

EXHIBIT A

Affidavit of Don Raveling

**UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION**

TATANKA WIND POWER, LLC,)	
)	
Complainant,)	
)	
v.)	Docket No. EL10-41-000
)	
MONTANA-DAKOTA UTILITIES CO., a division of MDU Resources Group, Inc.,)	
)	
Respondent.)	

**AFFIDAVIT OF DON RAVELING
ON BEHALF OF MONTANA-DAKOTA UTILITIES CO.**

DON RAVELING, being first duly sworn, on oath, deposes and states as follows:

1. My name is Don Raveling and my current address is 9115 Baine Drive, Bismarck, North Dakota 58503.
2. I was employed as a Senior Staff Engineer for Montana-Dakota Utilities Co., a Division of MDU Resources Group, Inc., ("Montana-Dakota") up until my retirement on September 1, 2009. I was employed by Montana-Dakota for 37 years. During that time I held various positions of increasing responsibility.
3. I received a Bachelor of Science degree in Electrical Engineering in 1972 from North Dakota State University.
4. I reviewed the affidavit of Iker Chocarro and the supporting attachments in preparation for this affidavit.
5. As a Senior Staff Engineer for Montana-Dakota, I was responsible for reviewing and commenting on the system protection aspects of generator interconnection requests on

Montana-Dakota's transmission system. Montana-Dakota is a member of the Midwest Independent Transmission System Operator, Inc. ("Midwest ISO") and all interconnection requests to the Montana-Dakota transmission system would be submitted directly to the Midwest ISO.

6. I first became aware of the project sometime in 2002 or 2003 when another Montana-Dakota engineer asked me to do a small fault study for a proposed 180 MW wind generation facility. My next involvement with the project was in connection with the negotiation and drafting of the appendices to the Large Generator Interconnection Agreement ("LGIA"). My understanding was that the project was placed into suspension sometime after the LGIA was finalized. As a result, I did not have any further involvement with the project until October 2006 when I received a call from Bill Barnhardt, a Senior Project Manager for HDR, Inc., an architectural, engineering and consulting firm, who informed me that his company had been hired to perform the design work for the generator interconnection facilities and network upgrades identified in the LGIA.
7. On October 16, 2006, I sent Mr. Barnhardt an email with attached drawings of the facilities that Montana-Dakota uses for the construction of similar interconnection projects. I also attached detailed specifications for the design and construction of the facilities to be installed at the substation. I have attached that email and attachments to this affidavit in Exhibit A.1.
8. On December 1, 2006, I received an email from Mr. Barnhardt in which he attached a one-line diagram of the design for the substation. He also indicated in that email that we should have a face-to-face meeting to discuss the station layout. After review of the one-

line diagram included in the December 1 email, I immediately noticed that the design for the substation deviated substantially from the design specifications I had included in my October 16 email as well as the specifications set forth in the LGIA. I have attached the December 1, 2006 email and one-line diagram to this affidavit in Exhibit A.2.

9. Shortly after receiving the December 1 e-mail, I spoke with Mr. Barnhardt and informed him that the one-line diagram deviated substantially from Montana-Dakota's design specifications and that the substation design was unacceptable to Montana-Dakota. Mr. Barnhardt said that his client was paying for the design work and the construction of the facilities that were being built and, therefore, he did not need to follow Montana-Dakota's design specifications.
10. In particular, during my initial conversation with Mr. Barnhardt and in subsequent conversations, I identified the following major deviations from the Montana-Dakota design specifications:
 - The proposed physical arrangement of the substation was not adaptable to a future breaker and one-half arrangement.
 - The physical arrangement of the substation called for three (3) 230 kV line switches to be installed. These line switches were not included in the original design work and were never installed at the substation.
 - The design specifications did not include a Station Service Voltage Transformer (SSVT). The failure to install an SSVT at the substation poses serious reliability issues if the substation loses power.
11. In addition, on January 31, 2007 I sent an email to Mr. Barnhardt in which I addressed the phasing necessary with respect to the substation three circuit breaker ring bus. I

informed Mr. Barnhardt that the proposed arrangement was not very adaptable and that Montana-Dakota preferred a north to south configuration. I received an email from Mr. Barnhardt that indicated he could not meet our specifications with respect to the phasing. I have attached that email to this affidavit in Exhibit A.3.

