI-3434	COUPLER, AL, WELDED, FOR 3 1/2" TO 3 1/2" IPS AL PIPE	
A13				NOT USED	
A14	15	ANDERSON	ACB-34	END PLUG, AL, WELDED, FOR 3 1/2" IPS AL PIPE	
A15	12	ANDERSON	WTT-15-3434	TEE, AL, WELDED, 15 DEGREE, FOR 1-3 1/2" IPS AL PIPE MAIN TO 1-3 1/2" IPS AL PIPE TAP	FOR A-FRAMES
A16	6	ANDERSON	WTT2-15-3434	TEE, AL, WELDED, 1-3 1/2" IPS AL PIPE MAIN TO 2-15 DEGREE 3 1/2" IPS AL PIPE TAPS	FOR A-FRAMES
A17	12	ANDERSON	ORT-2114	TEE, COMPRESSION FOR 1272 KCM AAC "NARCISSUS" TO NEMA 4-HOLE PAD	
A18	6	ANDERSON	WLI-45-3434	COUPLER, AL, WELDED, FOR 3 1/2" TO 3 1/2" AL PIPE, 45 DEGREE	
A19				NOT USED	
A20	26	ANDERSON	WURF-34-5	BUS SUPPORT, AL, FOR 3 1/2" AL PIPE TO 5" BOLT CIRCLE	
A21				NOT USED	
A22	3	ANDERSON	SC-30	SOCKET CLEVIS, 30,000 LB	
A23	3	ANDERSON	YBC-30	Y-CLEVIS BALL, 30,000 LB	
A24	4	ANDERSON	AS-25	CHAIN SHACKLE, 30,000 LB	
A25	4	ANDERSON	CFCC-30	CLEVIS-CLEVIS, 30,000 LB	
A26	4	ANDERSON	861225S	DEADEND, COMPRESSION, EYE FITTING WITH 2-HOLE PAD, FOR 3/8" EHS STATIC WIRE	
A27	AS REQ'D			3/8" EHS GALVANIZED STEEL STATIC WIRE	
A28	AS REQ'D	ANDERSON	TP-B	BI-METALLIC TRANSITION PLATE, NEMA 2-HOLE PAD, ALUMINUM TO COPPER CONNECTIONS	
A29				NOT USED	
A30				NOT USED	
A31	AS REQ'D			LOT OF ½" DIAMETER STAINLESS STEEL BOLTS WITH 2-STAINLESS STEEL FLAT WASHERS, 1-STAINLESS STEEL BELLEVILLE WASHER, AND 1-1/2" SILICON BRONZE NUT PER BOLT. LENGTH & QUANTITY TO BE AS REQUIRED.	
A32	3	ANDERSON	ADCS-50-5	BUS SUPPORT, ALUMINUM, FOR ONE 1272 KCM AAC 61 STRAND "NARCISSUS" TO 5" BOLT CIRCLE.	
A33	3	ANDERSON	A2CF-9-C	TERMINAL, BOLTED, ALUMINUM, FOR TWO 397.5 KCM 26/7 STRAND CABLES (ONE "T2IBIS" CABLE) TO 4-HOLE PAD.	
A34	AS REQ'D			CONDUCTOR, BUS, 5" IPS SCHEDULE 40 ALUMINUM, 6063-T6	
A35	AS REQ'D	ANDERSON	WCI-5050	COUPLER, AL, WELDED, FOR 5" TO 5" IPS AL PIPE	
A36	12	ANDERSON	WCI-5050-45	COUPLER, AL, WELDED, FOR 5" TO 5" IPS AL PIPE 45 DEGREE	
A37	6	ANDERSON	ACB-50	END PLUG, AL, WELDED, FOR 5" IPS AL PIPE	
A38				NOT USED	
A39	45	ANDERSON	WTTFR-30-60-D	CONNECTOR, TEE, AL, WELDED, FOR 3"-6" IPS AL PIPE TO NEMA 4-HOLE PAD	
A40	AS REQ'D			POWER CABLE, 35 KV, COPPER, 1000 KCM	
A41	36			TERMINATION KITS 35 KV, WITH SKIRTS AND 4-HOLE PAD TERMINALS, FOR ITEM A40	
A42	6	LAPP	315210-70	INSULATOR, STATION POST, STANDARD STRENGTH, 35 KV, 200 KV BIL, TR-210, 3" BOLT CIRCLE, GRAY	
A43	1	ANDERSON	WURF-50-3	BUS SUPPORT, AL, FOR 5" AL PIPE TO 3" BOLT CIRCLE	
A44	1	ALCOA		OPGW DEADEND UNIT, FOR 12 FIBER, SINGLE MODE, 1310 NM, OPT-GW AC-57/465, W/REINFORCING ROD, 120" MINIMUM LENGTH, WITH ITEMS A45 & A47	
A45	1	DULMISON/TYCO	11EL-12-30	EXTENSION LINK, WYE-CLEVIS EYE, 30,000LB	
A46	1	DULMISON/TYCO	11AS-30-L	ANCHOR SHACKLE	
A47	1	DULMISON/TYCO	11CT-100	CLEVIS THIMBLE	
A48	AS REQ'D			GROUND WIRE, #6 COPPER, STRANDED, BARE	
A49	1	BURNDY	UC33R	PARALLEL CLAMP FOR #6 CU TO OPGW	
A50	1	ANDERSON	VAUL-4-12BN	COMPRESSION TERMINAL, #6 CU TO NEMA 2-HOLE PAD	

CONDUIT MATERIAL

ITEM NO.	QUANTITY REQUIRED	MANUFACTURER	CATALOG NUMBER	DESCRIPTION	REMARKS
K1	AS REQ'D			CONDUIT, 1 1/4", RIGID STEEL GALVANIZED, SCH 40	
K2	AS REQ'D			CONDUIT, 2", RIGID STEEL GALVANIZED, SCH 40	
K3	AS REQ'D			CONDUIT, 3", RIGID STEEL GALVANIZED, SCH 40	
K4	AS REQ'D			CONDUIT, 2", PVC. SCH 40	
K5	AS REQ'D			CONDUIT, 3", PVC. SCH 40	
K6	AS REQ'D			CONDUIT, 6" PVC, SCH 40	
K7	AS REQ'D			CONDUIT, 6", RIGID STEEL, GALVANIZED, SCH 40	
K8	AS REQ'D			CONDUIT, 1 1/4", INNERDUCT FOR FIBER OPTIC CABLE	
K9	AS REQ'D			ELBOW, 90 DEGREE, 24" RADIUS SWEEP, 2" PVC. SCH 80	
K10	AS REQ'D			ELBOW, 90 DEGREE, 24" RADIUS SWEEP, 3" PVC. SCH 80	
K11	AS REQ'D			ELBOW, 90 DEGREE, 48" RADIUS SWEEP, 4" PVC, SCH 80	
K12	24			ELBOW, 90 DEGREE, 48" RADIUS SWEEP, 6" PVC, SCH 80	
K13	AS REQ'D			END BELL FOR 2" PVC CONDUIT	
K14	AS REQ'D			END BELL FOR 3" PVC CONDUIT	
K15	AS REQ'D			COUPLER FOR 2" TO 2" PVC CONDUIT	
K16	AS REQ'D			COUPLER FOR 3" TO 3" PVC CONDUIT	
K17	AS REQ'D			COUPLER FOR 4" TO 4" PVC CONDUIT	
K18	AS REQ'D			COUPLER FOR 6" TO 6" PVC CONDUIT	
K19	AS REQ'D			COUPLER FOR 2" TO 2" PVC CONDUIT	
K20	AS REQ'D			GALV. LOCKWASHERS FOR 1 1/4" CONDUIT	
K22	AS REQ'D			GALV. LOCKWASHERS FOR 2" CONDUIT	
K23	AS REQ'D			GALV. LOCKWASHERS FOR 3" CONDUIT	
K24	AS REQ'D			GALV. GROUNDING BUSHINGS FOR 1 1/4" RIGID CONDUIT	
K25	AS REQ'D			GALV. GROUNDING BUSHINGS FOR 2" CONDUIT	
K26	AS REQ'D			GALV. GROUNDING BUSHINGS FOR 3" CONDUIT	
K27	AS REQ'D			GALV. WATERTIGHT GROUNDING CONDUIT HUBS FOR 1 1/4" CONDUIT	
K28	AS REQ'D			GALV. WATERTIGHT GROUNDING CONDUIT HUBS FOR 2" CONDUIT	
K29	AS REQ'D			GALV. WATERTIGHT GROUNDING CONDUIT HUBS FOR 3" CONDUIT	
K30	AS REQ'D			ADAPTER FOR 1 1/4" PVC CONDUIT TO 1 1/4" RIGID STEEL CONDUIT	
K31	AS REQ'D			ADAPTER FOR 2" PVC CONDUIT TO 2" RIGID STEEL CONDUIT	
K32	AS REQ'D			ADAPTER FOR 3" PVC CONDUIT TO 3" RIGID STEEL CONDUIT	
K33	AS REQ'D			LOT MINOR CONDUIT MATERIAL, CLAMPS, CABLE SUPPORTS, CONDULETS, ELLS, TEES, UNISTRUT, SPRING NUTS, BOLTS W/ NUTS, WASHERS, LOCKWASHERS, SELF-TAPPINGSCREWS, ETC. SIZE AND NUMBER AND LENGTH AS REQUIRED TO COMPLETE CONDUIT INSTALLATION PER NESC, NEC, AND ALL OTHER APPLICABLE CODES.	
K34	AS REQ'D			16" X 16" X 6" HINGED COVER NEMA 3R JUNCTION BOXES WITH INTERIOR MOUNTING PANELS, HOFFMAN CAT. NO. A16166HCR WITH A16P16 PANEL OR EQUAL	
K35	AS REQ'D			24" X 24" X 8" HINGED COVER NEMA 3R JUNCTION BOXES WITH INTERIOR MOUNTING PANELS, HOFFMAN CAT. NO. A24R248HCR WITH A24P24 PANEL OR EQUAL	
K36	AS REQ'D			AC/DC YARD PANELS	
K37	AS REQ'D			PRIMER/CEMENT/ADHESIVE FOR PVC/HDPE CONDUIT	
K38	AS REQ'D			CONDUIT, 1 1/4", PVC. SCH 40	
K39	AS REQ'D			ELBOW, 90 DEGREE, 24" RADIUS SWEEP, 1 1/4" PVC. SCH 80	
K40	AS REQ'D			END BELL FOR 1 1/4" PVC CONDUIT	
K41	AS REQ'D			COUPLER FOR 1 1/4" TO 1 1/4" PVC CONDUIT	
K42	12			ADAPTER, FEMALE, FOR 6" RIGID STEEL CONDUIT TO 6" SCH 40 PVC CONDUIT	
K43	12			ADAPTER, MALE, FOR 6" SCH 40 PVC CONDUIT	
K44	12			CONDUIT STRAP FOR 6" RIGID STEEL CONDUIT	
K45	12	JACKMOON	JM-OUA-600216SG	CABLE SUPPORT/BREAKOUT FOR 6" RIGID STEEL CONDUIT; FOR 3-1000 KCM POWER CABLES AND 1-500KCM BARE CU CABLE. TO INCLUDE SLEEVE FOR 500 KCM CU CABLE.	
K46	1	ALCOA	0003	FIBER OPTIC SPLICE BOX	
K47	1	T&B	LN-103	LOCKNUT FOR 1"RIGID CONDUIT	
K48	1	T&B	LS-103	SEALING LOCKNUT, 1"	
K49	1	T&B	1224	BUSHING, NYLON INSULATED, METALLIC, 1"	
K50	AS REQ'D			CONDUIT, GALVANIZED STEEL, 1", THREAD BOTH ENDS	
K51	1	CROUSE-HINDS	REC603	REDUCER, GALVANIZED STEEL, 2"-1"	
K52	1	ALCOA	11-112 SC	EQUIPMENT JUNCTION BOX & INTERNAL COMPONENTS, PART #912875-00-00 (IN SWITCHGEAR BUILDING)	
K53	1	CARLON	E943J	MALE TERMINAL ADAPTER FOR 2" PVC CONDUIT	
K56	AS REQ'D	ALUMA-FORM	BB-1511-H	OPGW MOUNTING BRACKET	
K57	AS REQ'D	T&B	TYS6-280	CABLE TIE, STAINLESS STEEL, SELF-LOCKING	
K58	AS REQ'D	3M	2170	BUFFER TUBE, HEAT SHRINK, FOR FUSION SPLICE	
K59	1	ALCOA	C8591	ENTRY CONNECTOR ASSEMBLY	
K60	1	3M	5016-FO	WARNING LABEL	
K61	10			BOLT, HEX HEAD, GALVANIZED STEEL, 5/8" X 2" W/NUT	
K62	2			FLAT WASHER, ROUND, GALVANIZED STEEL, 5/8"	
K63	10			SPLIT LOCKWASHER, GALVANIZED STEEL, 5/8"	
K64	1	ALCOA	OGST01-24	SPLICE ORGANIZER TRAY, 24 FUSION SPLICE CAPACITY	

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
1	09-04-07	ADD NEW METERED FDR&PANEL FOR O+M BUILDING
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION MATERIAL LIST

0 1" 2"

FILENAME	TWESD-ML-01
SCALE	NONE

SHEET **ML-01**

YARD

ITEM NO.	QUANTITY REQUIRED	MANUFACTURER	CATALOG NUMBER	DESCRIPTION	REMARKS
	1 LOT			FENCE INCLUDING TWO (2) DRIVE GATES	
	1 LOT			SURFACE FINISH – 6" CRUSHED GRAVEL	

GROUNDING MATERIAL

ITEM NO.	QUANTITY REQUIRED	MANUFACTURER	CATALOG NUMBER	DESCRIPTION	REMARKS
01	AS REQ'D			CONDUCTOR, GROUNDING, 4/0 CU, 7 STRAND, SOFT DRAWN	
02	AS REQ'D	BURNDY	YGHC29C29	CONNECTOR, TAP, GROUNDING, FOR 4/0 CU TO 4/0 CU	
03	AS REQ'D	BURNDY	YGHC29C29	CONNECTOR, CROSS, GROUNDING, FOR 4/0 CU TO 4/0 CU	
04	AS REQ'D			GROUND ROD, COPPER CLAD, 3/4" X 10'-0"	
05	AS REQ'D	BURNDY	UC2W28-L	PARALLEL CLAMP FOR 4/0 CU TO GALV. BARBED WIRE.	
06	AS REQ'D	BURNDY	YHA-28-2N	CONNECTOR, GROUNDING, 4/0 CU TO NEMA 2-HOLE PAD	
07	AS REQ'D	ANDERSON	GC-141A-G2	CLAMP, GROUNDING, FOR ONE 4/0 STRANDED OR #2 AWG SOLID CU CABLE TO FLAT	
08	AS REQ'D	ANDERSON	GC-143-G2	CLAMP, GROUNDING, FOR TWO 4/0 CU CABLES OR ONE 4/0 CU STRANDED TO #2 AWG SOLID CU TRANSITION TO FLAT	
09	AS REQ'D	ANDERSON	TLD-52	TERMINAL.BOLTED. FOR ONE OR TWO 4/0 CU CABLES TO FLAT	
010	AS REQ'D	ANDERSON	GC-111-11C	CLAMP, GROUNDING, FOR 4/0 CU CABLE TO 4" IPS FENCE PIPE	
011	AS REQ'D	ANDERSON	GC-110-62C	CLAMP, GROUNDING, FOR 4/0 CU CABLE TO 2" IPS FENCE PIPE	
012	AS REQ'D	ANDERSON	GC-110-122C	CLAMP, GROUNDING, FOR 4/0 CU CABLE TO 3" IPS FENCE PIPE	
013	AS REQ'D			CONDUCTOR, GROUNDING, #2 AWG CU, SOLID, SOFT DRAWN	
014	AS REQ'D			CONDUCTOR, GROUNDING, 4/0 CU, EXTRA FLEXIBLE	
015	AS REQ'D			SWITCHING PLATFORM, GALVANIZED, 4' X 6'	
016	AS REQ'D			LOT MINOR GROUNDING MATERIAL INCLUDING NECESSARY BOLTS, WASHERS. LOCKWASHERS, MINOR COMPRESSION AND MECHANICAL CONNECTORS, TO INCLUDE ALL HARDWARE NECESSARY FOR A COMPLETE GROUNDING INSTALLATION PER NEC, NESC AND ALL OTHER ALL APPLICABLE CODES.	
017	AS REQ'D			CONNECTOR, TAP, GROUNDING, FOR 4/0 CU TO 500 KCM CU	
018	AS REQ'D			CONNECTOR,3/4" GROUND ROD TO 4/0 COPPER GROUND GRID CONNECTOR	
091	AS REQ'D			500 KCM CU CABLE, BARE	

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

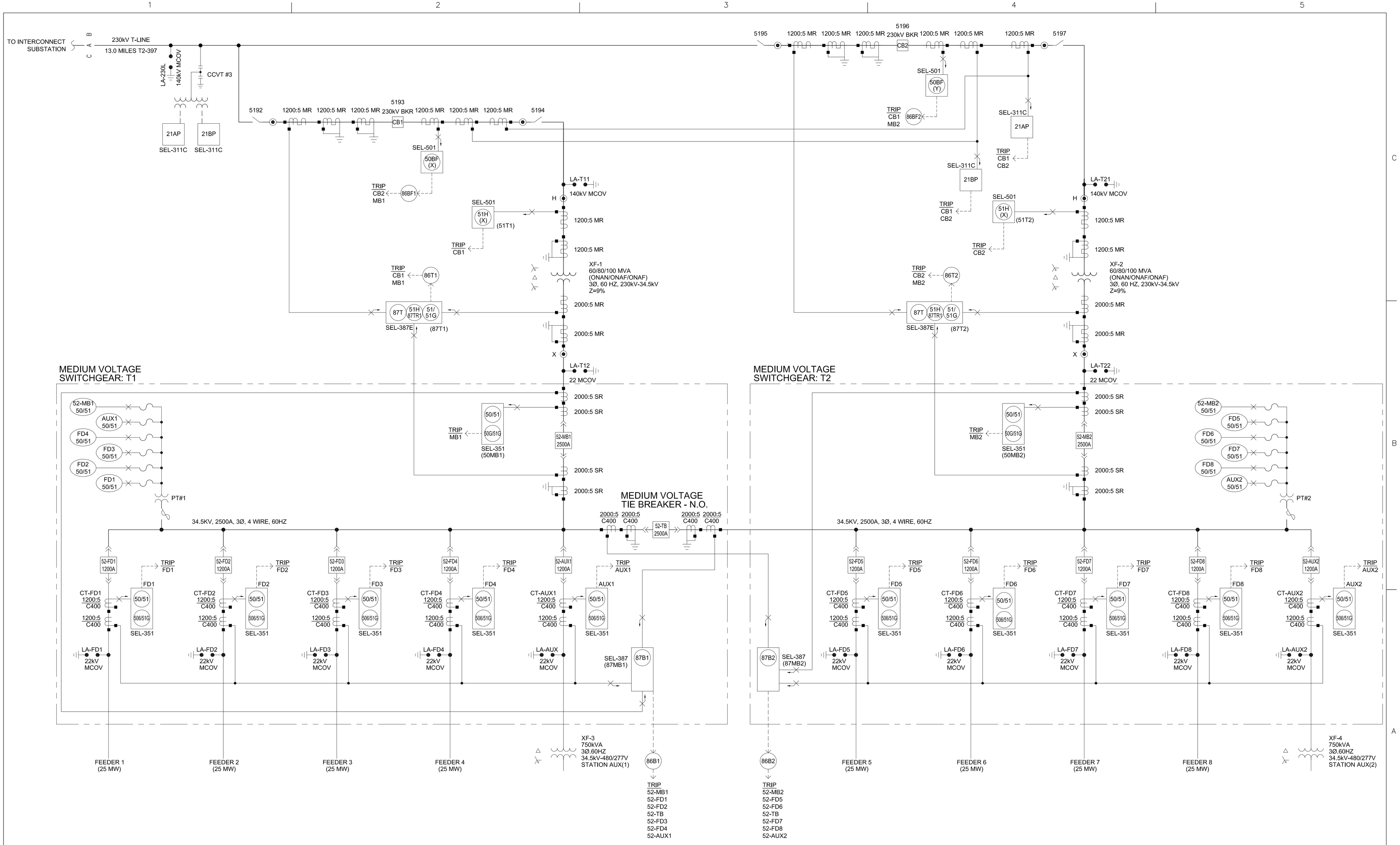
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
MATERIAL LIST

0 1" 2"

FILENAME	TWESD-ML-02
SCALE	NONE

SHEET **ML-02**



MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-31-07	ADD MDU NAMING CONVENTION
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

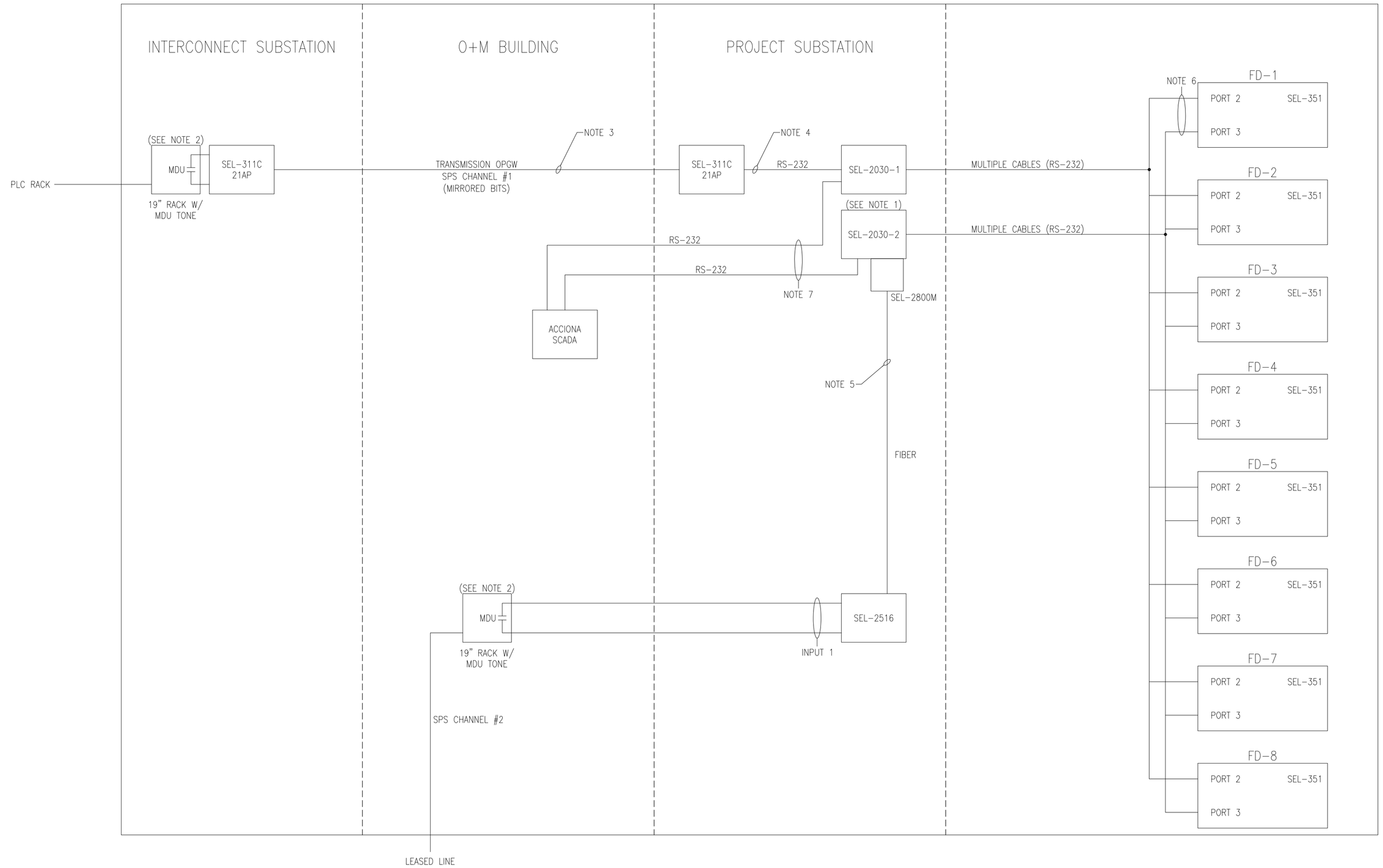
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION RELAY ONE LINE DIAGRAM

0 1" 2"

FILENAME	TWESD-OL-01.dwg
SCALE	NONE

SHEET **OL-01**



NOTES:

1. SEE SHEET CS-15 FOR DETAIL SEL-2030 PORT ASSIGNMENTS.
2. TONE EQUIPMENT TO BE PROVIDED BY MDU. COORDINATE EXACT LOCATION IN THE FIELD.