12. Because of the substation design flaws I identified and communicated to Mr. Barnhardt, I never formally approved the design work that was presented to Montana-Dakota for review. While I did provide comments to Mr. Barnhardt on certain aspects of the design of the network upgrades which, to the best of my knowledge, were followed, the major design work for the project did not meet the detailed specifications I provided to Mr. Barnhardt or the design specifications contained in the LGIA.
13. In addition, I raised the following major substation design flaws with the projects general contractor, Mortenson Construction, following a final walk through of the project prior to energization:
 - The size and configuration of the control house located at the substation was included in the design specifications, but these were not followed resulting in an unreasonably small control house for the type and size of substation constructed.
 - The current-type terminal boards that were installed at the substation deviated from Montana-Dakota's design specifications and the specifications contained in the appendices to the LGIA. These terminal boards posed serious reliability issues. For example, there was a risk that the terminal boards could short the incorrect circuits or open a circuit instead of shorting it. We were concerned enough about this problem that we replaced all of the terminal

blocks which had incoming currents with our conventional four circuit shorting block design.

- The station battery that was installed at the substation was a Nickel-Cadmium rather than the Lead-Acid that was set forth in Montana-Dakota's specifications.

14. To my knowledge, Montana-Dakota has not formally received a copy of the final "as built" drawings of the substation. I never formally approved the "as built" facilities, including the substation or any other network upgrade associated with this project.

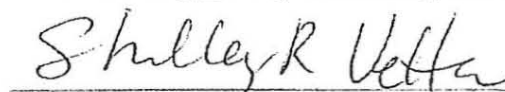
15. This concludes my affidavit.

COUNTY OF BURLEIGH)
) ss.
STATE OF NORTH DAKOTA)

DON RAVELING, being first duly sworn on oath, states that he caused the foregoing document to be prepared and that the statements appearing therein are true to the best of his knowledge, information, and belief.


Don Raveling

SUBSCRIBED AND SWORN TO before me this 26th day of February, 2010


Notary Public

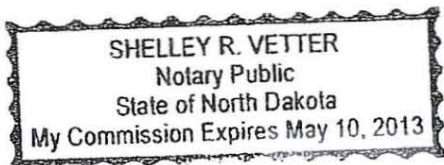


EXHIBIT A.1

October 16, 2006 E-mail & Attachments

From: "Raveling, Don" <don.raveling@mdu.com>
To: "Barnhart Sr., William E." <William.BarnhartSr@hdrinc.com>
Date: 10/16/2006 10:38:08 AM
Subject: RE: G132 Tatanka Wind Energy Project - Specifications sent 101606

Bill,

Because the interconnection will be at a 230kV switching station consisting of three-230kV circuit breakers in a ring bus configuration, there is no difficulty with the 230kV grounded wye/34.5kV grounded wye transformer. This transformer must of course include a delta tertiary for third harmonic suppression, and also so it will be a zero-sequence source.

I attached two zip files. One of typical drawings, the other of MDU specifications. Please call as questions arise.

Don Raveling, P.E.

Sr. Staff Engineer - Electric Substation Dept.

Montana-Dakota Utilities Co.

400 N. 4th Street

Bismarck, ND 58501-4022

phone: 701-222-7680

fax: 701-222-7970

email: don.raveling@mdu.com

From: Barnhart Sr., William E. [mailto:William.BarnhartSr@hdrinc.com]
Sent: Monday, October 16, 2006 9:10 AM
To: Raveling, Don
Cc: Ford, Henry; Pat Sims/Mortenson; Kevin.Deters@mortenson.com
Subject: Tatanka Wind Energy Project

Good morning Don,

I spoke to you last week about this project and to Henry this morning. Henry indicated that you sent the previous owners of this project an email package indicating your specifications and requirements for the interconnect substation. Henry thought you may be able to forward that same package to me.

Also, I wanted to confirm that MDU has no concerns about having a 230kV grounded wye/34.5 grounded wye transformer installed at the collection substation. The delivery of these transformers is critical and we want to release the order this week. I understand that this has been previously approved by MDU; but I want to be sure because some utilities won't allow a wye-wye on their transmission system.

Please confirm the wye-wye is acceptable. Thanks.

Bill

Bill Barnhart, Sr. P.E.

Senior Project Manager

HDR ONE COMPANY | Many Solutions

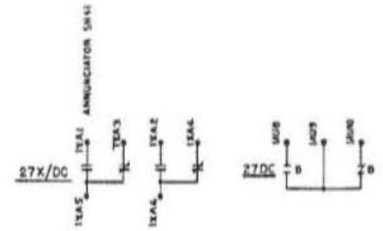
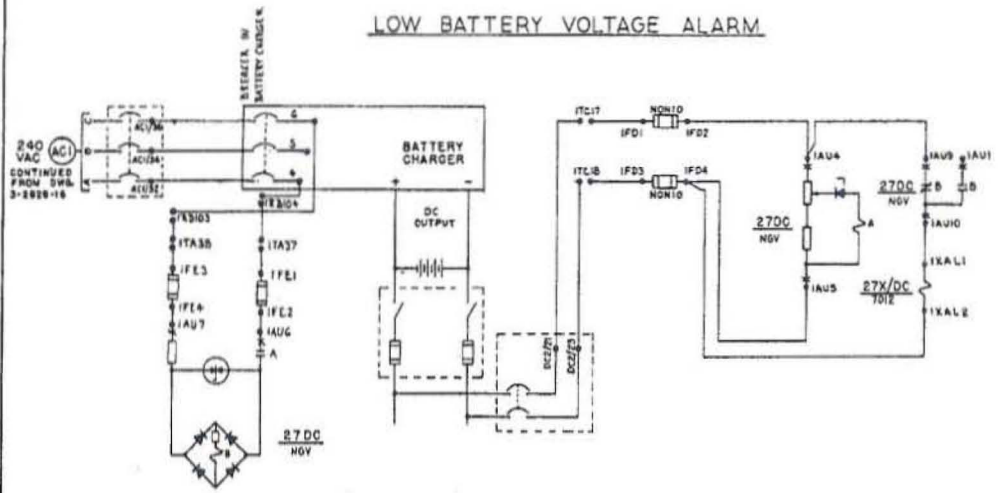
2913 Millennium Circle. | Billings, MT | 59102

Phone: 406.869.4937 | Fax: 406.652.2758

Email: william.barnhartsr@hdrinc.com

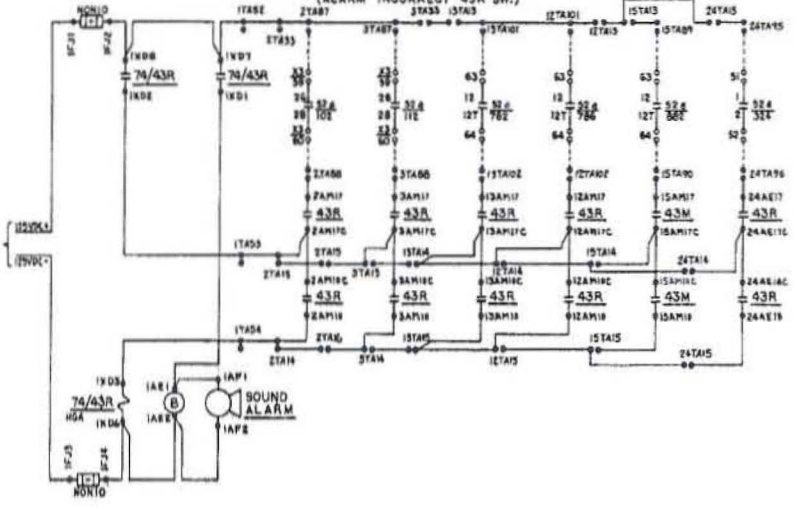
CC: "Ford, Henry" <Henry.Ford@mdu.com>, 'Pat Sims/Mortenson' <Pat.Sims@mortenson.com>, "Kevin.Deters@mortenson.com" <Kevin.Deters@mortenson.com>

LOW BATTERY VOLTAGE ALARM



74/43R SOUND ALARM CIRCUIT

(ALARM INCORRECT 43R SW.)