THE FOLLOWING NOTES EXPLAIN HOW THE SPS SCHEME IS IMPLEMENTED

3. INTERCONNECT SUB 21AP ASSERTS TMB4A IN TURN, ASSERTS RMB4A IN THE PROJECT SUB 21AP.
4. SEL-2030-1 ASSERTS RB5 IN THE FEEDER SEL-351'S WHEN RMB4A IN THE 21AP RELAY IS ASSERTED.
5. SEL-2030-2 ASSERTS RB6 IN THE FEEDER SEL-351'S WHEN IN1 IN THE SEL-2516 IS ASSERTED.
6. THE SEL-351 FEEDER RELAYS INITIATE THE TRIPPING TIMERS IF EITHER RB5 OR RB6 IS ASSERTED. THE TIMERS RESET WHEN BOTH RB5 AND RB6 ARE DE-ASSERTED.
7. DNP POINT 1 ON THE SEL-2030-1 AND SEL-2030-2 IS ASSERTED WHEN THE 21AP RMB4A AND THE SEL-2516 IN1 ARE ASSERTED, RESPECTIVELY.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE

PROJECT MANAGER	WEB
PROJECT ENGINEER	ALM
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION SPS ONE LINE

0 1" 2"

FILENAME	TWESD-OL-02.dwg
SCALE	NONE

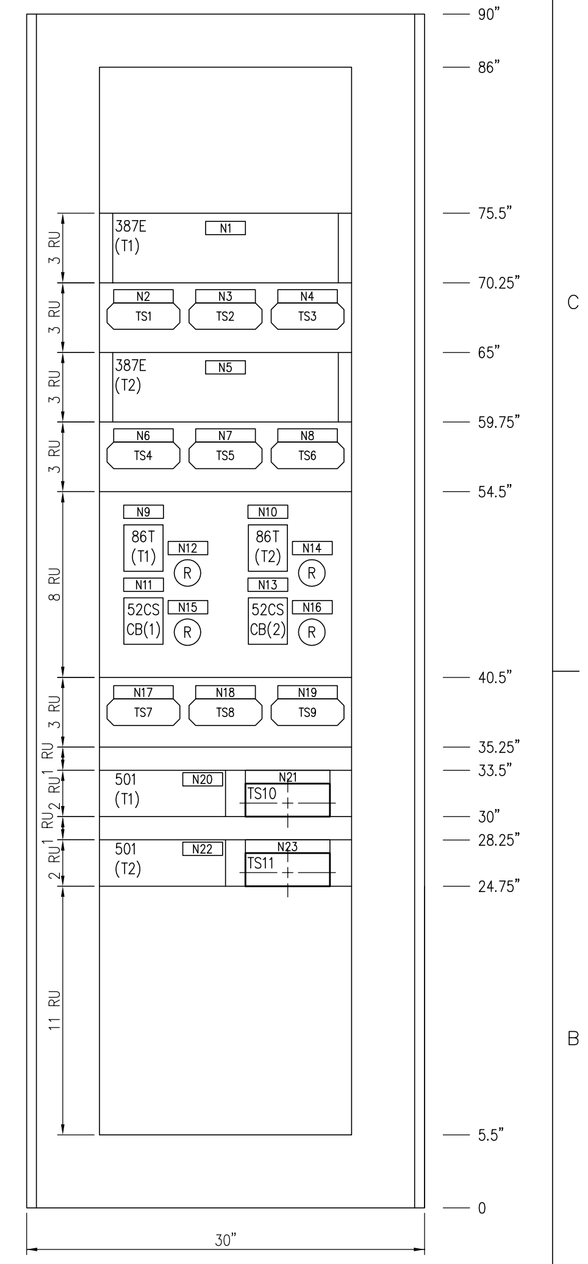
SHEET OL-02

BILL OF MATERIALS

ITEM NO.	QTY	DESCRIPTION	MANUFACTURER	STYLE/TYPE	CATALOG NO.
501	2	RELAY, DUAL OVERCURRENT PROTECTION, 125 VDC, 5 A, 60 HZ, 19" RACK MOUNT, WITH TEST SWITCH	SCHWEITZER	SEL-501	0501003X561CXB
52CS	2	BREAKER CONTROL SWITCH TRIP/CLOSE, 5 DECK, SPRING RETURN PISTOL GRIP HANDLE WITH LIGHTED NAMEPLATE, GREEN, RED, RED (DUAL TRIP COIL MONITOR)	ELECTROSWITCH	SERIES 24	74PD205LA
387E	2	RELAY, CURRENT DIFFERENTIAL & VOLTAGE PROTECTION 125 VDC, 5 A, 60 HZ, 19" RACK MOUNT	SCHWEITZER	SEL-387E	0387E003X5HXX4X
TS1,TS2,TS3	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, 6 CURRENT, 4 POTENTIAL	ABB	FT-19R	FR3G119119119
TS4,TS5,TS6	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, 6 CURRENT, 4 POTENTIAL	ABB	FT-19R	FR3G119119119
TS7,TS8,TS9	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, 10 POTENTIAL	ABB	FT-19R	FR3G001001001
86T	2	RELAY, LOCKOUT, 125 VDC, FIVE DECK, MANUAL RESET WITH LIGHTED TARGET NAMEPLATE, 1 AMBER INDICATING TRIP	ELECTROSWITCH	SERIES 24 LOR	78PA05D-002
R	4	CIRCUIT MONITOR DEVICE 125VDC	E-MAX	RAW-1D	632A304
TS10,TS11	2	FT-1 TEST SWITCH, 10 POLE, 6 CURRENT, 4 POTENTIAL	ABB	FT-1	1586C42G05

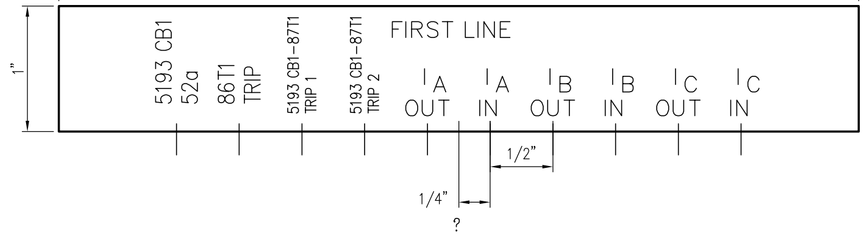
NAME-PLATE NO.	NAMEPLATE SIZE W x L	LETTER SIZE	FIRST LINE	SECOND LINE	THIRD LINE
1	1" x 3"	1/8"	SEL-387E	PROJECT SUB. TRANSFORMER (1)	DIFFERENTIAL RELAY
2	1" x 6-3/8"	1/8"	387E-REL'G TEST SW TS1	(SEE DETAIL TS1)	
3	1" x 6-3/8"	1/8"	387E-REL'G TEST SW TS2	(SEE DETAIL TS2)	
4	1" x 6-3/8"	1/8"	387E-REL'G TEST SW TS3	(SEE DETAIL TS3)	
5	1" x 3"	1/8"	SEL-387E	PROJECT SUB. TRANSFORMER (2)	DIFFERENTIAL RELAY
6	1" x 6-3/8"	1/8"	387E-REL'G TEST SW TS4	(SEE DETAIL TS4)	
7	1" x 6-3/8"	1/8"	387E-REL'G TEST SW TS5	(SEE DETAIL TS5)	
8	1" x 6-3/8"	1/8"	387E-REL'G TEST SW TS6	(SEE DETAIL TS6)	
9	1" x 3"	1/8"	86T TRANSFORMER 1	LOCKOUT RELAY	
10	1" x 3"	1/8"	86T TRANSFORMER 2	LOCKOUT RELAY	
11	1" x 3"	1/8"	52CS	CONTROL SWITCH	5193 CB(1)
12	1" x 3"	1/8"	74DC-ON	5193 CB(1) TRIP 1	CIRCUIT MONITOR
13	1" x 3"	1/8"	52CS	CONTROL SWITCH	5196 CB(2)
14	1" x 3"	1/8"	74DC-ON	5193 CB(1) TRIP 2	CIRCUIT MONITOR
15	1" x 3"	1/8"	74DC-ON	5196 CB(2) TRIP 1	CIRCUIT MONITOR
16	1" x 3"	1/8"	74DC-ON	5196 CB(2) TRIP 2	CIRCUIT MONITOR
17	1" x 6-3/8"	1/8"	86T1 TEST SW TS7	(SEE DETAIL TS7)	
18	1" x 6-3/8"	1/8"	86T2 TEST SW TS8	(SEE DETAIL TS8)	
19	1" x 6-3/8"	1/8"	SPARE TEST SW TS9	(SEE DETAIL TS9)	
20	1" x 3"	1/8"	SEL-501	PROJECT SUB. TRANSFORMER (1)	OVERCURRENT RELAY
21	1" x 6-3/8"	1/8"	501-REL'G TEST SW TS10	(SEE DETAIL TS10)	
22	1" x 3"	1/8"	SEL-501	PROJECT SUB. TRANSFORMER (2)	OVERCURRENT RELAY
23	1" x 6-3/8"	1/8"	501-REL'G TEST SW TS11	(SEE DETAIL TS11)	

RELAY RACK (1R)

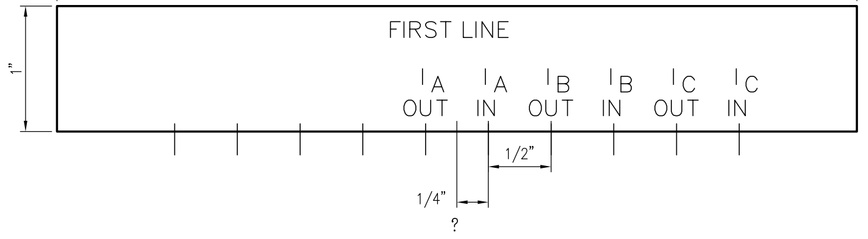


FRONT VIEW

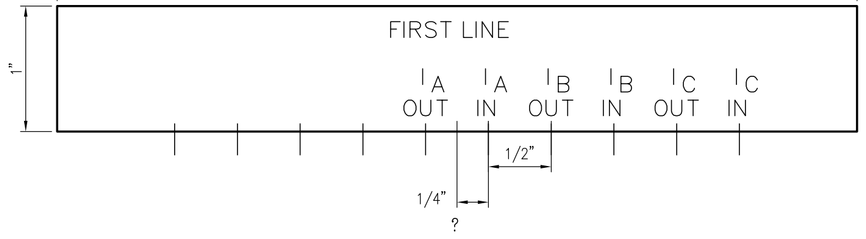
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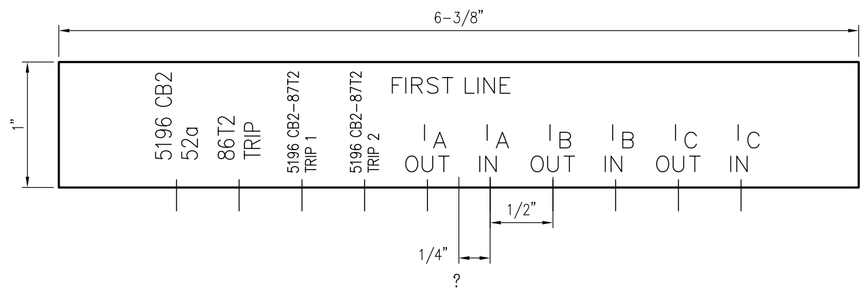
DETAIL TS1



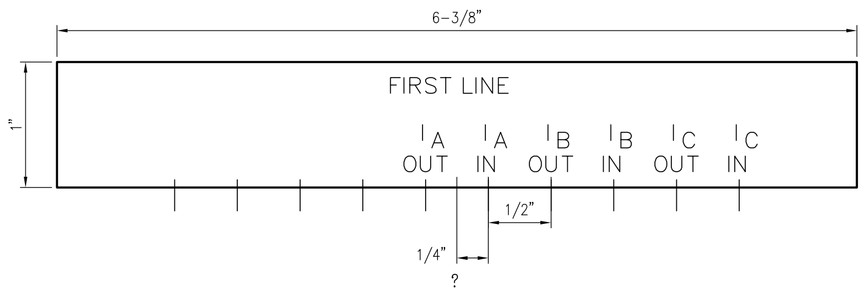
DETAIL TS2



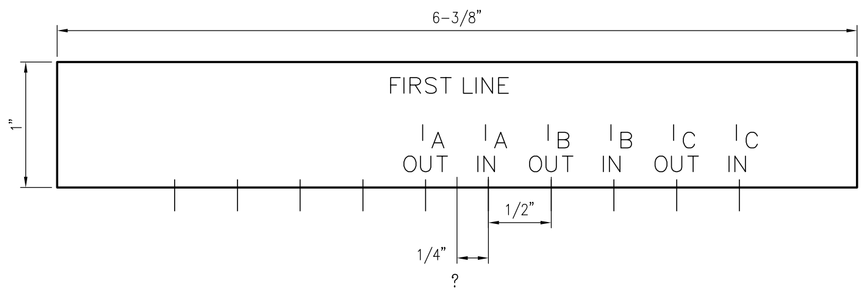
DETAIL TS3



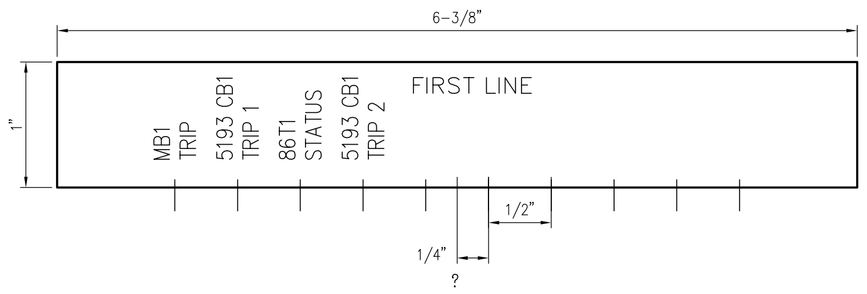
DETAIL TS4



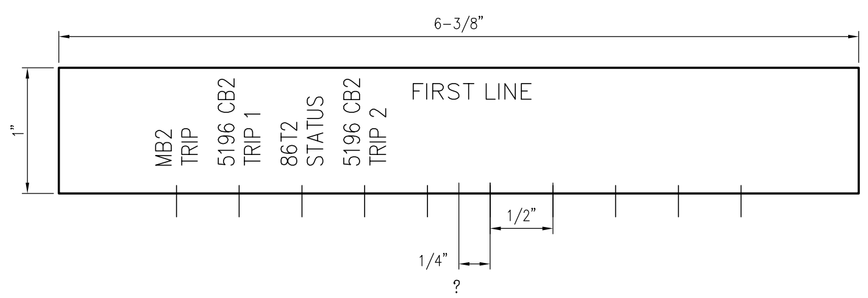
DETAIL TS5



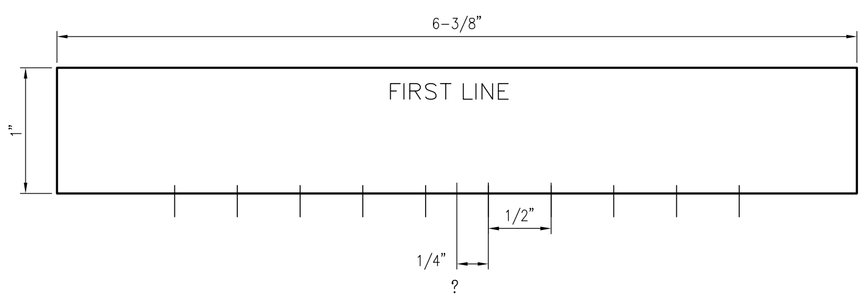
DETAIL TS6



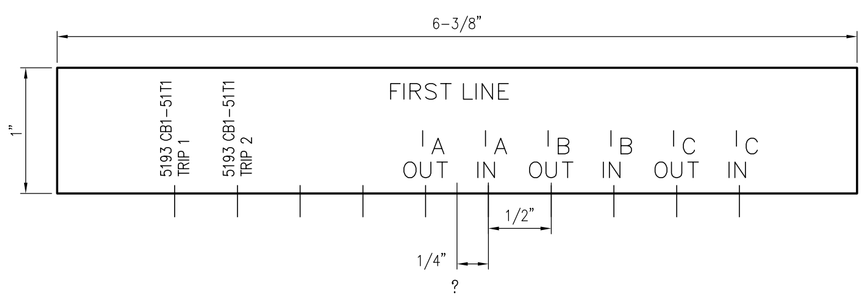
DETAIL TS7



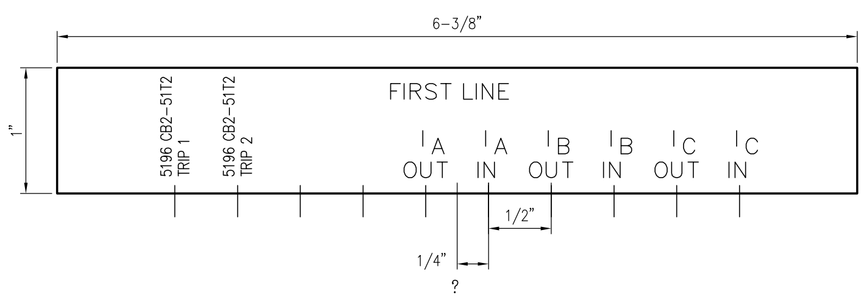
DETAIL TS8



DETAIL TS9



DETAIL TS10



DETAIL TS11

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
A	10-31-07	ADD MDU NAMING CONVENTION
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION RELAY RACK (1R) LAYOUT, MATERIAL LIST & NAMEPLATE SCHEDULE

0 1" 2"

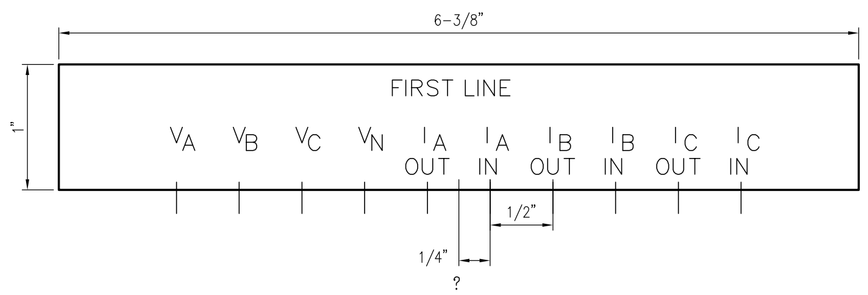
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SCALE	NONE

SHEET **RL-01**

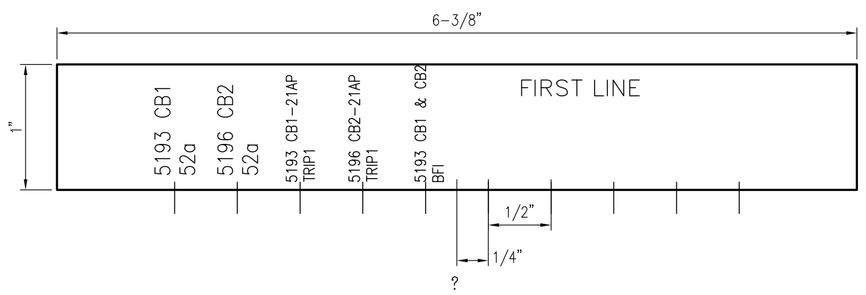
BILL OF MATERIALS

ITEM NO.	QTY	DESCRIPTION	MANUFACTURER	STYLE/TYPE	CATALOG NO.
CLOCK	1	SATELLITE CLOCK WITH ANTENNA	SCHWEITZER	SEL-2407	24070001B
2030	2	COMMUNICATIONS PROCESSOR	SCHWEITZER	SEL-2030	203003X30XH0XX
501	1	RELAY, DUAL OVERCURRENT PROTECTION, 125 VDC, 5 A, 60 HZ, 19" RACK MOUNT	SCHWEITZER	SEL-501	0501003X561BXB
311C	2	RELAY, LINE PROTECTION, 125VDC, 5A, 60Hz, 19" RACK MOUNT	SCHWEITZER	SEL-311C	0311C01H23255X
TS1,TS2,TS3 TS4,TS5,TS6	2	3 FT-1 TEST SWITCHES, EACH 10 POLE, TS1, TS4 (4P,6C), TS2, TS3, TS5, TS6(10P)	ABB	FT-19R	FR3G119001001
TS7,TS8,TS9	1	3 FT-1 TEST SWITCHES, EACH 10 POLE, TS7, TS8 (4P,6C), TS9(10P)	ABB	FT-19R	FR3G119119001
86BF1 86BF2	2	RELAY, LOCKOUT 125 VDC FIVE DECK, MANUAL RESET WITH LIGHTED TARGET NAMEPLATE, 1 AMBER INDICATING TRIP	ELECTROSWITCH	LOR	78PA05D-C02
TS10,TS11 TS12	1	3 FT-1 TEST SWITCHES, ALL 10 POLE, 10 POTENTIAL, TS10, TS11, TS12 (10P)	ABB	FT-19R	FR3G001001001
2516	1	REMOTE I/O MODULE	SCHWEITZER	SEL-2516	

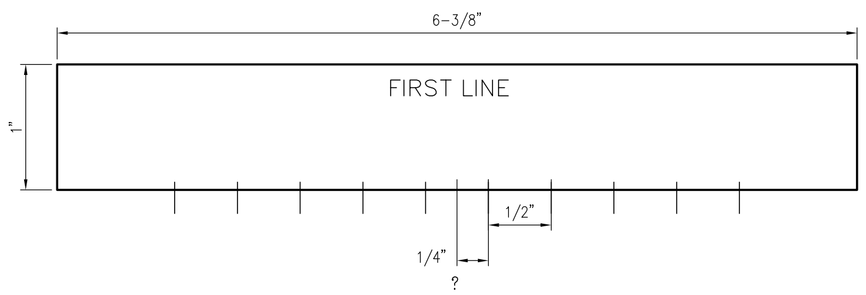
NAME-PLATE NO.	NAMEPLATE SIZE W x L	LETTER SIZE	FIRST LINE	SECOND LINE	THIRD LINE
1	1" x 3"	1/8"	ARBITER 1088B	SATELLITE RECEIVER	
2	1" x 3"	1/8"	SEL-2030-1	COMMUNICATIONS PROCESSOR	
3	1" x 3"	1/8"	SEL-2030-2	COMMUNICATIONS PROCESSOR	
4	1" x 3"	1/8"	SEL-311C-1	21AP	DISTANCE RELAY
5	1" x 6-3/8"	1/8"	21AP REL'G TEST SW TS1	(SEE DETAIL TS1)	
6	1" x 6-3/8"	1/8"	21AP REL'G TEST SW TS2	(SEE DETAIL TS2)	
7	1" x 6-3/8"	1/8"	21AP REL'G TEST SW TS3	(SEE DETAIL TS3)	
8	1" x 3"	1/8"	SEL-311C-2	21BP	DISTANCE RELAY
9	1" x 6-3/8"	1/8"	21BP REL'G TEST SW TS4	(SEE DETAIL TS4)	
10	1" x 6-3/8"	1/8"	21BP REL'G TEST SW TS5	(SEE DETAIL TS5)	
11	1" x 6-3/8"	1/8"	21BP REL'G TEST SW TS6	(SEE DETAIL TS6)	
12	1" x 6-3/8"	1/8"	50BF REL'G TEST SW TS7	(SEE DETAIL TS7)	
13	1" x 6-3/8"	1/8"	50BF REL'G TEST SW TS8	(SEE DETAIL TS8)	
14	1" x 6-3/8"	1/8"	50BF REL'G TEST SW TS9	(SEE DETAIL TS9)	
15	1" x 3"	1/8"	SEL-501	50BF	BREAKER FAIL
16	1" x 3"	1/8"	5193 86BF1-CB1	LOCKOUT RELAY	
17	1" x 3"	1/8"	5196 86BF2-CB2	LOCKOUT RELAY	
18	1" x 6-3/8"	1/8"	86BF1 TEST SW TS10	(SEE DETAIL TS10)	
19	1" x 6-3/8"	1/8"	86BF2 TEST SW TS11	(SEE DETAIL TS11)	
20	1" x 6-3/8"	1/8"	SPARE TEST SW TS12	(SEE DETAIL TS12)	
21	1" x 6-3/8"	1/8"	SEL-2516	REMOTE I/O	



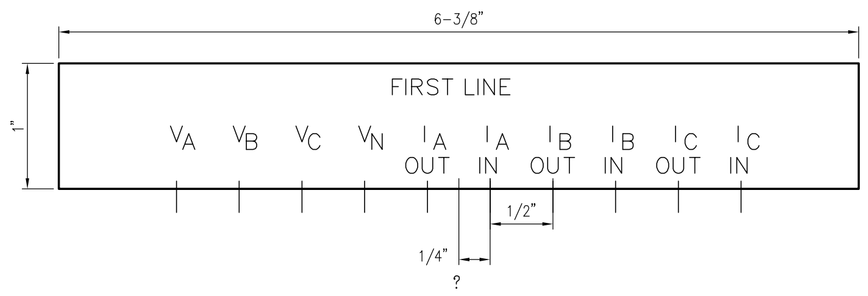
DETAIL TS1



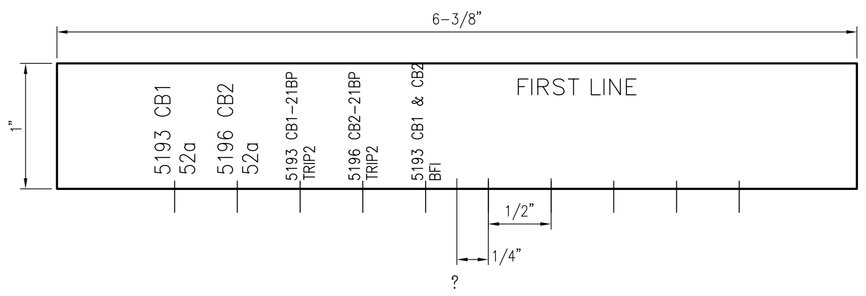
DETAIL TS2



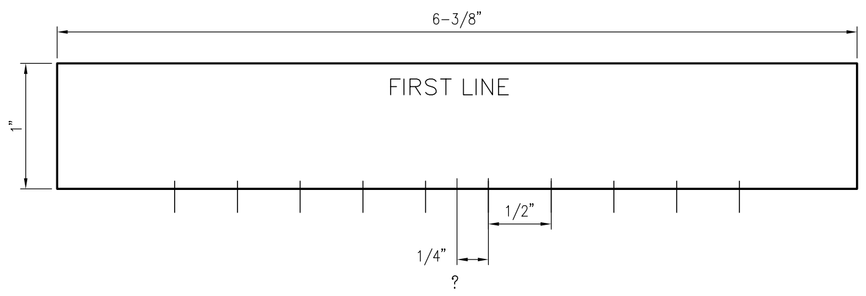
DETAIL TS3



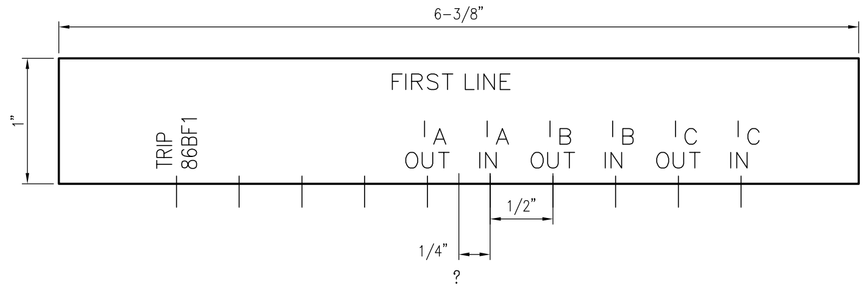
DETAIL TS4



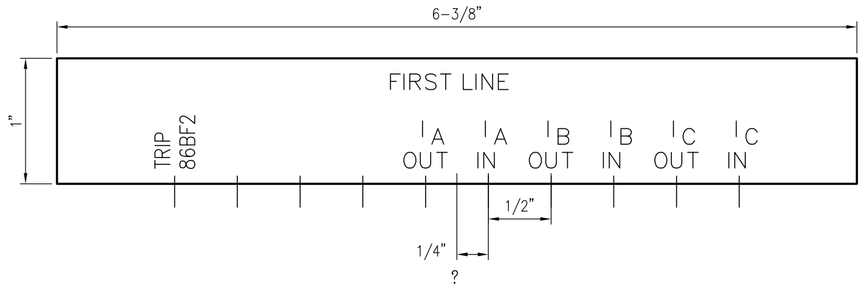
DETAIL TS5



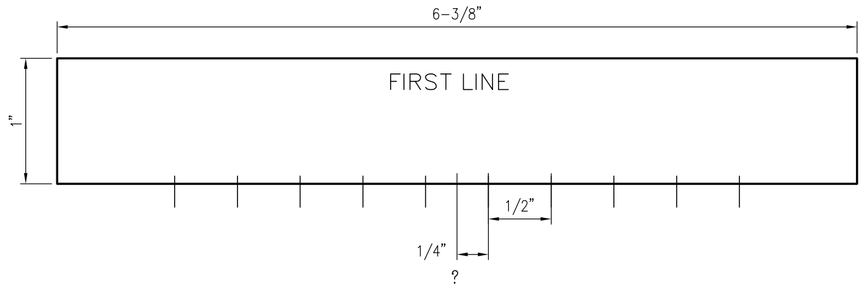
DETAIL TS6



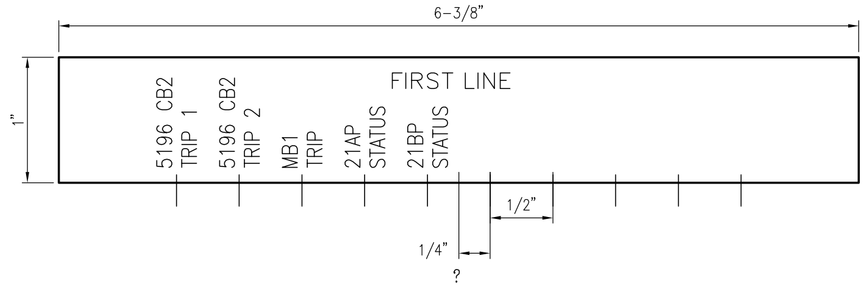
DETAIL TS7



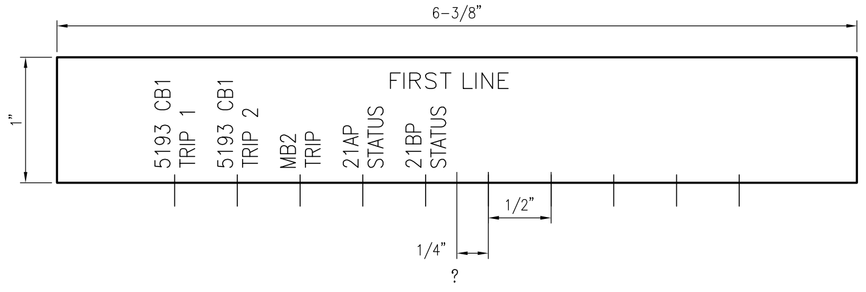
DETAIL TS8



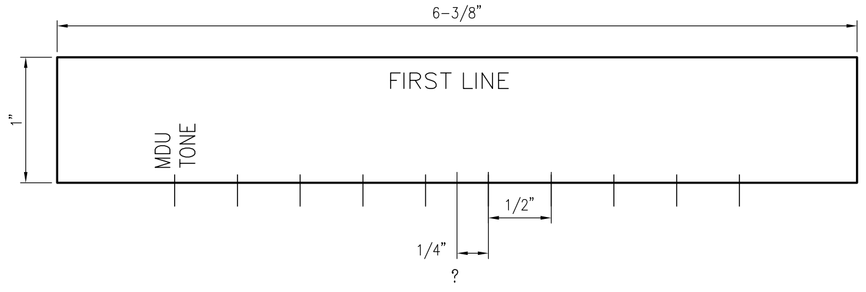
DETAIL TS9



DETAIL TS10

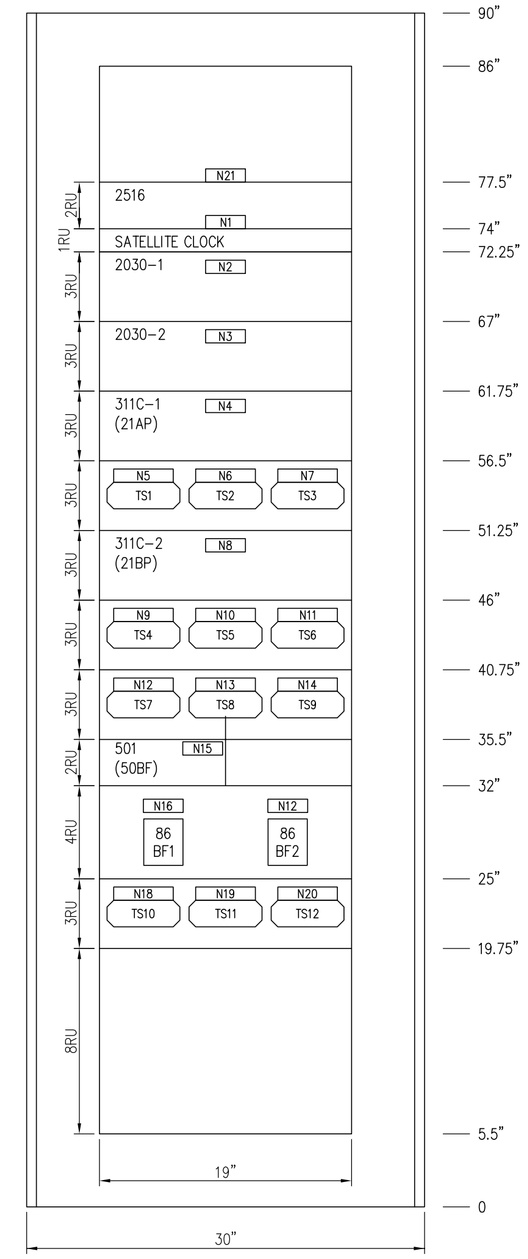


DETAIL TS11



DETAIL TS12

RELAY RACK (2R)



FRONT VIEW

SCALE 0 4 8

ISSUE	DATE	DESCRIPTION
	06-24-08	AS RECORDED DRAWINGS
B	10-31-07	ADD MDU NAMING CONVENTION
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

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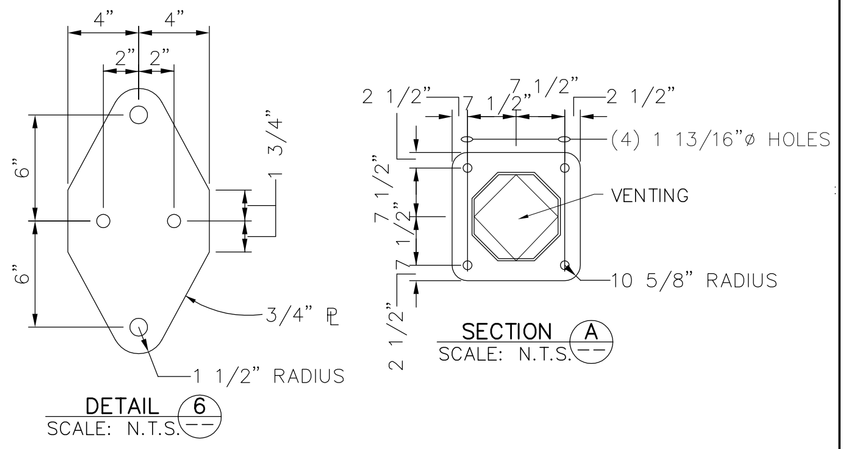
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
RELAY RACK (2R) LAYOUT,
MATERIAL LIST & NAMEPLATE SCHEDULE

0 1" 2"

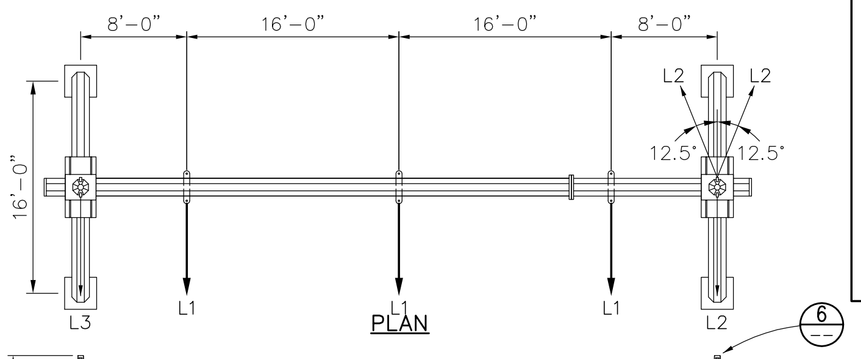
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SCALE	NONE

SHEET **RL-02**

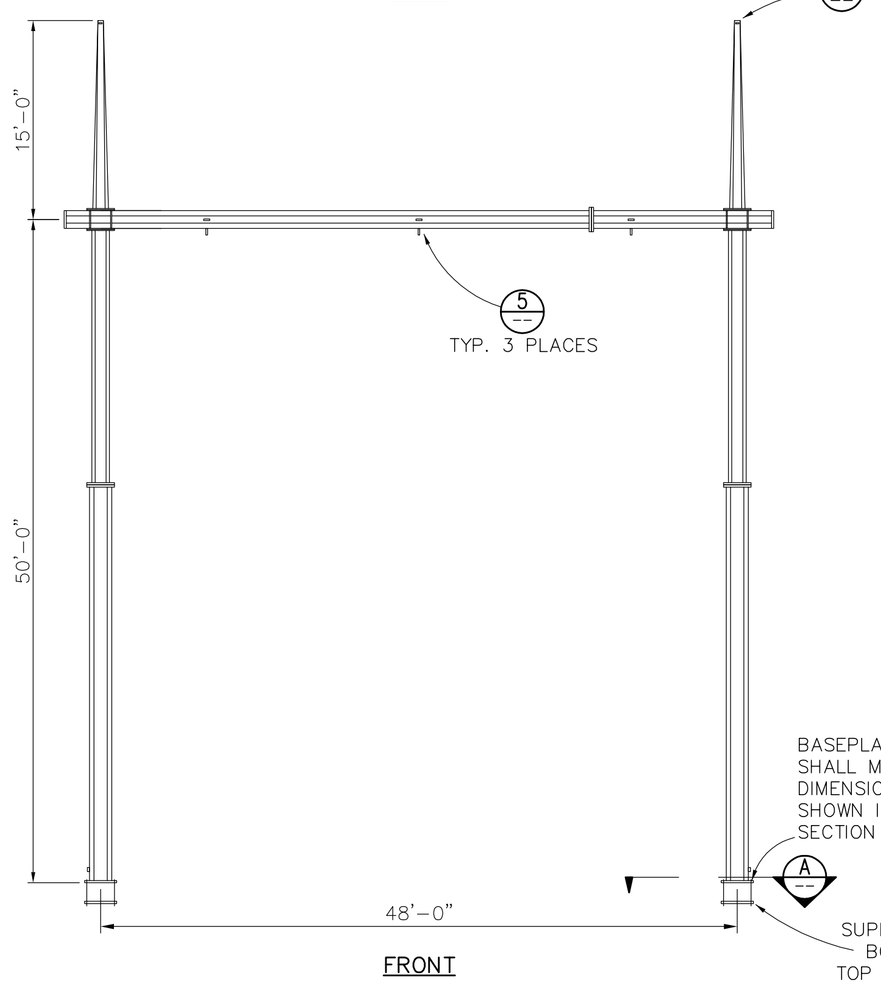


DETAIL 6
SCALE: N.T.S.

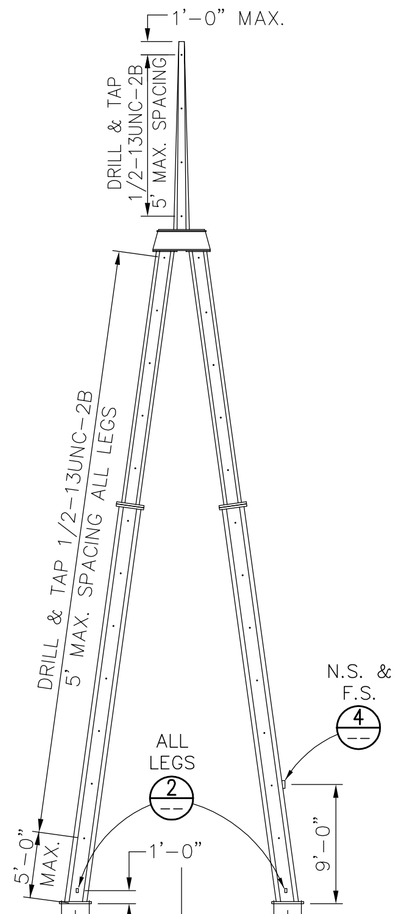
SECTION A
SCALE: N.T.S.



PLAN



FRONT



SIDE

230kV DEADEND TOWER – 230DE (1 REQ'D)

SCALE: 1/8"=1'-0"

STRUCTURE DESIGN CRITERIA

CASE 1 – EXTREME WIND

LONGITUDINAL– ALL WIRES INTACT; UTILIZE HIGH WIND LOADS ON WIRES AND STRUCTURE, OLF=1.1

TRANSVERSE– WIND ON BARE WIRES AND ANGLE COMPONENT, OLF=1.1

VERTICAL – WEIGHT OF BARE WIRES, OLF=1.1

CASE 2 – NESC HEAVY

LONGITUDINAL– ANY OR ALL WIRES DEAD ENDED UTILIZING NESC TENSIONS, OLF=1.65

TRANSVERSE– WIND ON ATTACHED ICE WIRES, OLF=2.5 AND ANGLE COMPONENT OF DEADEND, OLF=1.65

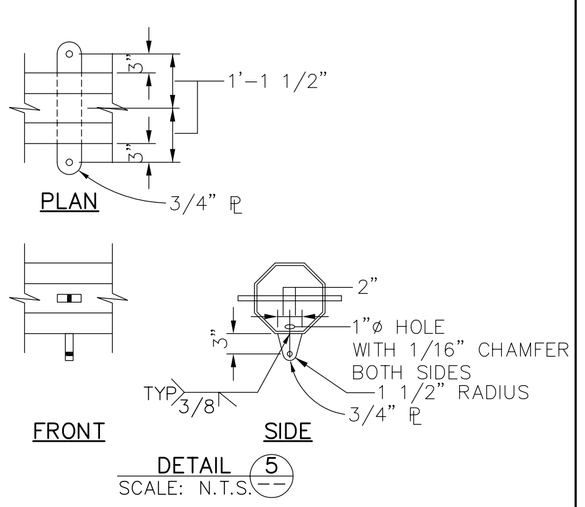
VERTICAL – WEIGHT OF ATTACHED ICED WIRES, OLF=1.5

DEFLECTION LIMITATIONS

1. HORIZONTAL DEFLECTION OF VERTICAL MEMBERS <1/50 VERTICAL HEIGHT (STATIC MAST)
   HORIZONTAL DEFLECTION OF VERTICAL MEMBERS <1/50 VERTICAL HEIGHT (DEADEND STRUCTURES)
2. VERTICAL DEFLECTION OF HORIZONTAL MEMBERS <1/200 OF SPAN
3. HORIZONTAL DEFLECTION OF HORIZONTAL MEMBERS <1/100 OF SPAN

NOTES

1. STRUCTURES SHALL BE DESIGNED FOR THE FOLLOWING DESIGN CONDITIONS:
   A. L1, L3 AND OUTBOUND L2 INTACT WITH (2) L2 @ 12.5° DOWN
   B. (2) L2 @ 12.5° INTACT WITH ALL OTHER CONDUCTORS DOWN
   C. DEFLECTION CRITERIA SHALL APPLY TO CONDITIONS A AND B WITHOUT OVERLOAD FACTORS
2. ANCHOR BOLTS SHALL BE DESIGNED ACCORDING TO AISC AND ACI FOR F'c=4000psi.
3. REFER TO WRITTEN SPECIFICATIONS FOR DESIGN AND MATERIAL REQUIREMENTS.

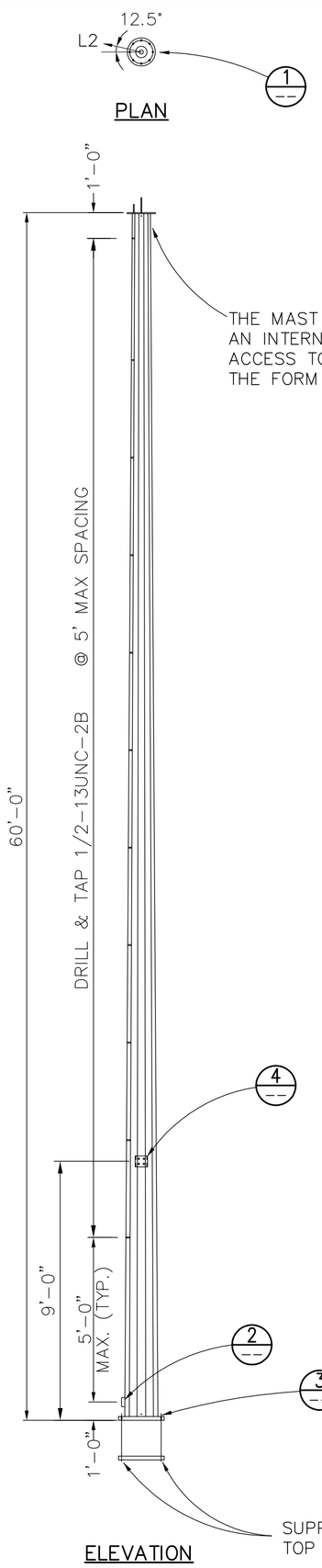


FRONT SIDE

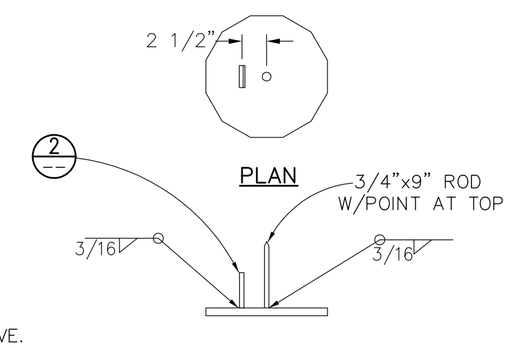
DETAIL 5
SCALE: N.T.S.