MONTANA-DAKOTA UTILITIES CO.
 TIOGA 230/115KV SUBSTATION
 LOW BATTERY VOLTAGE ALARM
 74/43R SOUND ALARM
 SCHEMATICS

REV	NO	DATE	BY	CHKD
1	1	08/01/87	JW	JW
2	2	08/01/87	JW	JW
3	3	08/01/87	JW	JW
4	4	08/01/87	JW	JW
5	5	08/01/87	JW	JW
6	6	08/01/87	JW	JW
7	7	08/01/87	JW	JW
8	8	08/01/87	JW	JW
9	9	08/01/87	JW	JW
10	10	08/01/87	JW	JW

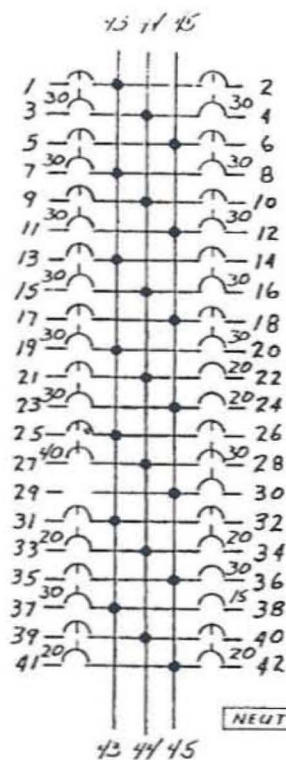
PPV	PERSEN POWER PRODUCTS
SCALE	SCALE
6-20-83 RCB	67-98
DATE	DATE
08/01/87	08/01/87
REV	REV