NOTES

1. THE DEADEND TOWER SHALL BE 8 SIDED (MINIMUM) GALVANIZED STEEL TUBE.

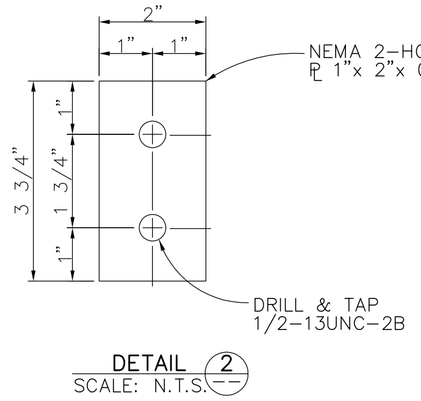


ELEVATION

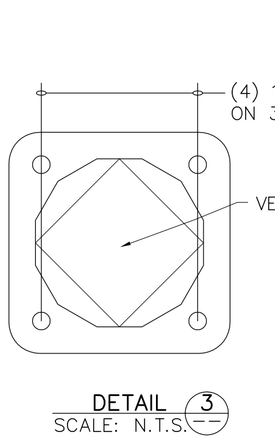


FRONT

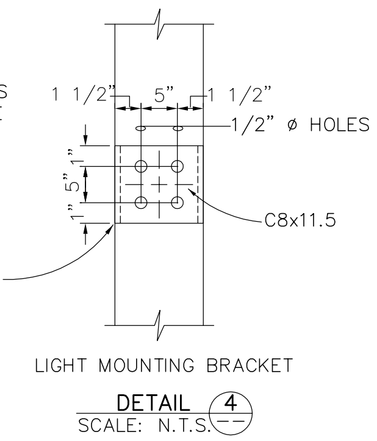
DETAIL 1
SCALE: N.T.S.



DETAIL 2
SCALE: N.T.S.



DETAIL 3
SCALE: N.T.S.



LIGHT MOUNTING BRACKET

DETAIL 4
SCALE: N.T.S.

STATIC MAST – STATIC (2 REQ'D)

SCALE: N.T.S.

NOTES

1. THE STATIC MAST SHALL BE 12 SIDED (MINIMUM) GALVANIZED STEEL TUBE.

LOAD	DESCRIPTION	NESC HEAVY (W/O OLF) 1/2" ICE, 4lb. WIND, 0° F	HIGH WIND (W/O OLF) NO ICE, 90 MPH WIND, 60° F
L1	1272 KCMIL 45/7 ACSR, BITTERN,	4000 lb	3383 lb
	400' MAX. SPAN, 15° MAX. LINE ANGLE		
L2	3/8 DIA. 7 STRAND EHS, 400' MAX. SPAN,	2000 lb	1131 lb
	15° MAX. LINE ANGLE		
L3	OPGW		

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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
1	06-21-07	REVISED BASE PLATE DETAILS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

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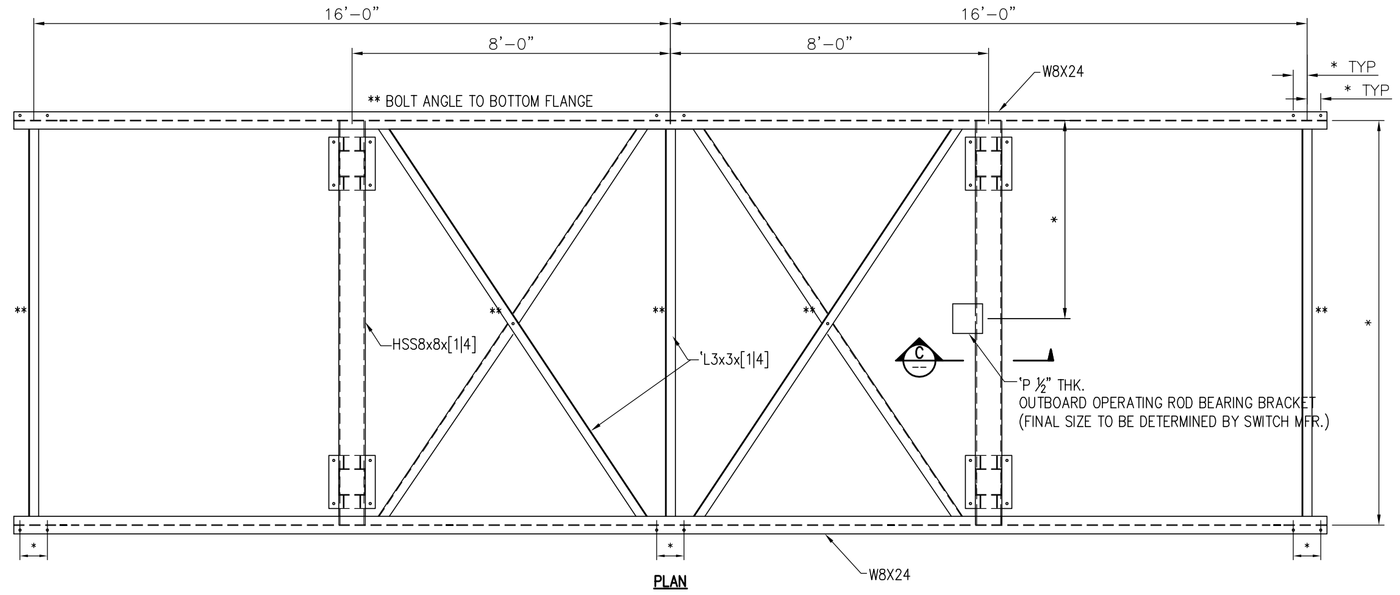
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
STRUCTURAL STEEL - DEADEND TOWER

0 1" 2"

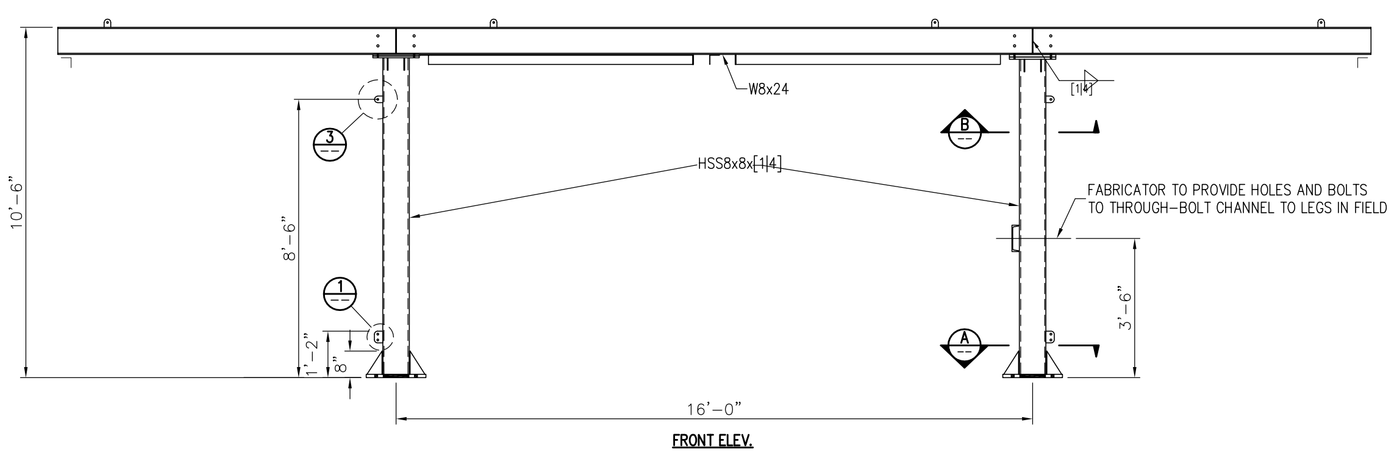
FILENAME	TWESD-SM-01
SCALE	1/8" = 1'-0"

SHEET **SM-01**

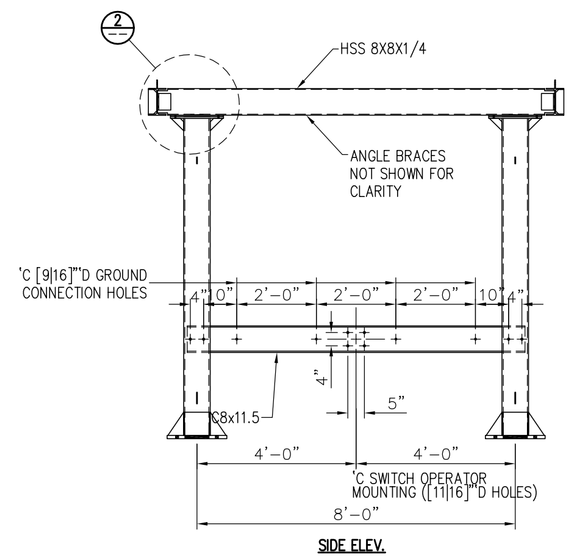


PLAN

HOLD FOR SWITCH MANUFACTURER'S DRAWINGS



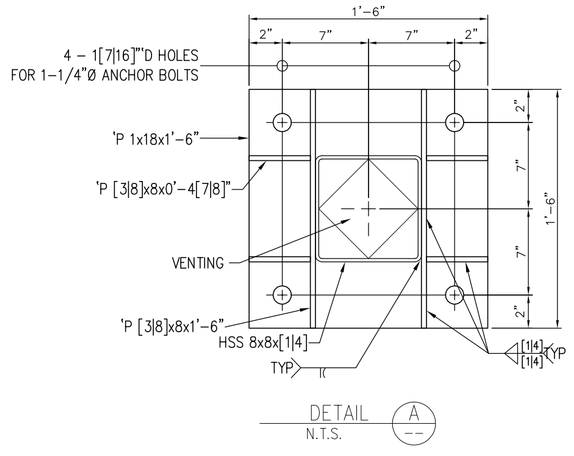
FRONT ELEV.



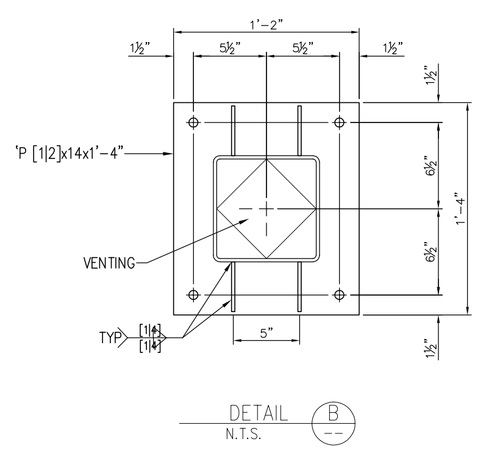
SIDE ELEV.

230kV 3Ø SWITCH STAND – 230SS1 (4 REQ'D)

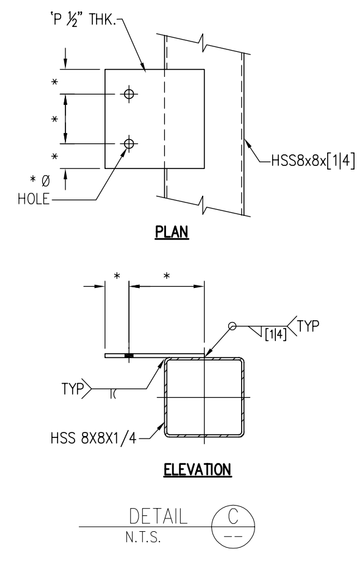
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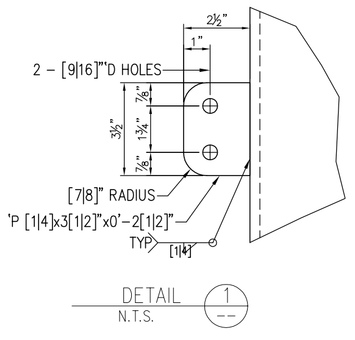
DETAIL A
N.T.S.



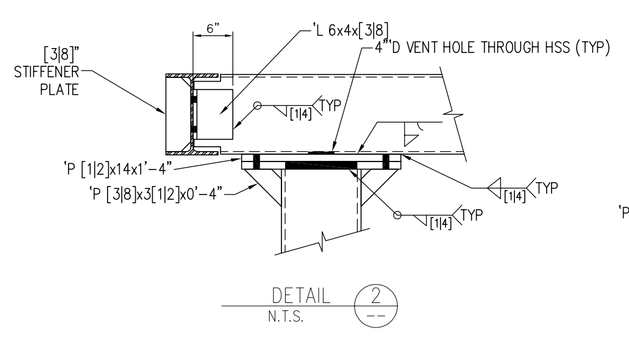
DETAIL B
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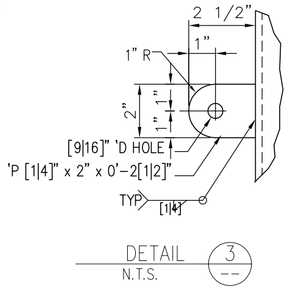
DETAIL C
N.T.S.



DETAIL 1
N.T.S.



DETAIL 2
N.T.S.



DETAIL 3
N.T.S.

NOTES:

1. ALL HOLES [3|4]"D UNLESS NOTED.
2. ALL MEMBERS TO BE HOT DIPPED GALVANIZED.
3. PLATES, BARS, AND MISC SHAPES SHALL CONFORM TO ASTM A36 AMENDED TO DATE. WIDE FLANGE SHALL BE ASTM A992 AMENDED TO DATE. HSS SECTIONS SHALL BE ASTM A500 GR.B MINIMUM YIELD STRENGTH 46.0 KSI.

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HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

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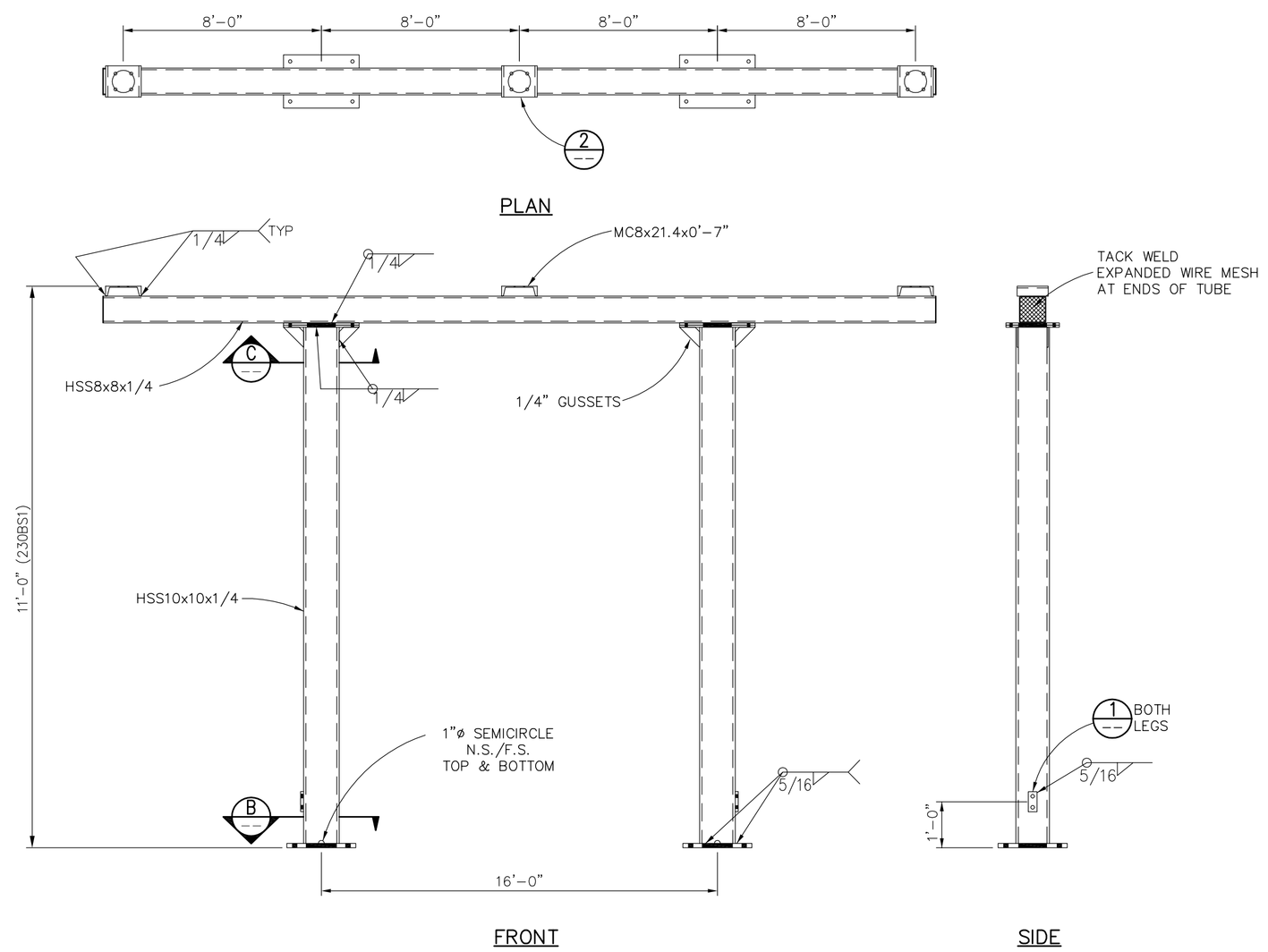
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION STRUCTURAL STEEL - SWITCH STAND

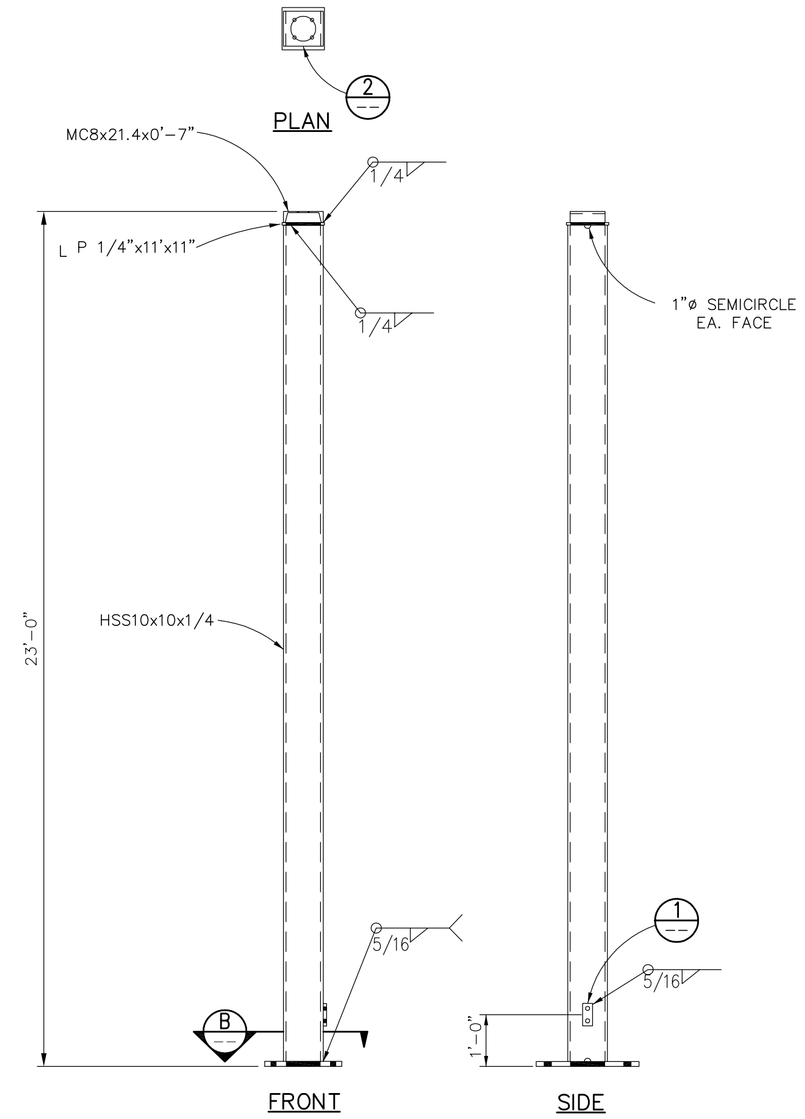
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SCALE	NONE

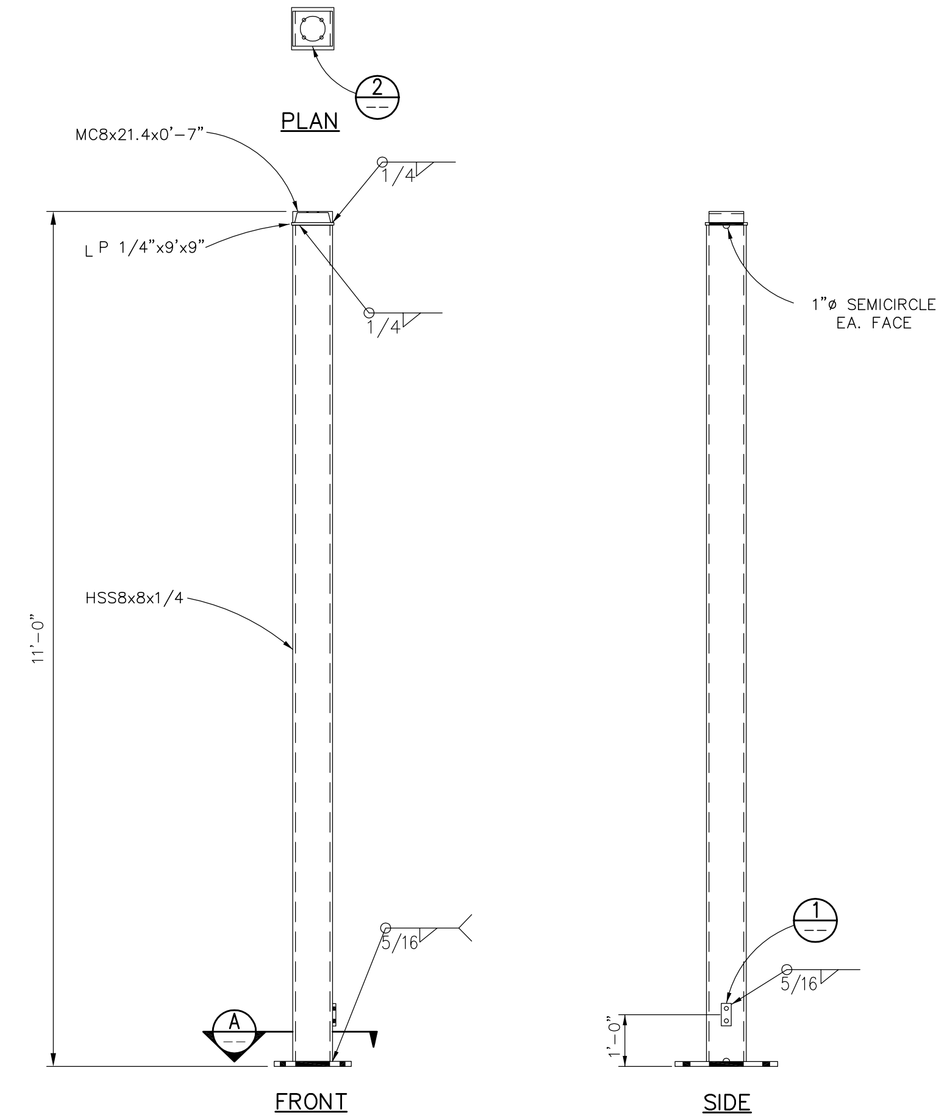
SHEET SS-01



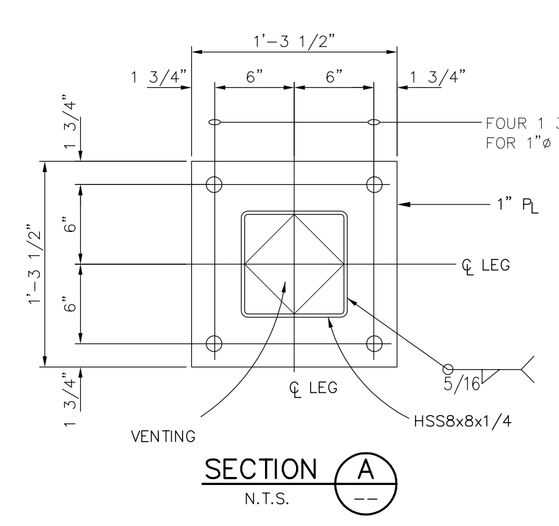
230kV BUS SUPPORT – 230BS1 (5 REQ'D)
N.T.S.



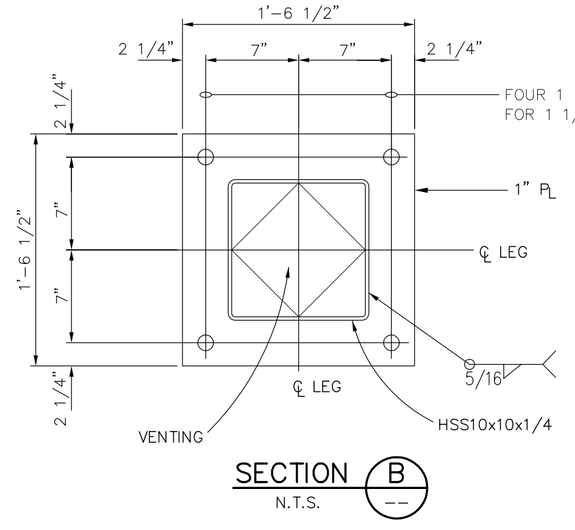
230kV BUS SUPPORT PEDESTAL – 230BS2 (3 REQ'D)
N.T.S.



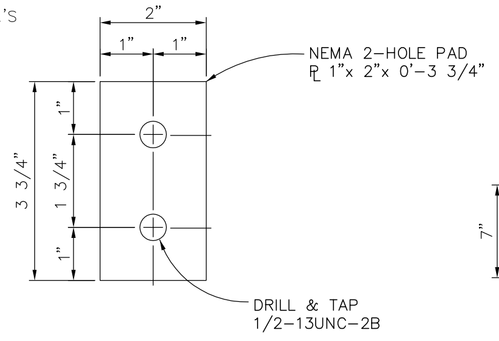
230kV BUS SUPPORT PEDESTAL – 230BS3 (6 REQ'D)
N.T.S.



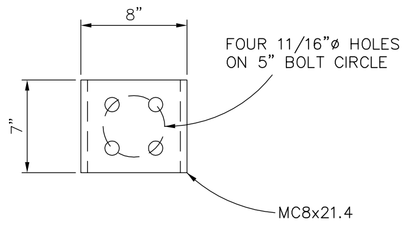
SECTION A
N.T.S.



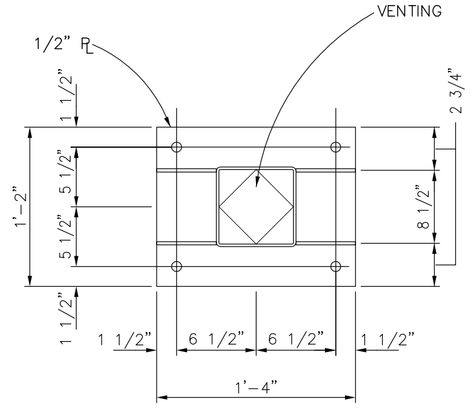
SECTION B
N.T.S.



DETAIL 1
N.T.S.



DETAIL 2
N.T.S.



SECTION C
N.T.S.

NOTES:

1. ALL STRUCTURE MOUNTING HOLES ARE 3/4" DIA. FOR A325 5/8" DIA. BOLTS UNLESS OTHERWISE NOTED.
2. ALL MEMBERS TO BE HOT DIPPED GALVANIZED.
3. PLATES, BARS, AND MISC SHAPES SHALL CONFORM TO ASTM A36 AMENDED TO DATE. WIDE FLANGE SHALL BE ASTM A992 AMENDED TO DATE. HSS SECTIONS SHALL BE ASTM A500 GR.B MINIMUM YIELD STRENGTH 46.0 KSI.

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HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

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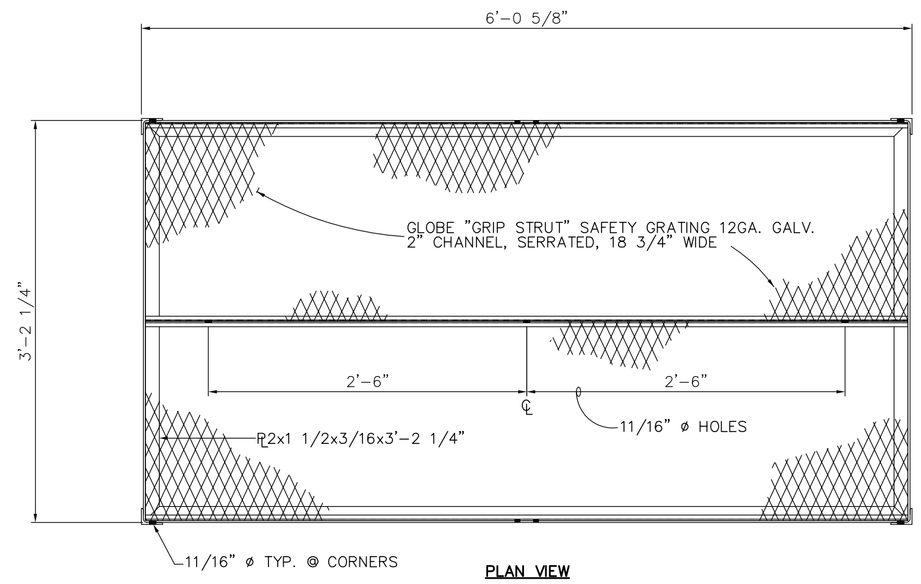
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
STRUCTURAL STEEL - BUS SUPPORTS

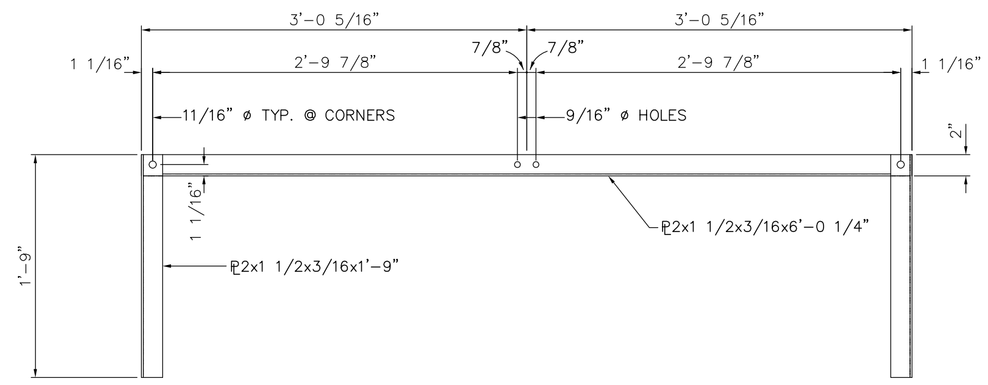
0 1" 2"

FILENAME	TWESD-SS-02
SCALE	NONE

SHEET
SS-02



PLAN VIEW



ELEVATION

GROUND PLATFORM – GP-1 (4 REQ'D)
N.T.S.

NOTES:

1. ALL MEMBERS TO BE HOT DIPPED GALVANIZED.
2. PLATES, BARS, AND MISC SHAPES SHALL CONFORM TO ASTM A36 AMENDED TO DATE. WIDE FLANGE SHALL BE ASTM A992 AMENDED TO DATE. HSS SECTIONS SHALL BE ASTM A500 GR.B MINIMUM YIELD STRENGTH 46.0 KSI.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

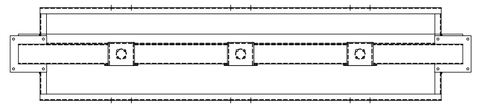
230/34.5kV PROJECT SUBSTATION
STRUCTURAL STEEL - MISC. STEEL

0 1" 2"

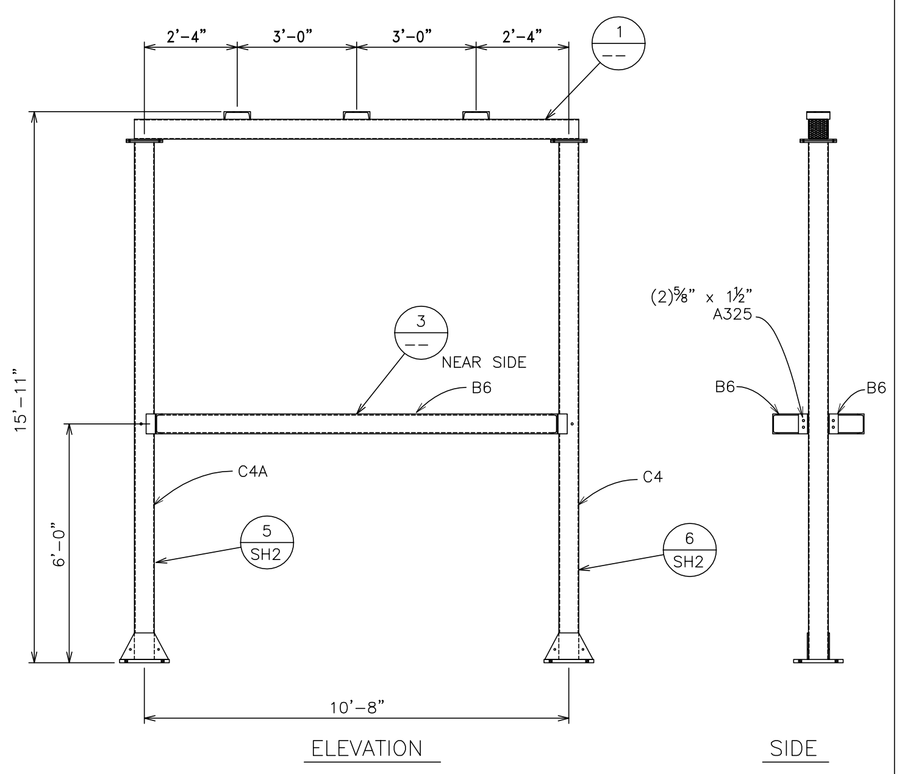
FILENAME	TWESD-SS-03
SCALE	NONE

SHEET
SS-03

BUS HEIGHT:
35TERM = 15'-9"



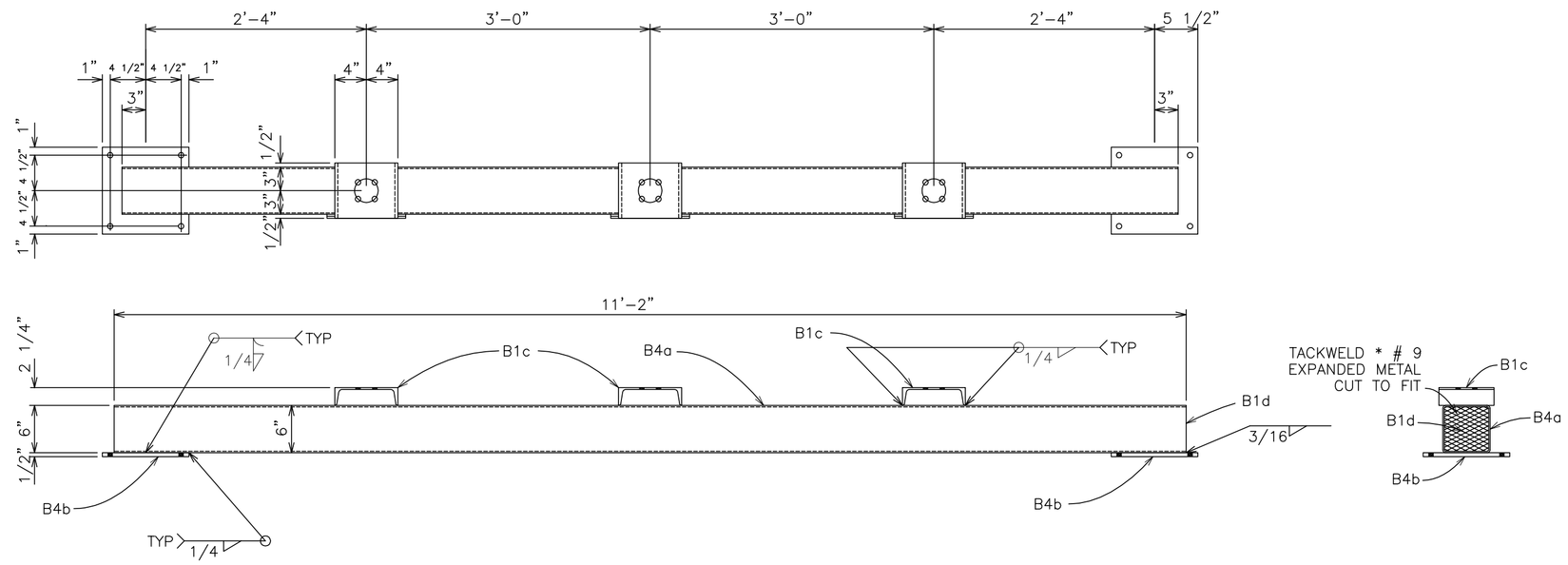
PLAN



ELEVATION SIDE

35kV TERMINATION STAND – 35TERM (2 REQ'D)

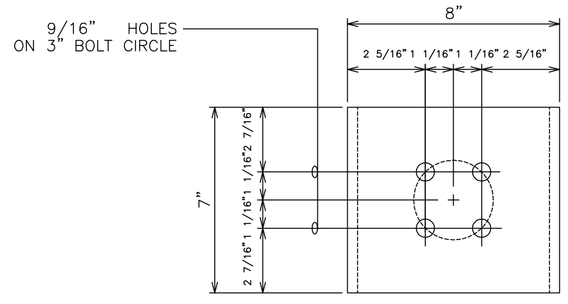
SCALE: 3/8" = 1'-0"



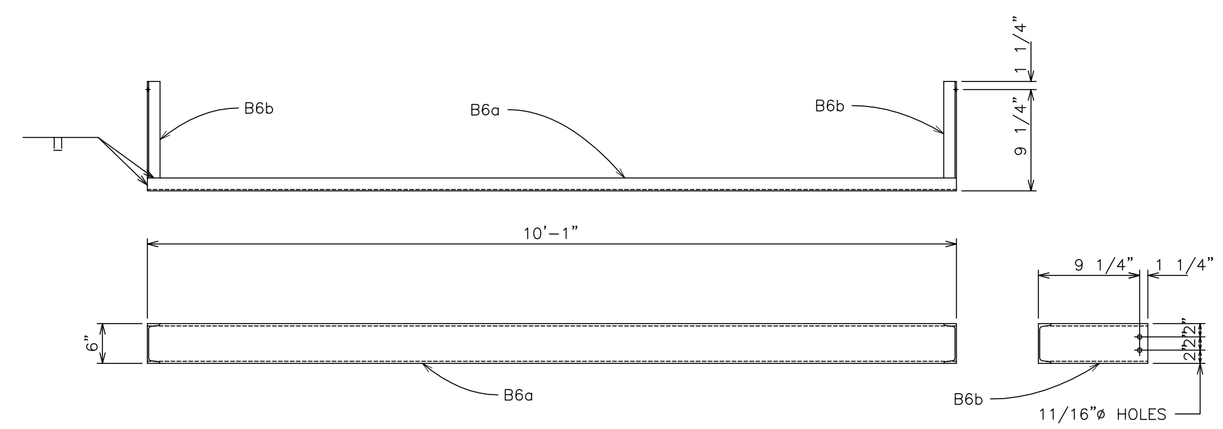
MAKE ONE BEAM AS SHOWN – MK B4

DETAIL – BEAM (1)

NTS



PC B1c



MAKE TWO BEAMS AS SHOWN – MK B6

DETAIL – BEAM (3)

NTS

MATERIAL LIST (1) 35TERM

MARK	QTY	DESCRIPTION	LENGTH FT	LENGTH IN	WT	REMARKS
B4	1	WELDMENT	11	7		GALV
B4a	1	HSS 6 x 6 x 3/16	11	2	162.3	WELD
B4b	2	PL 1/2 x 0'-11"	0	11	34.3	WELD
B1c	3	C8 x 11.5	0	7	20.1	WELD
B1d	2	EXP. METAL 0'-6"	0	6	0.9	WELD
		TOTAL WT. (1) B4			217.6	
B6	2	WELDMENT	10	1		GALV
B6a	2	C6 x 8.2	10	1	165.4	WELD
B6b	4	C6 x 8.2	0	10 1/2	28.8	WELD
		TOTAL WT. (2) B6			194.2	WELD
C4	1	WELDMENT	13	1*		GALV
C4a	1	HSS 6 x 6 x 3/16	12	11*	188.7	WELD
C4b	1	L 3 x 3 x 1/4	0	6	2.5	WELD
B4b	2	PL 1/2" x 0'-11"	0	11	34.3	WELD
C1b	1	PL 1" x 1'-5 1/2"	1	3*	68.1	WELD
C1c	2	PL 3/8" x 0'-8"	1	3	25.5	WELD
C1e	1	C8 x 11.5	0	6	5.8	WELD
		TOTAL WT. (1) C4			324.9	
C4A	1	WELDMENT	13	1 3/8		GALV.
C4a	1	HSS 6 x 6 x 3/16	12	11 7/8	188.7	WELD
C4b	1	L 3 x 3 x 1/4	0	6	2.5	WELD
B4b	2	PL 1/2" x 0'-11"	0	11	34.3	WELD
C1b	1	PL 1" x 1'-5 1/2"	1	5 1/2	68.1	WELD
C1c	2	PL 3/8" x 0'-8"	1	3	25.5	WELD
		TOTAL WT. (1) C4A			320.7	

STRUCTURE BOLT LIST (1) 15TERM

DESCRIPTION	TYPE	QTY	REMARKS
5/8" x 2" H. HEX BOLT	A325	9	GALV. STEEL
5/8" x 1 1/2" H. HEX BOLT	A325	11	GALV. STEEL
5/8" H. HEX NUT	A563	20	GALV. STEEL
5/8" L/W	HARDENED	20	GALV. STEEL
TOTAL WT (1) 35TERM	5.0		

EQUIPMENT BOLT LIST (1) 15TERM

DESCRIPTION	TYPE	QTY	REMARKS
1/2" x 1" HEX BOLT	A307	13	GALV. STEEL FOR INS
TOTAL WT (1) 35TERM	2.5		

TOTAL WT (1) 35TERM ____ 1047.2
MAKE (2) TIMES
TOTAL BLACK WEIGHT ____ 2094.4
(2) 35TERM

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

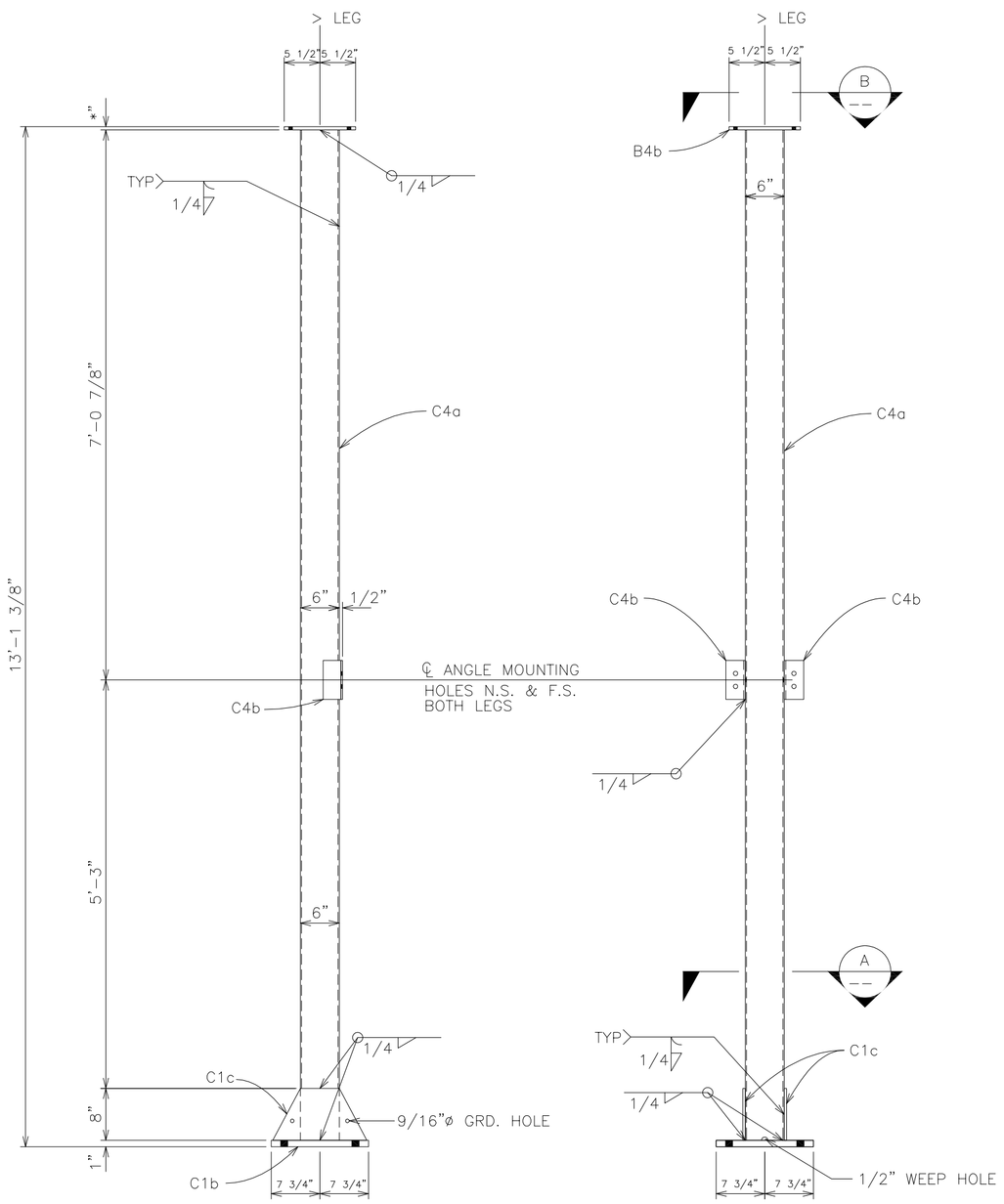
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
STRUCTURAL STEEL - TERMINATION STAND
SHEET 1 OF 2

0 1" 2"

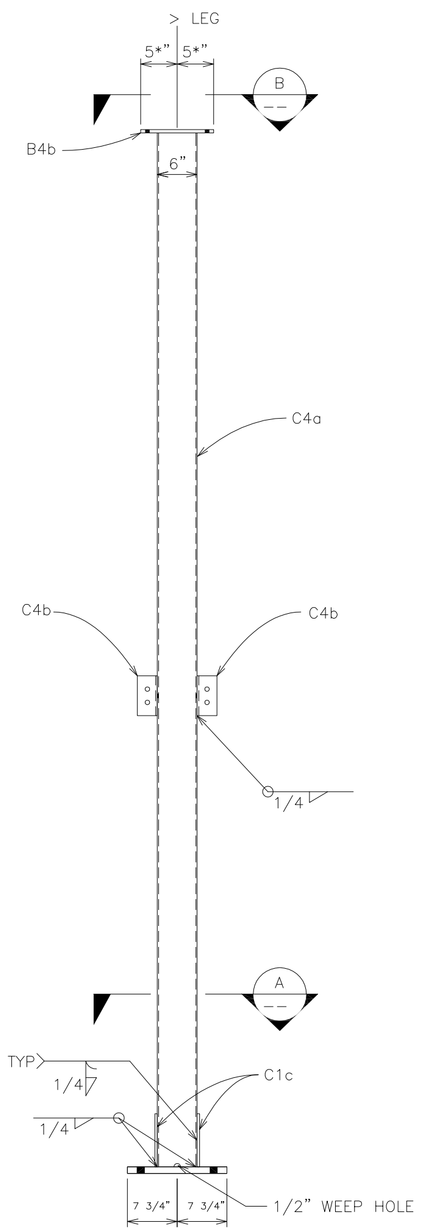
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SCALE	NONE