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10

230 KV PCB#282	230 KV PCB#182
FUTURE PCB	230 KV PCB#186
FUTURE PCB	SPARE
SPARE	SPARE
SPARE	SPARE
REACTOR PCB#324	230CVT HEAT 115 CVT HEAT
AUTO XFMR	3Ø TEST OUTLET
Space	
SPARE	SPARE
SPARE	1Ø TEST OUTLET
230KV YARD LIGHTS	WALL LIGHT 115KV YARD LIGHTS

120/240 VAC 3Ø4W SOLID NEUTRAL
10,000 AMP INTERRUPTING
NEMA TYPE 1 ENCLOSURE
MAIN BUS TO HAVE FEED THROUGH LUGS
42-1 POLE SPACES WITH THE

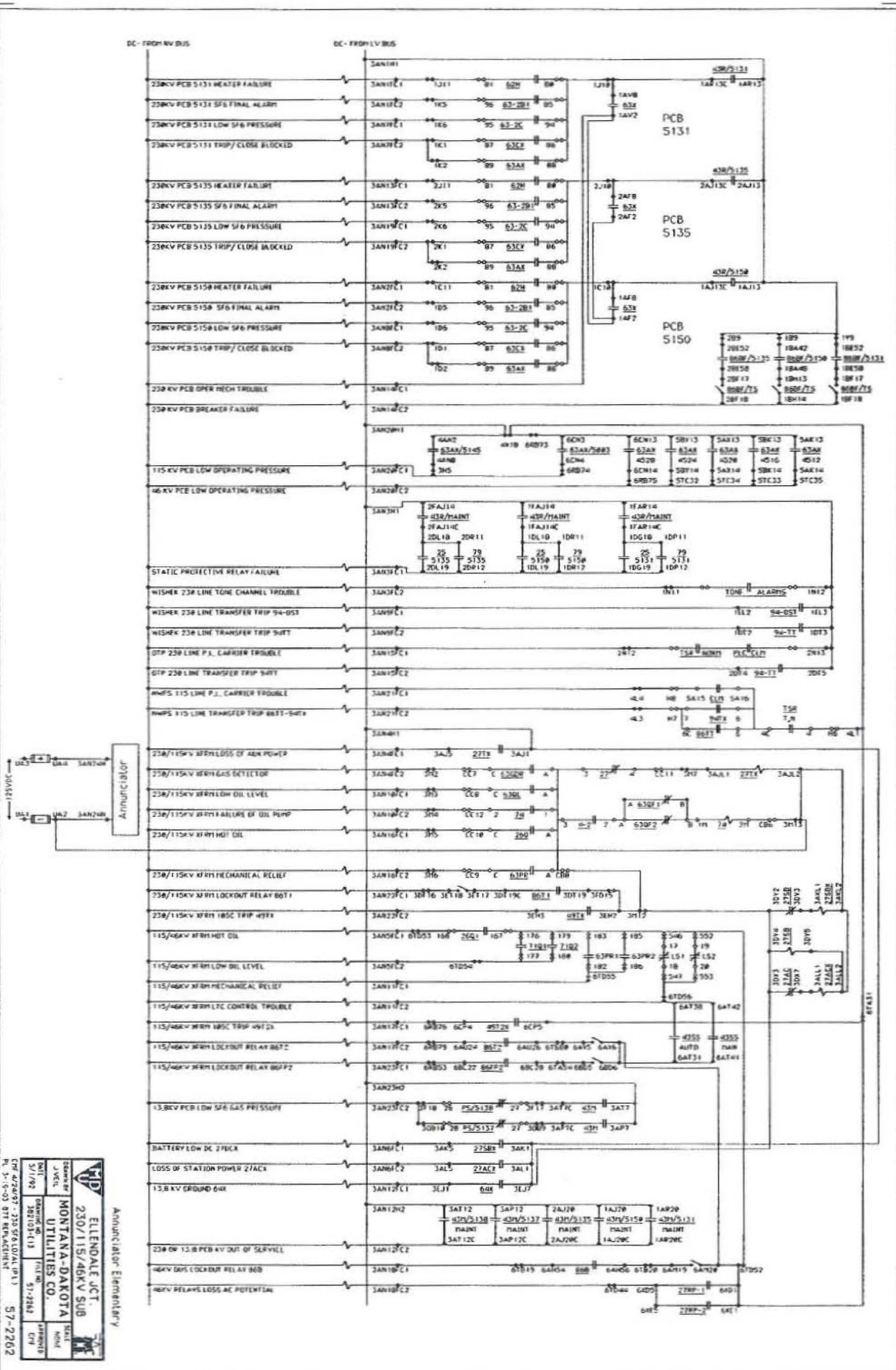
FOLLOWING BREAKERS:

- | | |
|---------------------|--------------------|
| 1- 40 AMP - 2 POLE | 1- 30 AMP - 1 POLE |
| 1- 30 AMP - 3 POLE | 2- 20 AMP - 1 POLE |
| 12- 30 AMP - 2 POLE | 1- 15 AMP - 1 POLE |
| 4- 20 AMP - 2 POLE | |



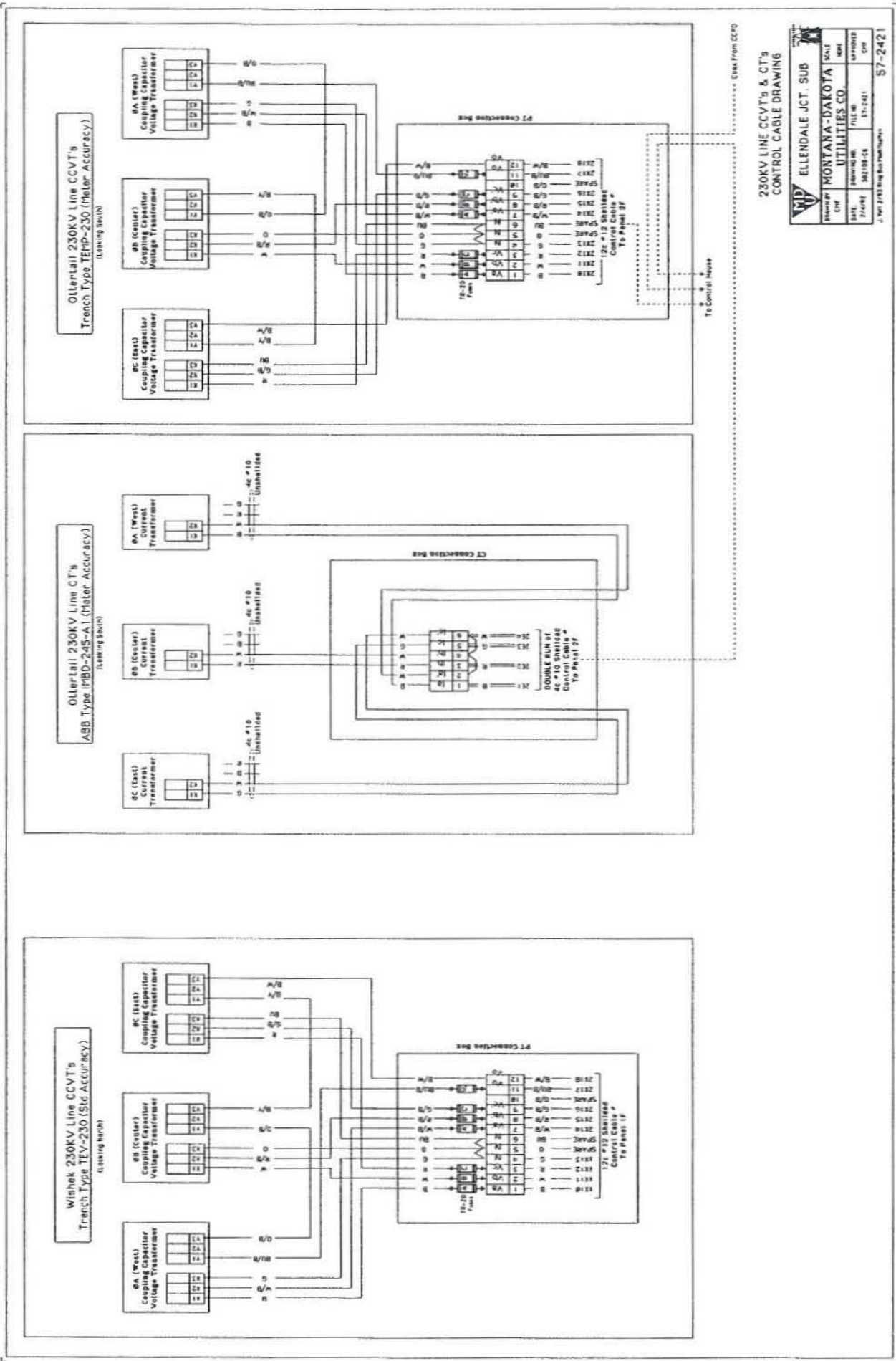
SAMPLE DRAWING

AC PANEL #1 HETTINGER JCT SUB.		
DRAWN BY DLG	MONTANA-DAKOTA UTILITIES CO.	SCALE
APPROVED BY		FILE No.
DATE 4-1-81	DRAWING No. 040181-7	



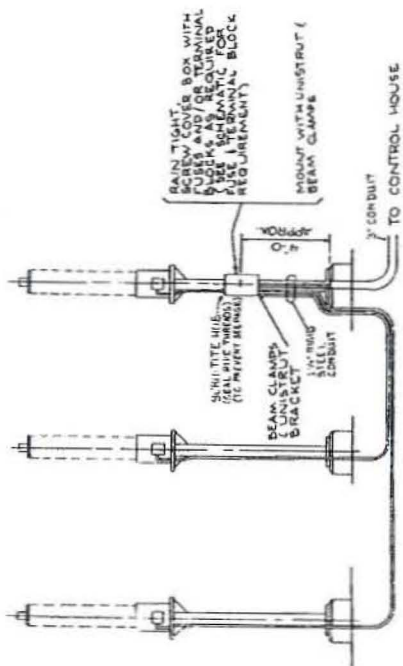
ANNUNCIATOR Elementary

<p>ELLENDALE JCT. 230/115/46KV SUB MONTANA-DAKOTA UTILITIES CO. 3/1/92 387101413 51-2642 57-2262</p>	<p>ANNUNCIATOR RELAY TYPE 57-2262</p>
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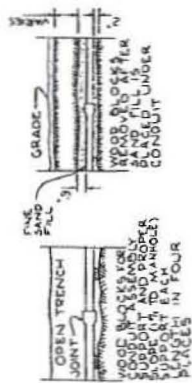