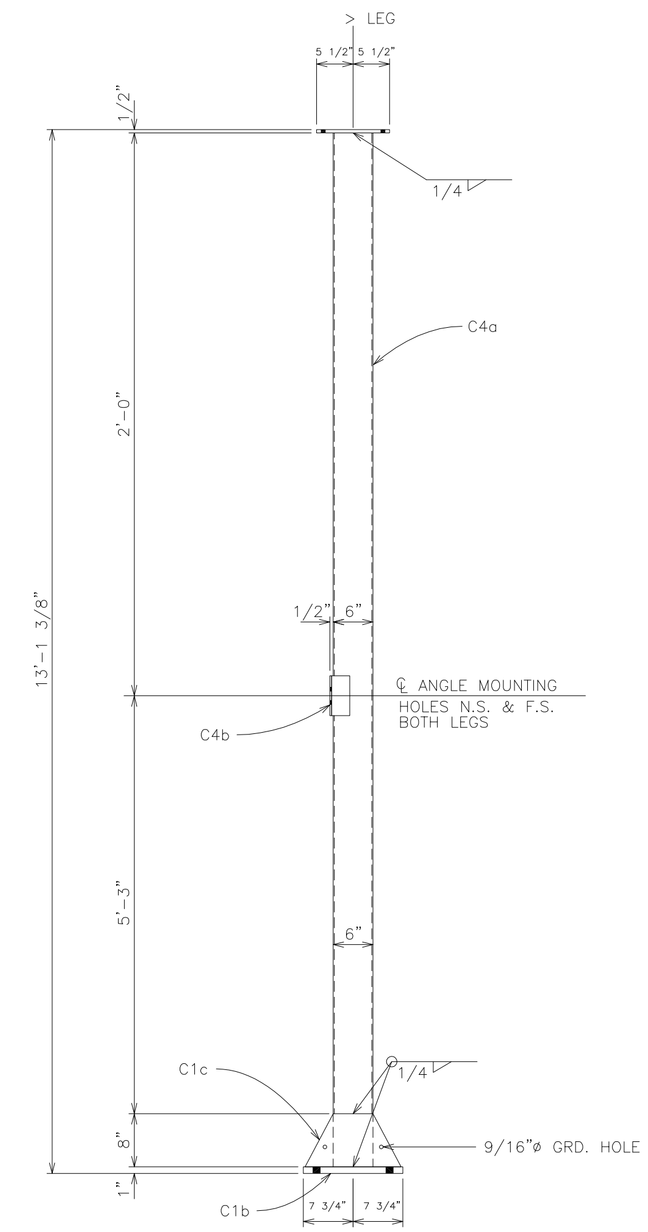
SHEET
SS-04



MAKE ONE LEG AS SHOWN – MK C4A

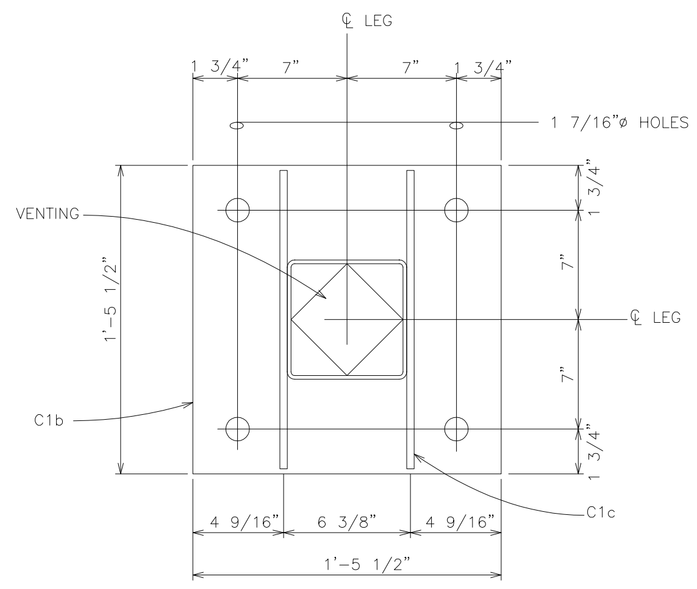
DETAIL – LEG (5) NTS



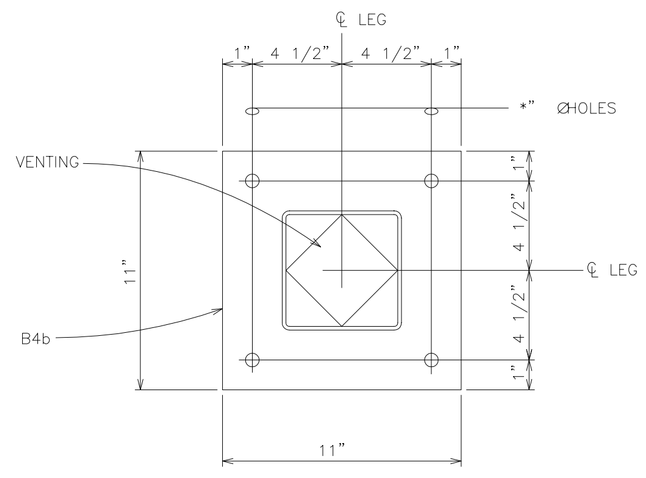


MAKE ONE LEG AS SHOWN – MK C4

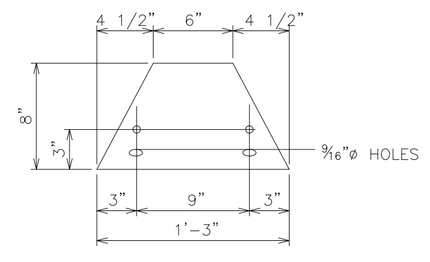
DETAIL – LEG (6) NTS



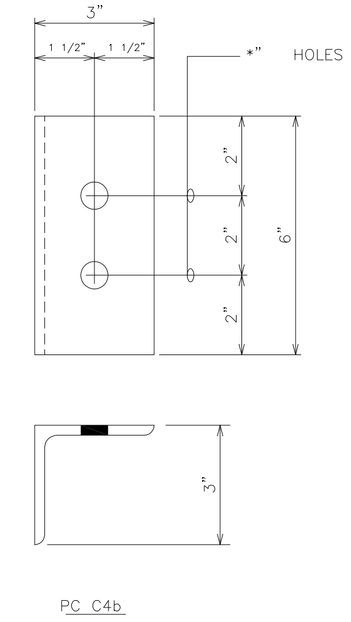
SECTION (A) NTS



SECTION (B) NTS



PC C1c



PC C4b

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

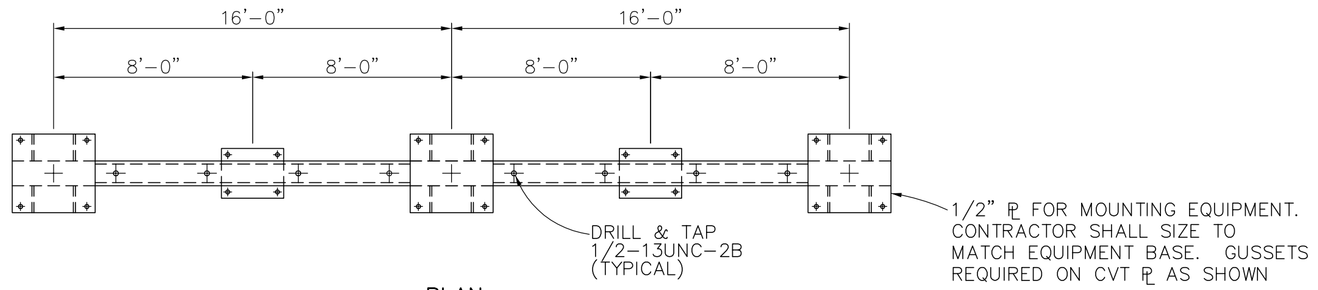
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
STRUCTURAL STEEL - TERMINATION STAND
SHEET 2 OF 2

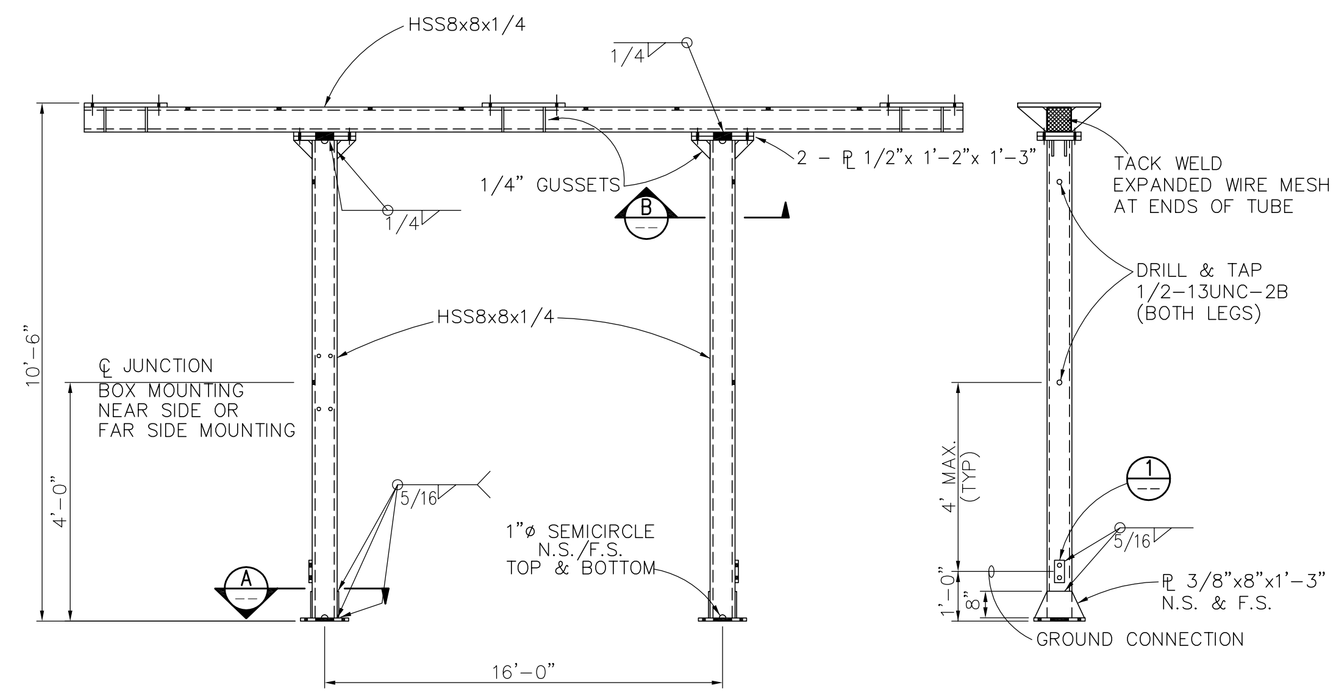
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FILENAME	TWESD-SS-05
SCALE	NONE

SHEET SS-05



PLAN

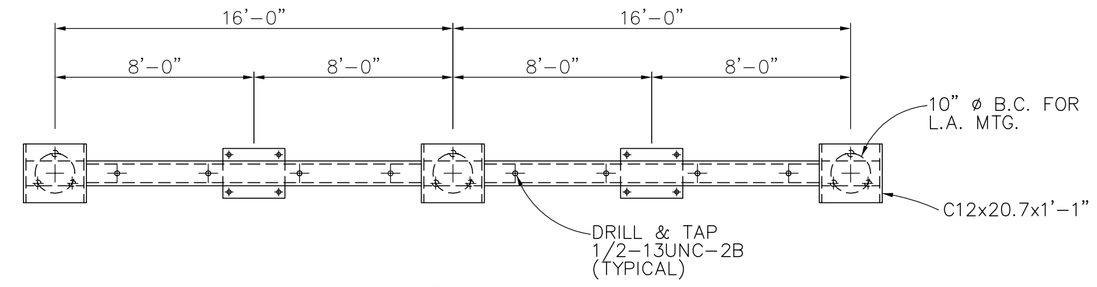


FRONT

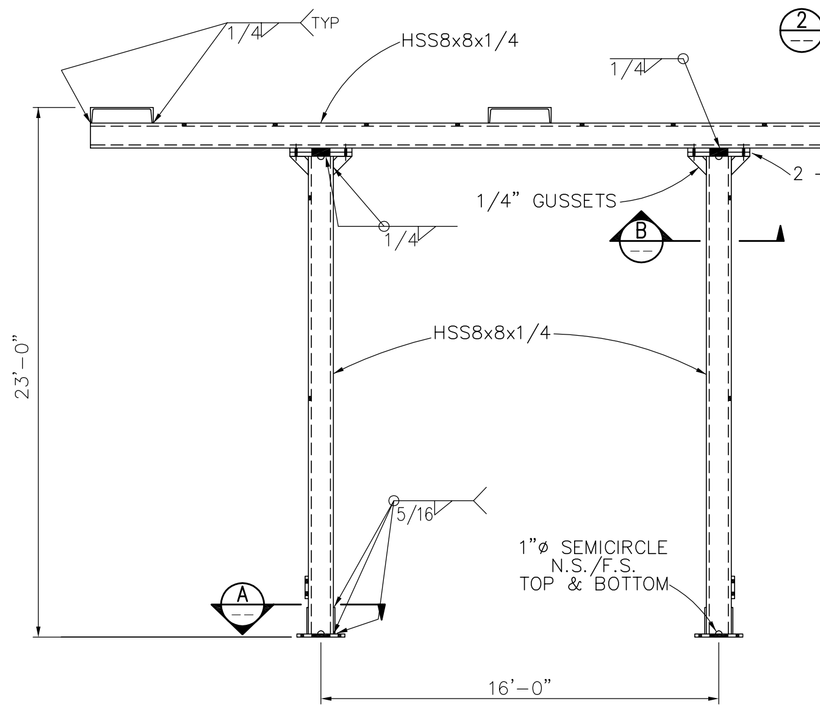
SIDE

230kV CVT/CT STAND – 230CVT (1 REQ'D)

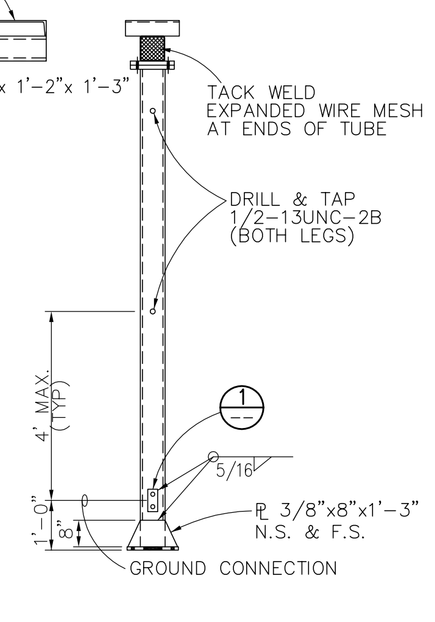
N.T.S.



PLAN



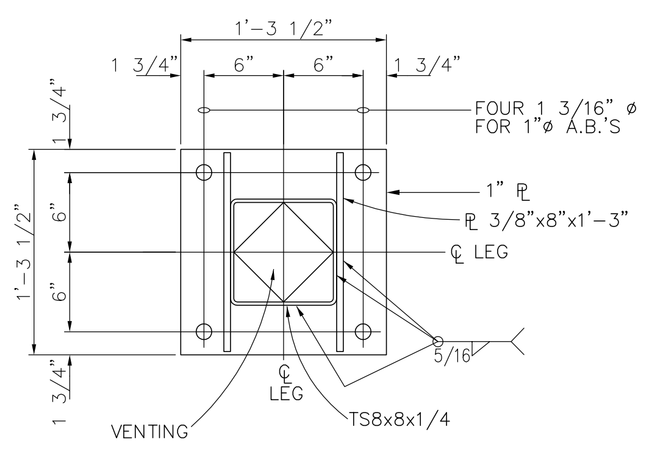
FRONT



SIDE

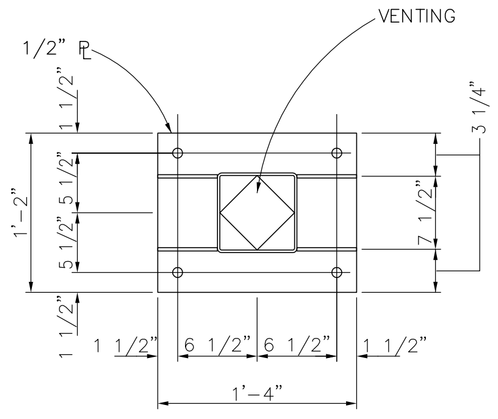
230kV LIGHTNING ARRESTER STAND – 230LA (1 REQ'D)

N.T.S.



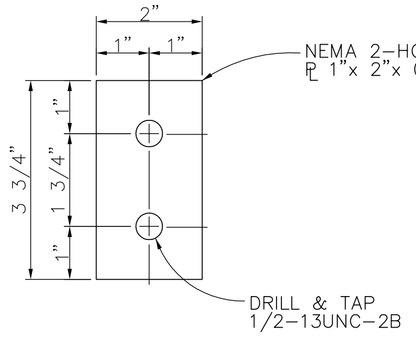
SECTION A

N.T.S.



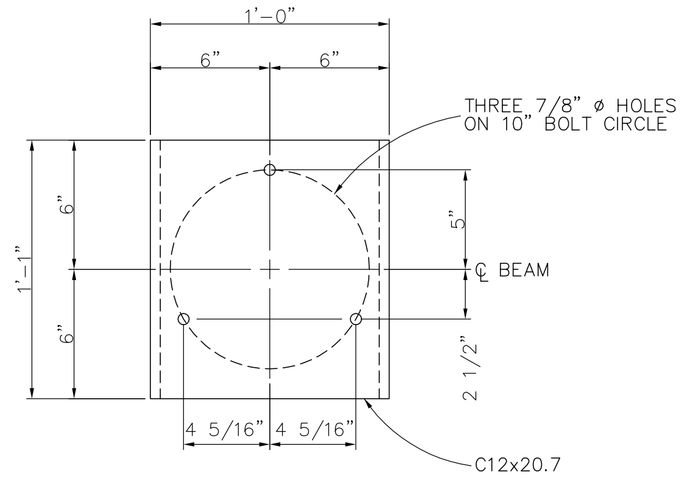
SECTION B

N.T.S.



DETAIL 1

N.T.S.



DETAIL 2

N.T.S.

NOTES:

1. ALL STRUCTURE MOUNTING HOLES ARE 3/4" DIA. FOR A325 5/8" DIA. BOLTS UNLESS OTHERWISE NOTED.
2. ALL MEMBERS TO BE HOT DIPPED GALVANIZED.
3. PLATES, BARS, AND MISC SHAPES SHALL CONFORM TO ASTM A36 AMENDED TO DATE. WIDE FLANGE SHALL BE ASTM A992 AMENDED TO DATE. HSS SECTIONS SHALL BE ASTM A500 GR.B MINIMUM YIELD STRENGTH 46.0 KSI.

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	
PROJECT NUMBER	48049

acciona

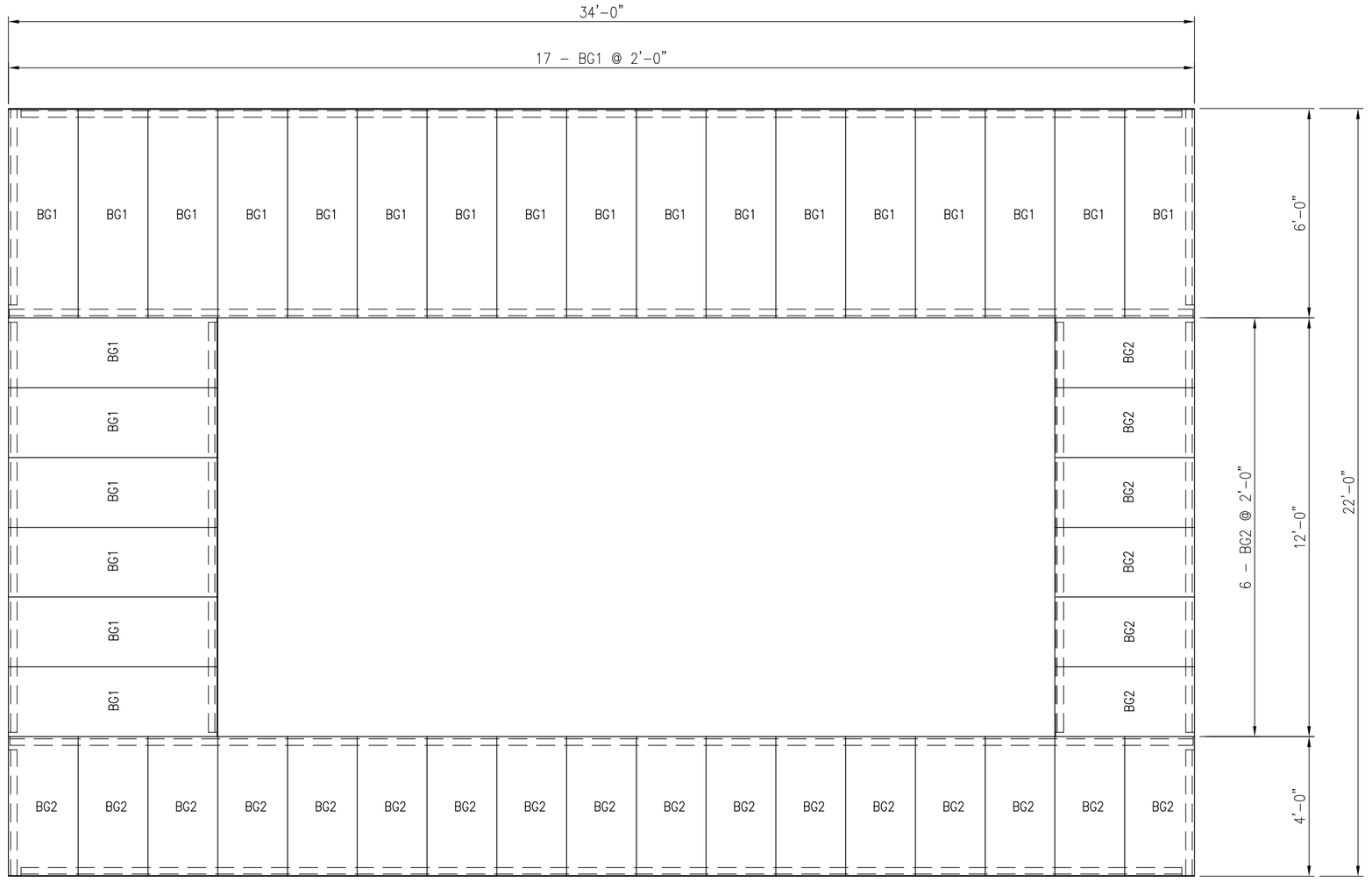
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
STRUCTURAL STEEL - EQUIPMENT SUPPORTS

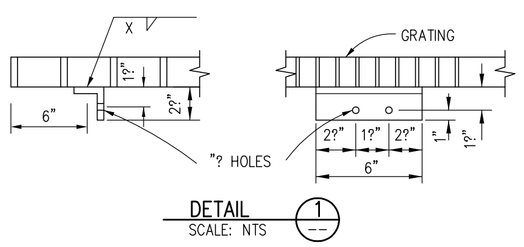
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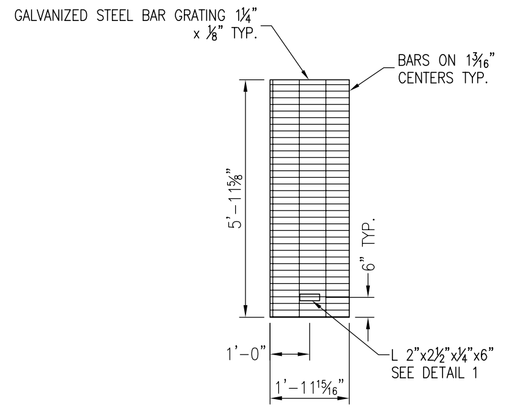
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SCALE	NONE

SHEET SS-06

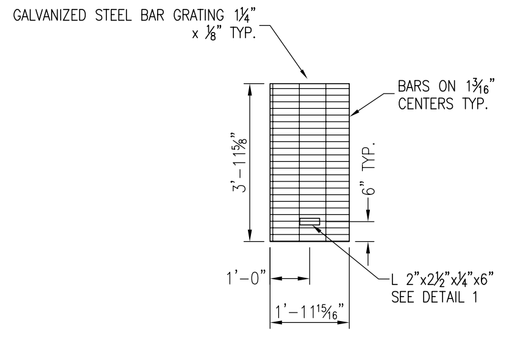


PLAN





BAR GRATING – MARK BG1 (23 REQ'D)



BAR GRATING – MARK BG2 (23 REQ'D)

GENERAL NOTES

1. REFER TO FOUNDATION DETAIL FD-03 FOR TOP OF CONCRETE ELEVATION.
2. GRATING SUPPLIER SHALL VERIFY SPAN DIRECTION OF STEEL GRATING PANELS PRIOR TO FABRICATION.

REFERENCE DRAWINGS

FOUNDATION PLAN FD-01
FOUNDATION TF DETAILS FD-03

MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
1	06-21-07	REVISED TRANSFORMER GRATING
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

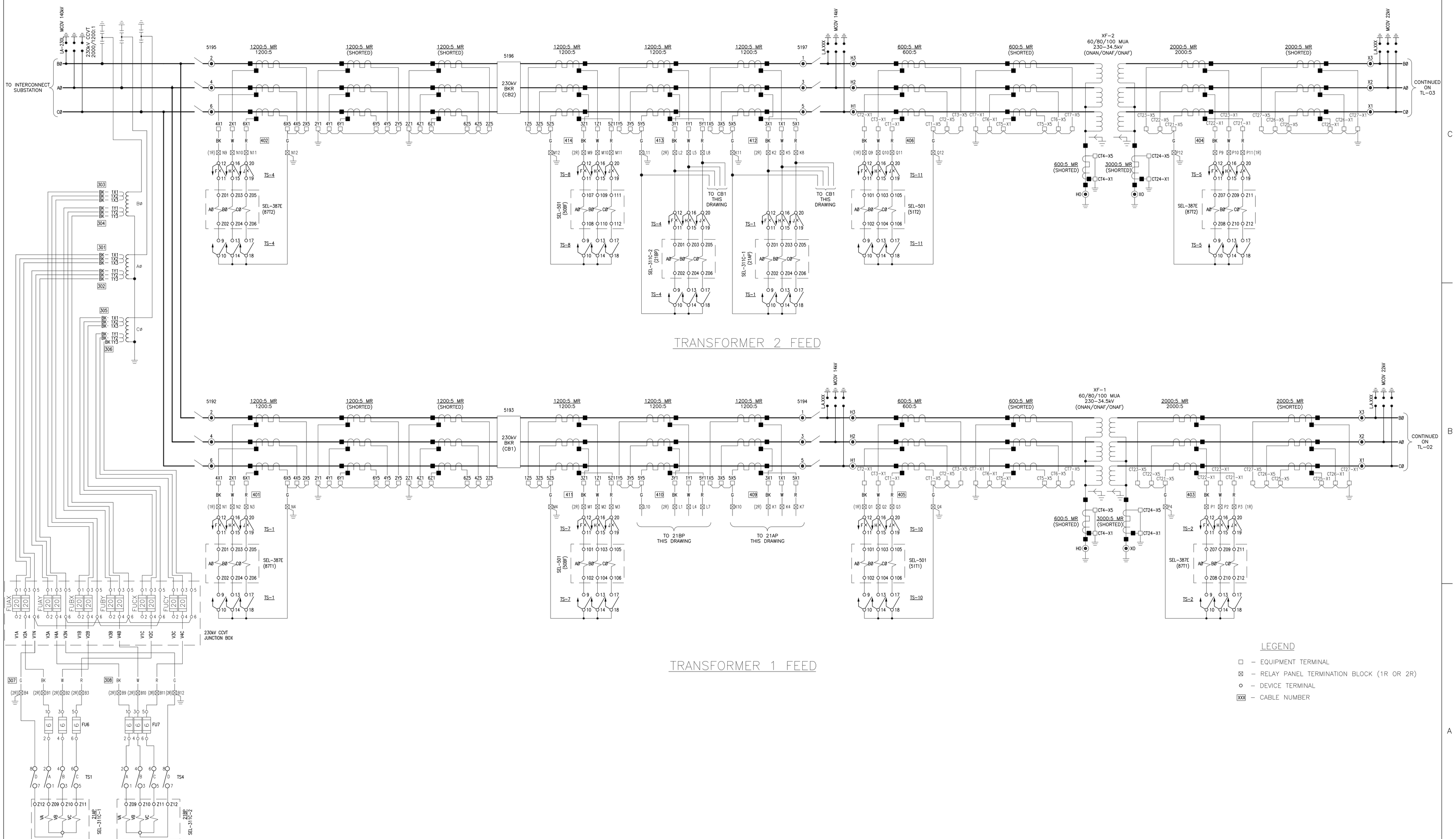
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
STRUCTURAL STEEL - TRANSFORMER GRATING

0 1" 2"

FILENAME	TWESD-SS-07
SCALE	NONE

SHEET
SS-07



MORTENSON

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
B	10-31-07	ADD MDU NAMING CONVENTION
A	10-25-07	PER VENDOR DRAWINGS
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

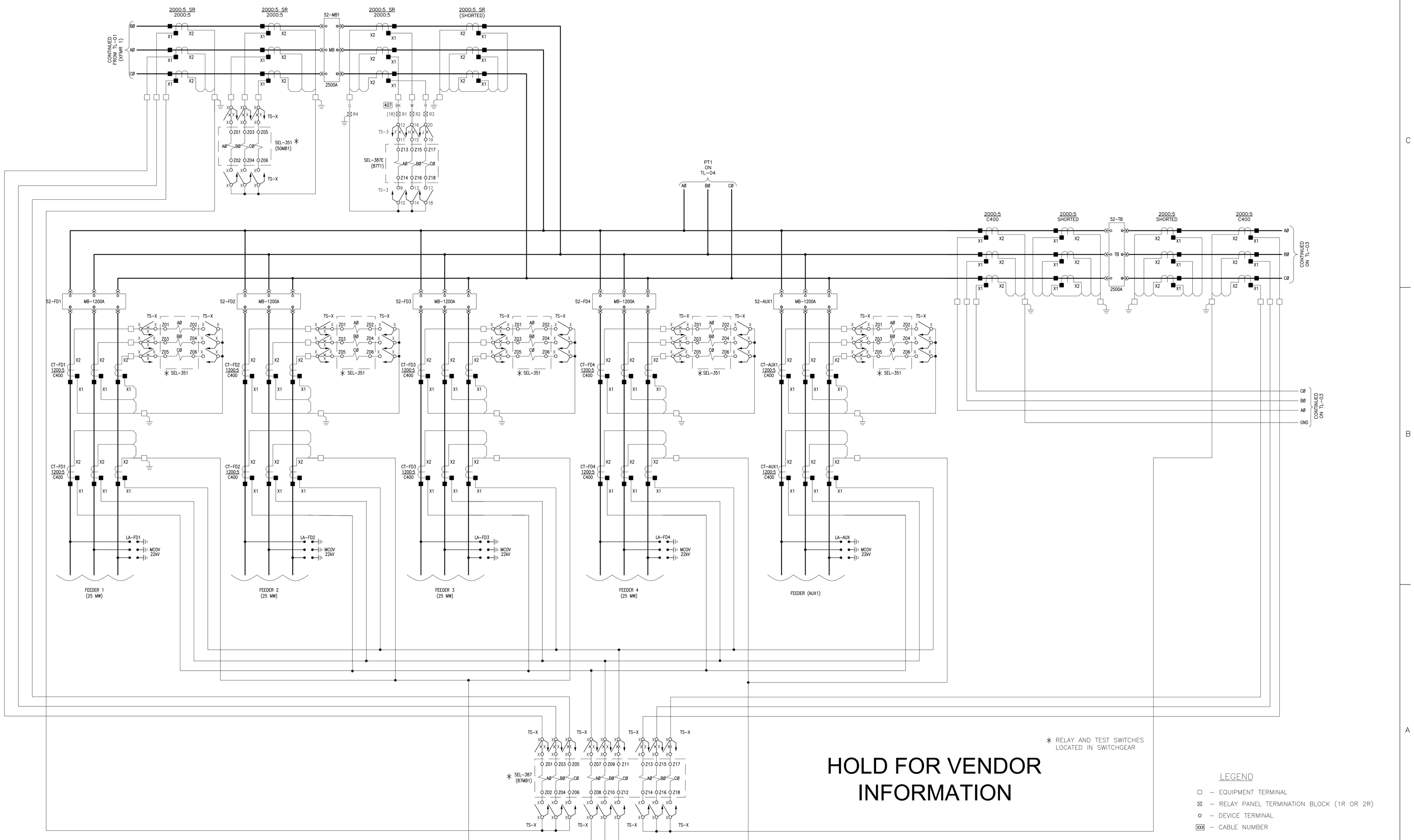
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION THREE LINE DIAGRAM

0 1" 2"

FILENAME	TWESD-TL-01.DWG
SCALE	NONE

SHEET **TL-01**



MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

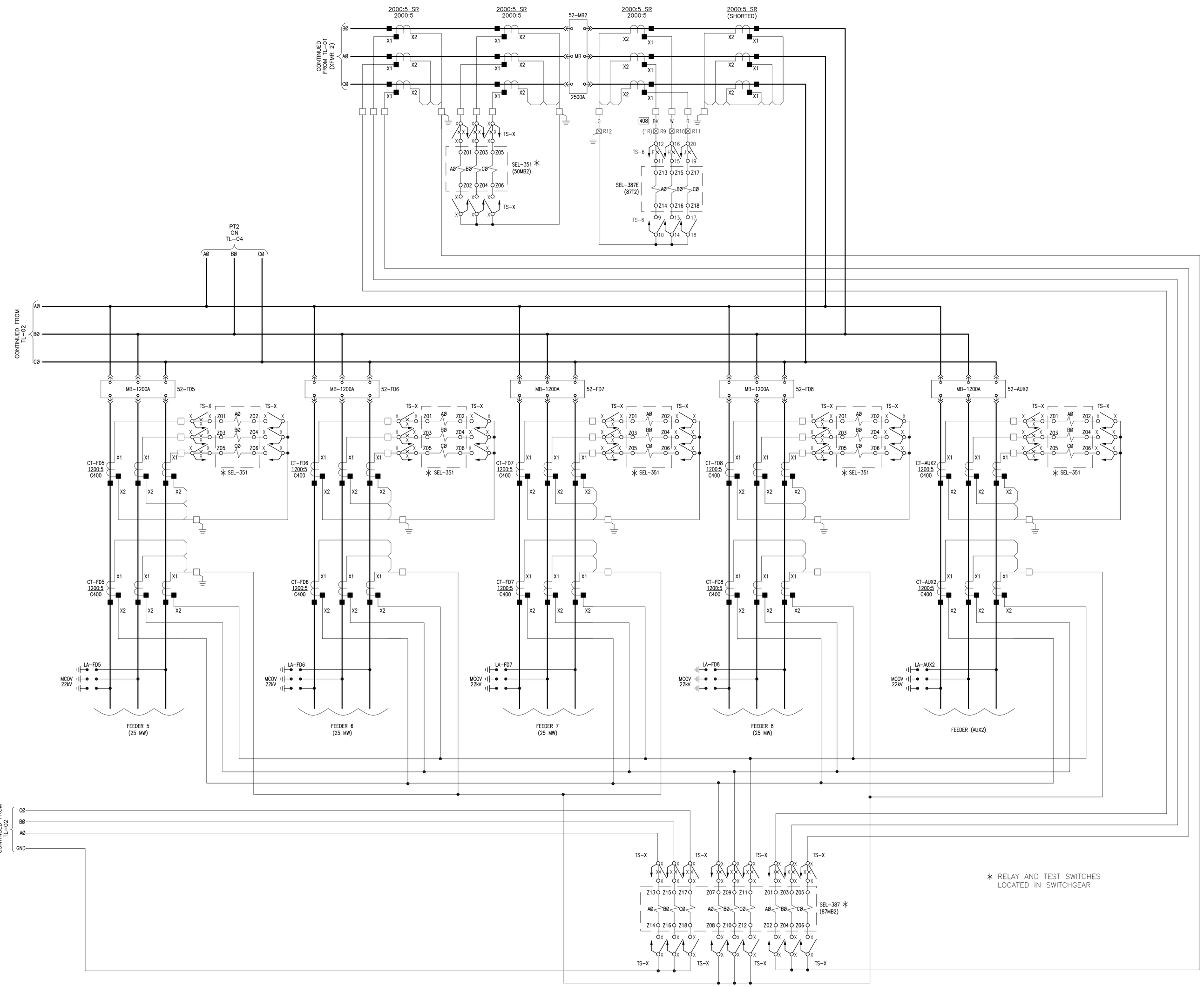
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION THREE LINE DIAGRAM

0 1" 2"

FILENAME	TWESD-TL-02
SCALE	NONE

SHEET **TL-02**



HOLD FOR VENDOR INFORMATION

LEGEND

- □ – EQUIPMENT TERMINAL
- ⊠ – RELAY PANEL TERMINATION BLOCK (1R OR 2R)
- ○ – DEVICE TERMINAL
- XXX – CABLE NUMBER

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

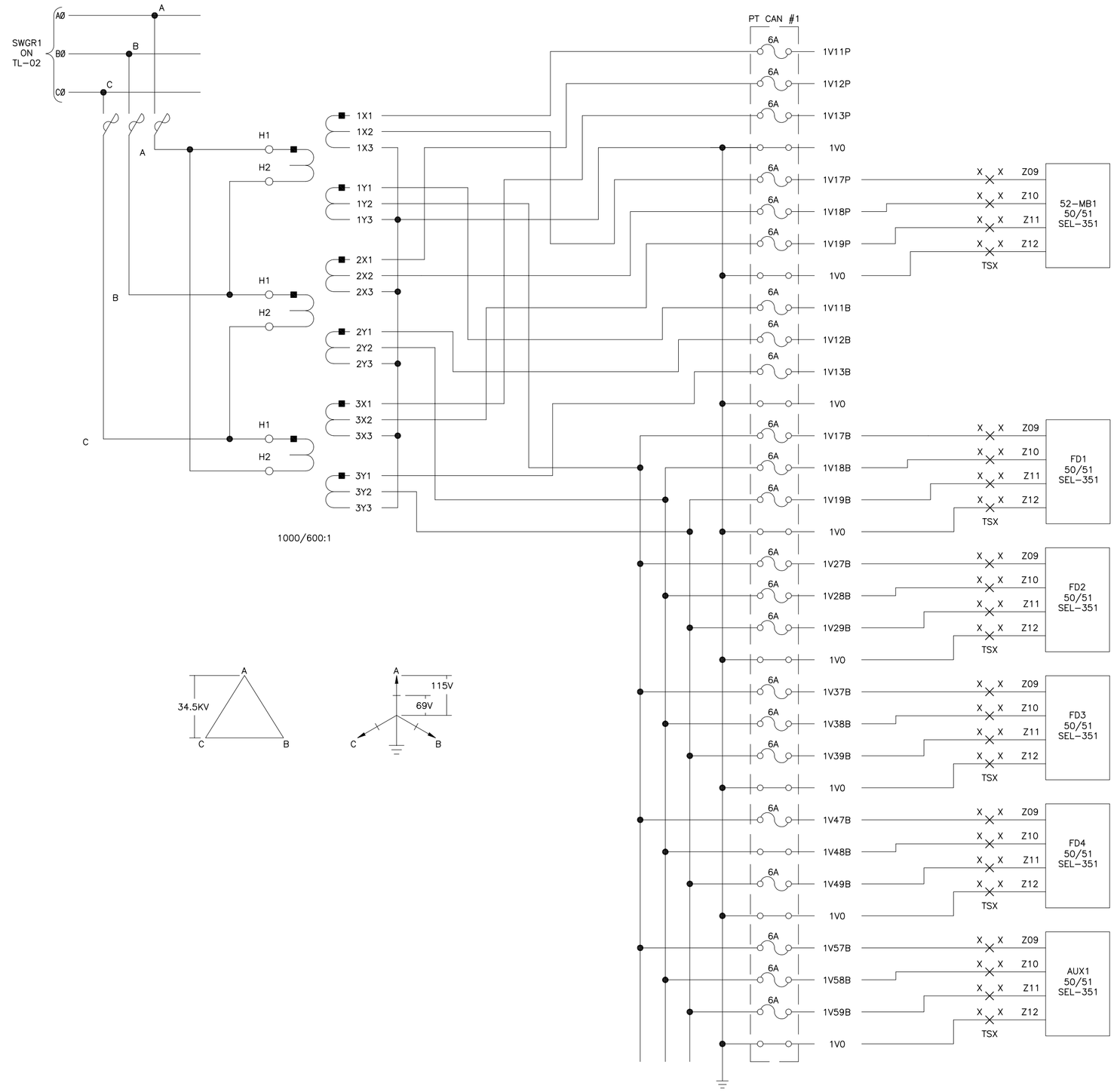
230/34.5kV PROJECT SUBSTATION THREE LINE DIAGRAM

0 1" 2"

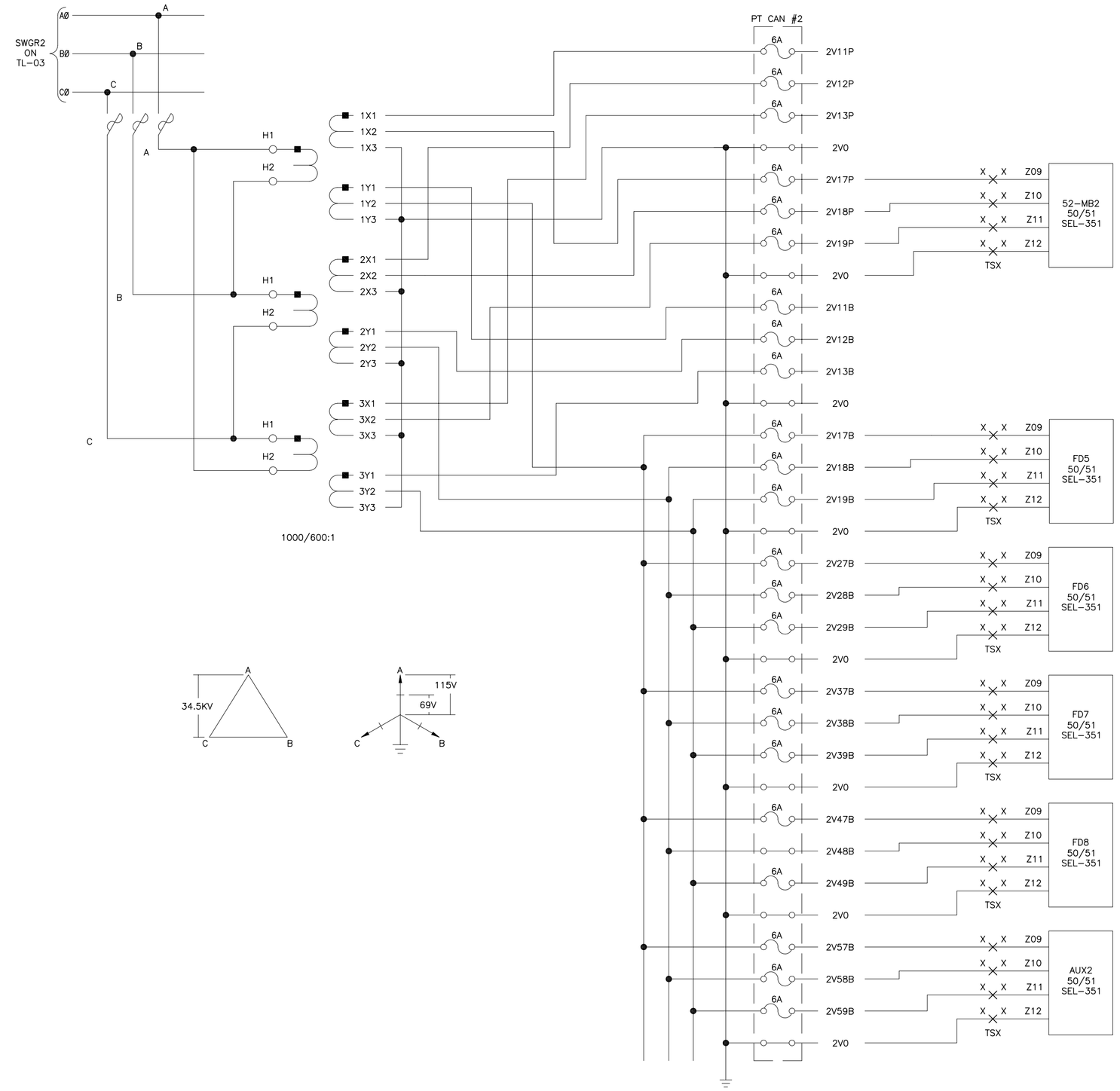
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SCALE	NONE

SHEET **TL-03**

34.5kV PT#1
XFMR 1 PT IN SWITCHGEAR



34.5kV PT#2
XFMR 2 PT IN SWITCHGEAR



HOLD FOR VENDOR INFORMATION

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
THREE LINE DIAGRAM

0 1" 2"

FILENAME	TWESD-TL-04
SCALE	NONE

SHEET **TL-04**

ACCIONA, LLC
McPHERSON COUNTY, SOUTH DAKOTA

TATANKA WIND ENERGY
SOUTH DAKOTA PROJECT SUBSTATION
DRAWING LIST

DRAWING DESCRIPTION	SHEET NUMBER	REVISION
TITLE SHEET	TS-01	AS-BUILT
GENERAL ARRANGEMENT	GA-01	AS-BUILT
GENERAL ARRANGEMENT SECTIONS A&B	GA-02	AS-BUILT
GENERAL ARRANGEMENT SECTIONS C, D, E & F	GA-03	AS-BUILT
BUS ASSEMBLY DETAILS B1 THROUGH B11	GA-04	AS-BUILT
BUS DETAILS B12 THROUGH B16	GA-05	AS-BUILT
MATERIAL LIST	ML-01	AS-BUILT
MATERIAL LIST	ML-02	AS-BUILT
GROUNDING PLAN	GD-01	AS-BUILT
GROUNDING DETAILS 01 THROUGH 011	GD-02	AS-BUILT
GROUNDING DETAILS 012 THROUGH 016	GD-03	AS-BUILT
CONDUIT PLAN	CC-01	AS-BUILT
CONDUIT DETAILS K1 THROUGH K4	CC-02	AS-BUILT
CONDUIT DETAILS K5	CC-03	AS-BUILT
CONDUIT DETAILS K6	CC-04	AS-BUILT
FOUNDATION PLAN	FD-01	AS-BUILT
FOUNDATION DETAILS	FD-02	AS-BUILT
FOUNDATION DETAILS	FD-03	AS-BUILT
STRUCTURAL STEEL-230kV SWITCH STANDS	SS-01	AS-BUILT
STRUCTURAL STEEL-230kV BUS SUPPORTS	SS-02	AS-BUILT
STRUCTURAL STEEL-230kV MISC. STEEL	SS-03	AS-BUILT
STRUCTURAL STEEL - TERMINATION STAND SHEET 1 OF 2	SS-04	AS-BUILT
STRUCTURAL STEEL - TERMINATION STAND SHEET 2 OF 2	SS-05	AS-BUILT
STRUCTURAL STEEL - EQUIPMENT SUPPORTS	SS-06	AS-BUILT
STRUCTURAL STEEL - TRANSFORMER GRATING	SS-07	AS-BUILT
STATIC MAST (STATIC) - 230kV DEAD END TOWER	SM-01	AS-BUILT
RELAY ONE LINE DIAGRAM	OL-01	AS-BUILT
SPS ONE LINE	OL-02	AS-BUILT
THREE LINE DIAGRAM	TL-01	AS-BUILT
THREE LINE DIAGRAM	TL-02	AS-BUILT
THREE LINE DIAGRAM	TL-03	AS-BUILT
THREE LINE DIAGRAM PT 1 & 2	TL-04	AS-BUILT
TRANSFORMER (1) DC CONTROL SCHEMATIC	CS-01	AS-BUILT
TRANSFORMER (1) AC CONTROL SCHEMATIC	CS-02	AS-BUILT
TRANSFORMER (2) DC CONTROL SCHEMATIC	CS-03	AS-BUILT
TRANSFORMER (2) AC CONTROL SCHEMATIC	CS-04	AS-BUILT
TRIP AND CLOSE (CB1) DC SCHEMATIC DIAGRAM	CS-05	AS-BUILT
CB1 AC & DC SCHEMATIC DIAGRAM	CS-06	AS-BUILT
TRIP AND CLOSE (CB2) DC SCHEMATIC DIAGRAM	CS-07	AS-BUILT
CB2 AC & DC SCHEMATIC DIAGRAM	CS-08	AS-BUILT
BUS DIFFERENTAIL SCHEMATIC	CS-09	AS-BUILT
BUS DIFFERENTIAL SCHEMATIC	CS-10	AS-BUILT
RELAY COMMUNICATIONS EQUIPMENT DC SCHEMATIC	CS-11	AS-BUILT
21AP DC CONTROL SCHEMATIC	CS-12	AS-BUILT
21BP DC CONTROL SCHEMATIC	CS-13	AS-BUILT
CB1 & CB2 BREAKER FAILURE DC SCHEMATIC	CS-14	AS-BUILT
COMMUNICATION CONTROL SCHEMATIC	CS-15	AS-BUILT
TRANSFORMER (1) COOLING SYSTEM DIAGRAM	CS-16	AS-BUILT
TRANSFORMER (2) COOLING SYSTEM DIAGRAM	CS-17	AS-BUILT
DC CONTROL SCHEMATIC	CS-18	AS-BUILT
MDU TONE EQUIP CONTROL SCHEMATIC	CS-19	AS-BUILT
SPS LOGIC DESCRIPTION	CS-20	AS-BUILT
SPS LOGIC DIAGRAM	CS-21	AS-BUILT

RELAY RACK (1R) LAYOUT	RL-01	AS-BUILT
RELAY RACK (2R) LAYOUT	RL-02	AS-BUILT
CABLE LIST	CL-01	AS-BUILT
RACK 1 (1R) WIRING DIAGRAM SH. 1	WD-01	AS-BUILT
RACK 1 (1R) WIRING DIAGRAM SH. 2	WD-02	AS-BUILT
RACK 2 (2R) WIRING DIAGRAM SH. 1	WD-03	AS-BUILT
RACK 2 (2R) WIRING DIAGRAM SH. 2	WD-04	AS-BUILT
CB1 CABINET CONNECTION DIAGRAM	CD-01	AS-BUILT
CB2 CABINET CONNECTION DIAGRAM	CD-02	AS-BUILT
TRANSFORMER 1 CONNECTION DIAGRAM	CD-03	AS-BUILT
TRANSFORMER 2 CONNECTION DIAGRAM	CD-04	AS-BUILT
CCVT #3 JUNCTION BOX CONNECTION DIAGRAM	CD-05	AS-BUILT
34.5kV SWITCHGEAR 1 & 2 CONNECTION DIAGRAM	CD-06	AS-BUILT
AC AND DC PANEL BOARDS (ACPB1, ACPB2, ACPB3 & DCPB1)	LC-01	AS-BUILT
ELECTRICAL BUILDING ELEVATIONS	EB-01	AS-BUILT
ELECTRICAL BUILDING POWER AND LIGHTING	EB-02	AS-BUILT
ELECTRICAL BUILDING CONDUIT PLAN	CP-01	AS-BUILT
CABLE TRAY LAYOUT	CT-01	AS-BUILT
230kV PCB CB1, CB2 LEGEND	MD-01	AS-BUILT
230kV PCB CB1, CB2 CONTROL SCHEMATIC	MD-02	AS-BUILT
230kV PCB CB1, CB2 CONTROL SCHEMATIC	MD-03	AS-BUILT
230kV PCB CB1, CB2 AUX SWITCH AND CUSTOMER ALARM	MD-04	AS-BUILT
230kV PCB CB1, CB2 CABINET HEATING	MD-05	AS-BUILT
230kV PCB CB1, CB2 WIRING DIAGRAM	MD-06	AS-BUILT
230kV PCB CB1, CB2 WIRING DIAGRAM	MD-07	AS-BUILT
230kV PCB CB1, CB2 WIRING DIAGRAM	MD-08	AS-BUILT
230kV PCB CB1, CB2 WIRING DIAGRAM	MD-09	AS-BUILT
230kV PCB CB1, CB2 PANEL LAYOUT	MD-10	AS-BUILT
230kV PCB CB1, CB2 BILL OF MATERIALS	MD-11	AS-BUILT
230kV PCB CB1, CB2 BCT WIRING/NAMEPLATE	MD-12	AS-BUILT
230kV PCB CB1, CB2 SF6 GAS PIPING/RATING NAMEPLATE	MD-13	AS-BUILT
230kV PCB CB1, CB2 TERMINAL MARKER STRIPS	MD-14	AS-BUILT
230kV PCB CB1, CB2 OUTLINE DRAWING	MD-15	AS-BUILT

MORTENSON®

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
B	10-24-07	PER VENDOR DRAWINGS & TEMP SWGR & MDU NAMING
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
1	09-04-07	ADD NEW METERED FDR&PANEL FOR O+M BUILDING
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

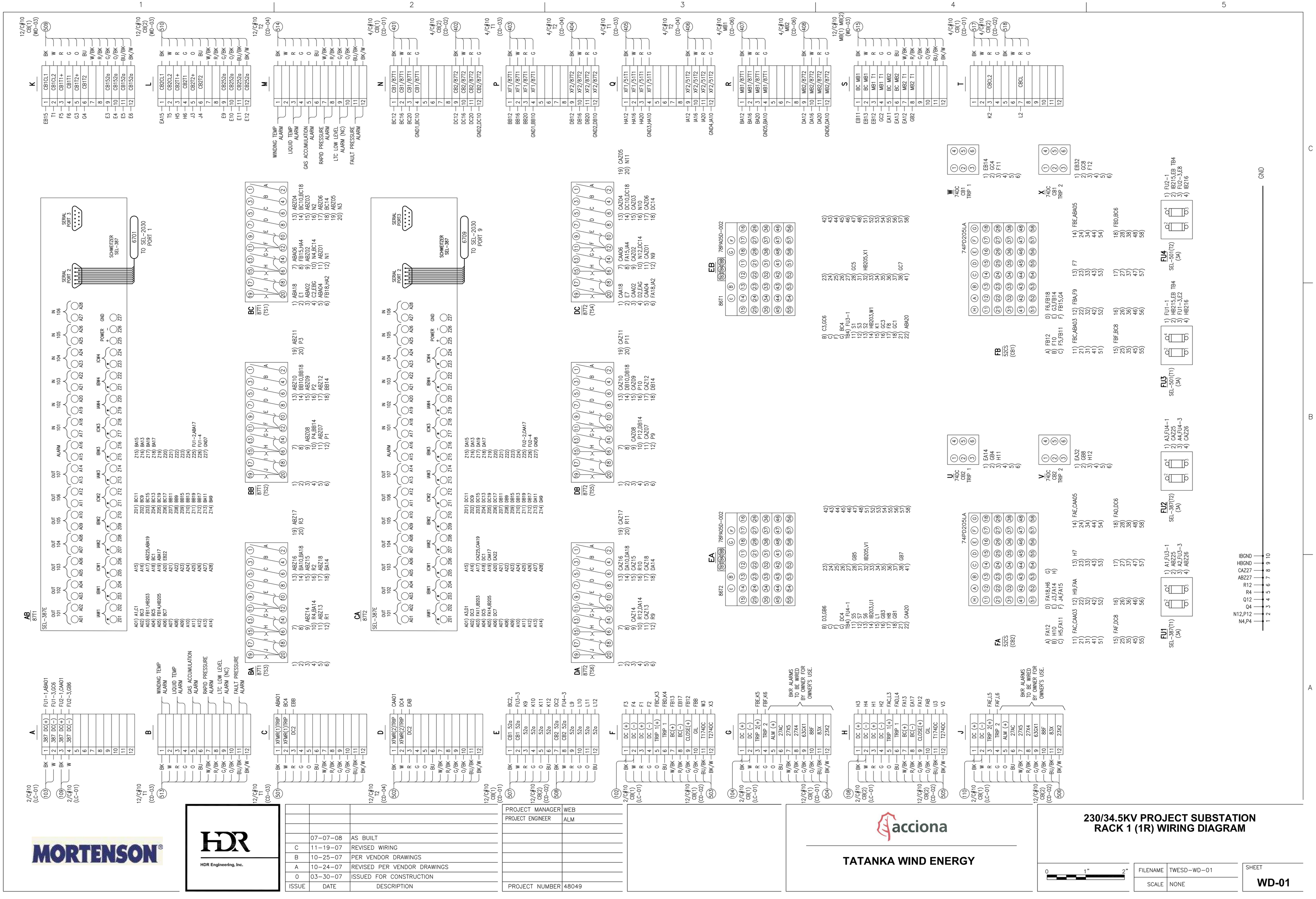
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
TITLE SHEET

0 1" 2"

FILENAME	TWESD-TS-01.dwg
SCALE	NONE

SHEET **TS-01**



ISSUE	DATE	DESCRIPTION
0	03-30-07	ISSUED FOR CONSTRUCTION
A	10-24-07	REVISED PER VENDOR DRAWINGS
B	10-25-07	PER VENDOR DRAWINGS
C	11-19-07	REVISED WIRING
	07-07-08	AS BUILT

PROJECT MANAGER	WEB
PROJECT ENGINEER	ALM
PROJECT NUMBER	48049

MORTENSON

HDR Engineering, Inc.

acciona

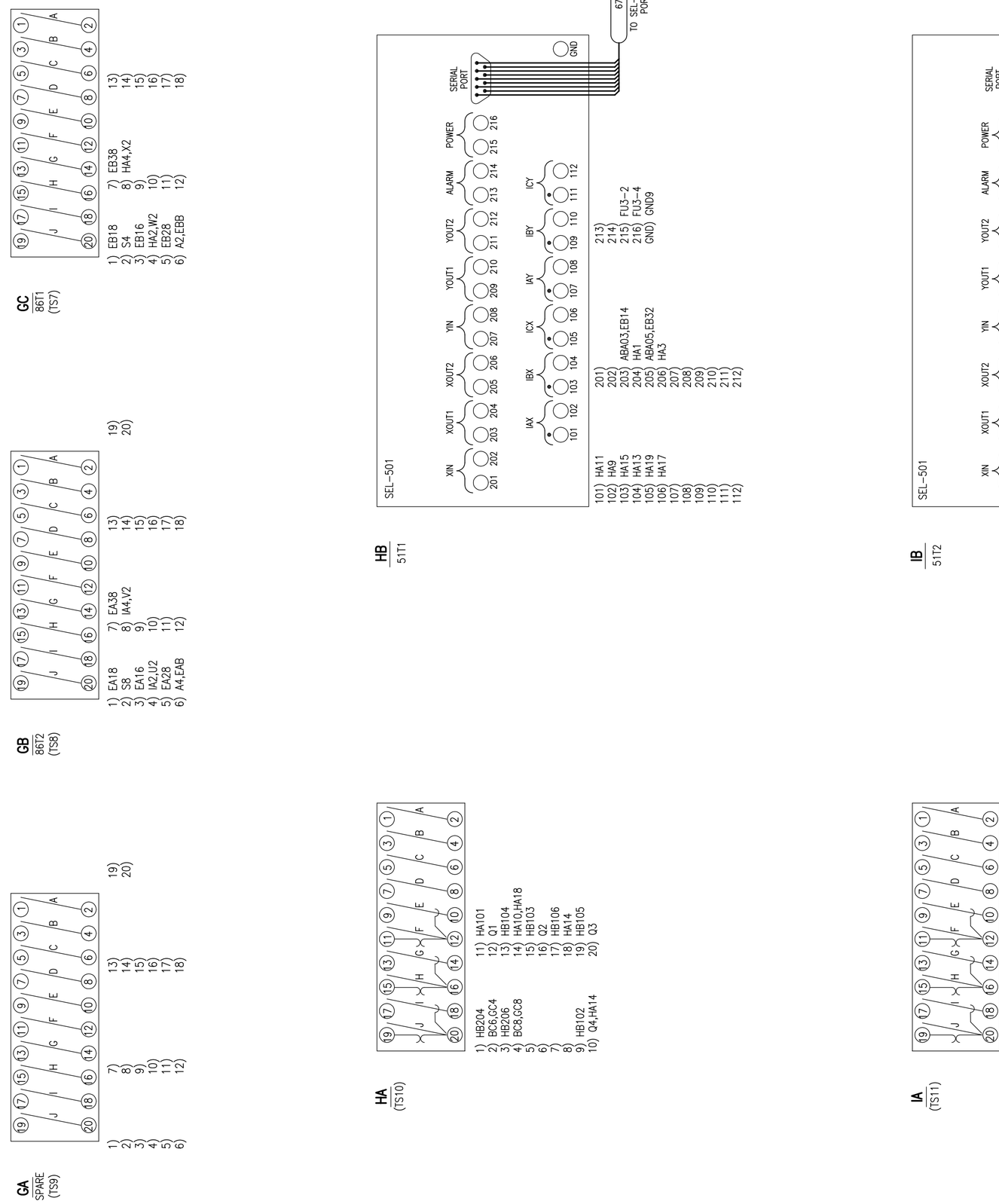
TATANKA WIND ENERGY

230/34.5KV PROJECT SUBSTATION RACK 1 (1R) WIRING DIAGRAM

0 1" 2"

FILENAME	TWESD-WD-01
SCALE	NONE

SHEET WD-01



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HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
PROJECT NUMBER	48049

acciona

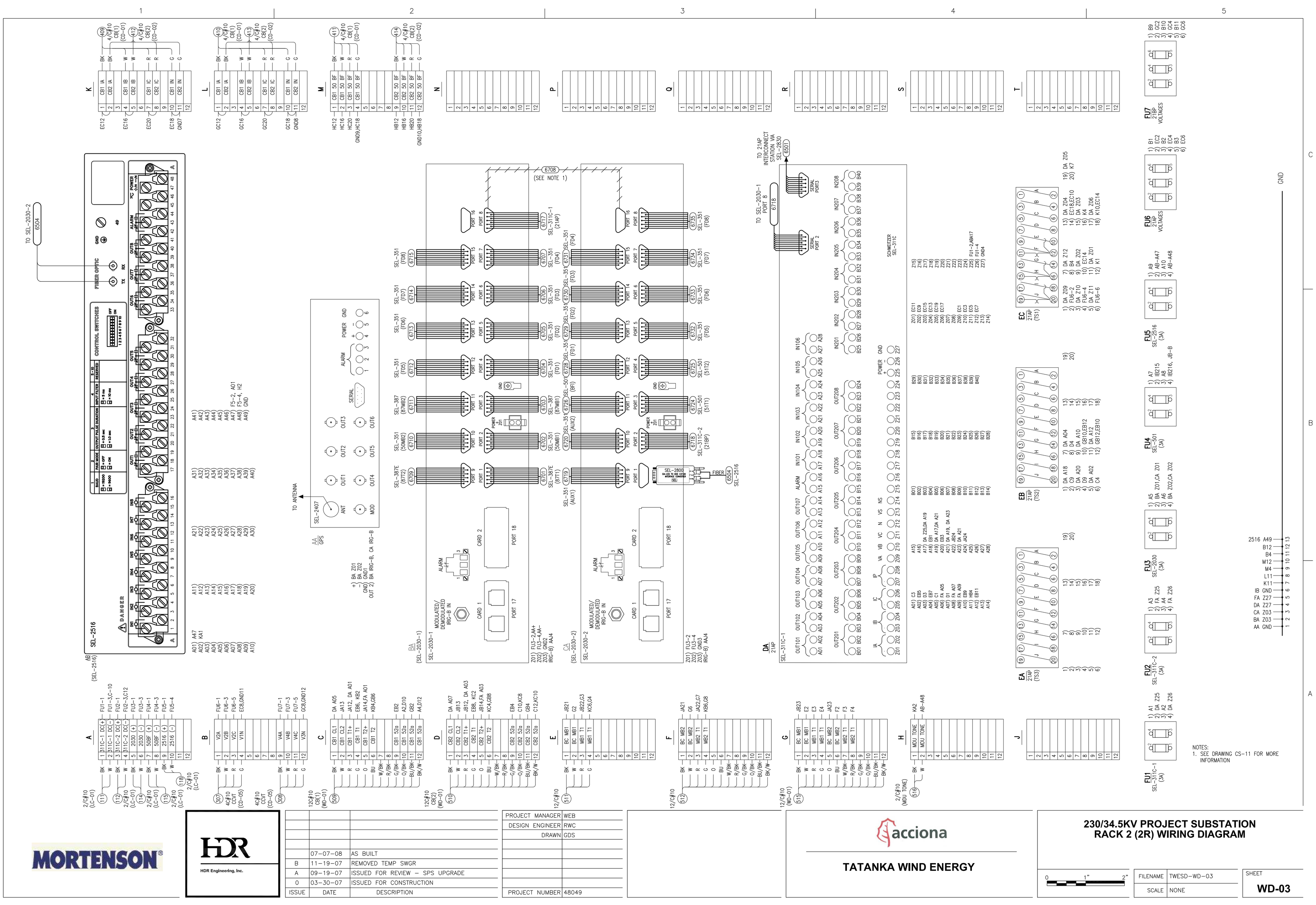
TATANKA WIND ENERGY

230/34.5kV PROJECT SUBSTATION
RACK 1 (1R) WIRING DIAGRAM

0 1" 2"

FILENAME	TWESD-WD-02
SCALE	NONE

SHEET
WD-02



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ISSUE	DATE	DESCRIPTION
	07-07-08	AS BUILT
B	11-19-07	REMOVED TEMP SWGR
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION

PROJECT MANAGER	WEB
DESIGN ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

acciona

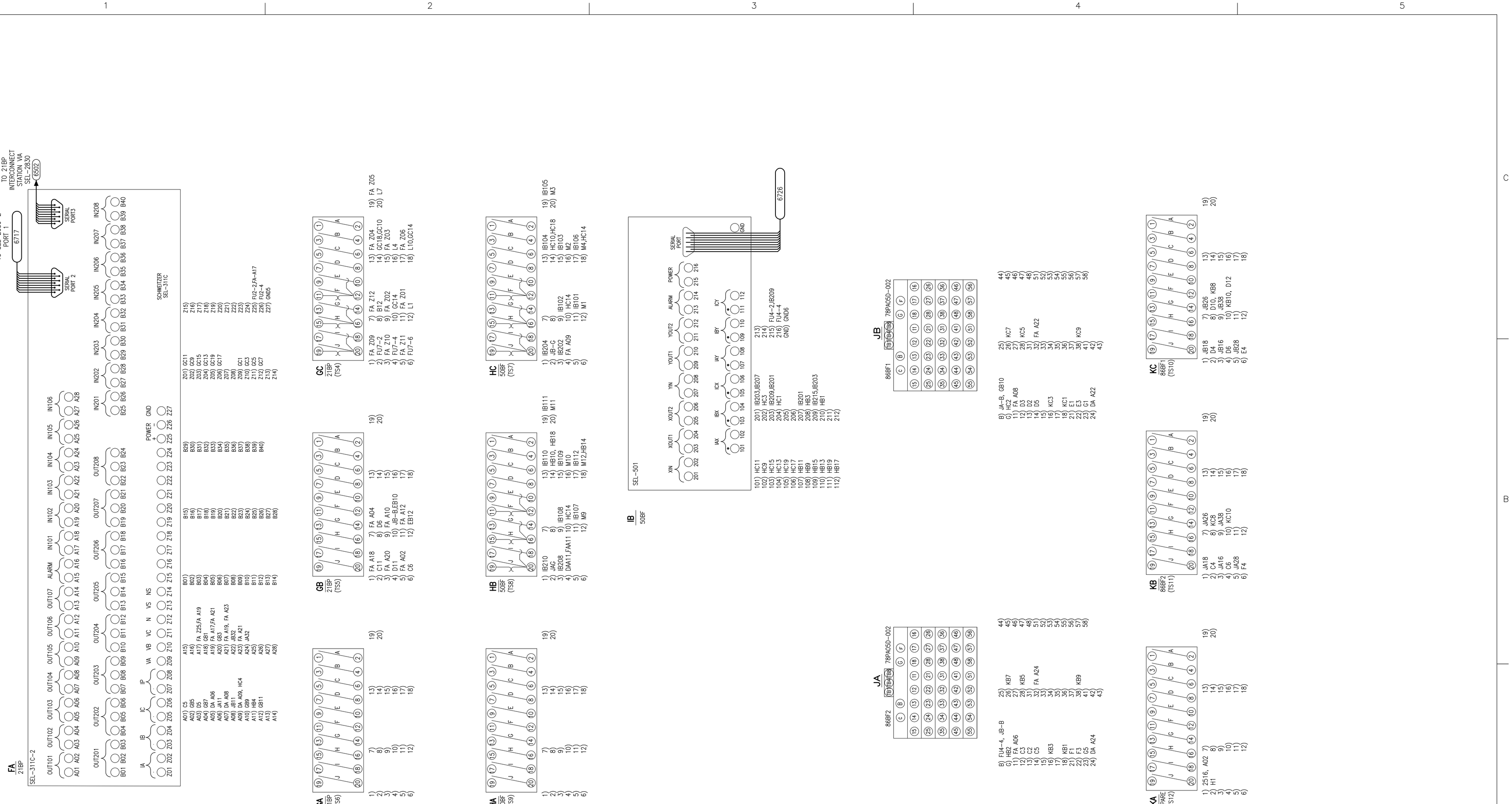
TATANKA WIND ENERGY

230/34.5KV PROJECT SUBSTATION
RACK 2 (2R) WIRING DIAGRAM

0 1" 2"

FILENAME	TWESD-WD-03
SCALE	NONE

SHEET **WD-03**



	07-07-08	AS BUILT
A	09-19-07	ISSUED FOR REVIEW – SPS UPGRADE
0	03-30-07	ISSUED FOR CONSTRUCTION
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	WEB
PROJECT ENGINEER	RWC
DRAWN	GDS
PROJECT NUMBER	48049

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TATANKA WIND ENERGY

230/34.5KV PROJECT SUBSTATION RACK 2 (2R) WIRING DIAGRAM

0 1" 2"

FILENAME	TWESD-WD-04
SCALE	NONE

SHEET **WD-04**

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

IN REPLY REFER TO:

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225-0486

STREET LOCATION:
134 Union Blvd.
Lakewood, Colorado 80228-1807

NWRS / HB 10.3
Tatanka Wind Farm Project
Mailstop 60130

NOV 30 2007

Mr. Peter Kennon
Acciona Energy – N.A.
101 North Wacker Drive
Chicago, Illinois 60606

Dear Mr. Kennon:

This letter is to confirm an e-mail sent on July 17, 2007, concerning the status of the cultural resource work for Acciona's Tatanka Wind Farm Project in North and South Dakota. That e-mail stated that cultural resource work on the U.S. Fish and Wildlife Service (FWS) easement lands in the Tatanka Project had concluded, and no additional work was needed.

The full report, *Tatanka Wind Farm: Dickey and McIntosh Counties, North Dakota, McPherson County, South Dakota*, Westwood Professional Services, May 23, 2007, and request for comments were sent by certified mail to both State Historic Preservation Offices and four Tribal Historic Preservation Offices and were received no later than June 8, 2007. The regulations provide 30 days for comments and with time allowed for mail service, that period was up by July 17, 2007. We also sent information to ten other Native American individuals and asked for comments by the end of June. The only response we received from these 16 mailings was from the Rosebud Sioux who thanked us for the information, but said they had no other concerns.

If the project changes and extends into easement lands outside of the areas that were surveyed, additional work may be necessary. If cultural resources are encountered during project construction, work should stop in that area and FWS staff should be notified.

Thank you and please do not hesitate to contact us if you have any questions or concerns.

Sincerely,

Meg Van Ness

Meg Van Ness
Regional Historic Preservation Officer
(303) 236-8103
Meg_VanNess@fws.gov