**230KV LINE CCVT's & CT's
CONTROL CABLE DRAWING**

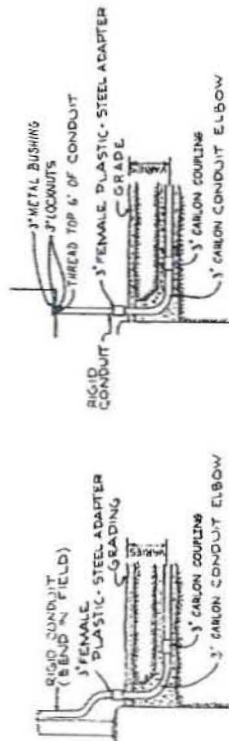
ELLENDALE JCT. SUB	
DRAWN BY	SCALE
CHKD BY	DATE
MONTANA-DAKOTA UTILITIES CO.	APPROVED
DATE: 7/1/91	FILE NO. 87-1241
DRAWING NO. 84108-04	SHEET NO. 57-2421
J. W. 743 King Ave. Helena, MT	



TYPICAL FOUNDATIONS CAPACITOR POTENTIAL DEVICE
POTENTIAL TRANSFER CURRENT TRANSFER VIBRO
CONDUIT INSTALLATION

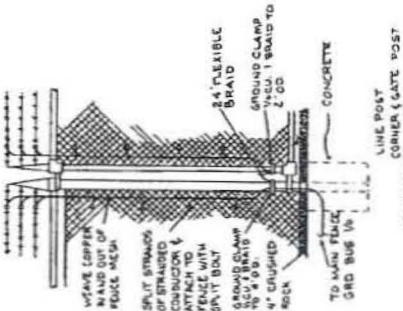


DETAIL OF PLASTIC CONDUIT INSTALLATION
WITHOUT CONCRETE ENVELOPE

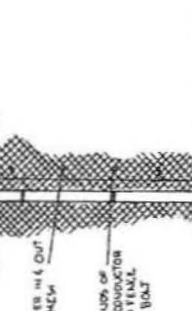


CONDUIT TERMINATION DETAIL
ADJACENT TO FOOTING

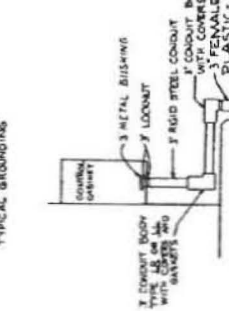
DIRECT CONDUIT TERMINATION DETAIL
FOR SLAB MOUNTED EQUIPMENT



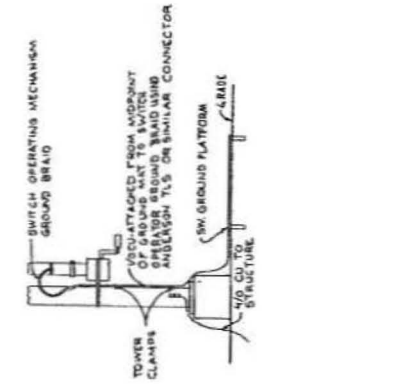
TYPICAL GROUNDING



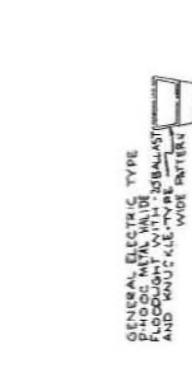
TYPICAL GROUNDING



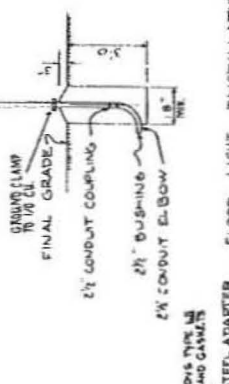
CONDUIT TERMINATION DETAIL
FOR SLAB MOUNTED EQUIPMENT



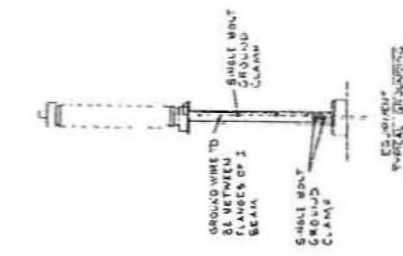
TYPICAL GROUNDING



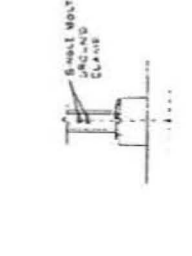
TYPICAL GROUNDING



CONDUIT TERMINATION DETAIL
FOR FLOOD LIGHT INSTALLATION



TYPICAL GROUNDING



TYPICAL GROUNDING



CONDUIT TERMINATION DETAIL
FOR FLOOD LIGHT INSTALLATION

STANDARD DRAWING

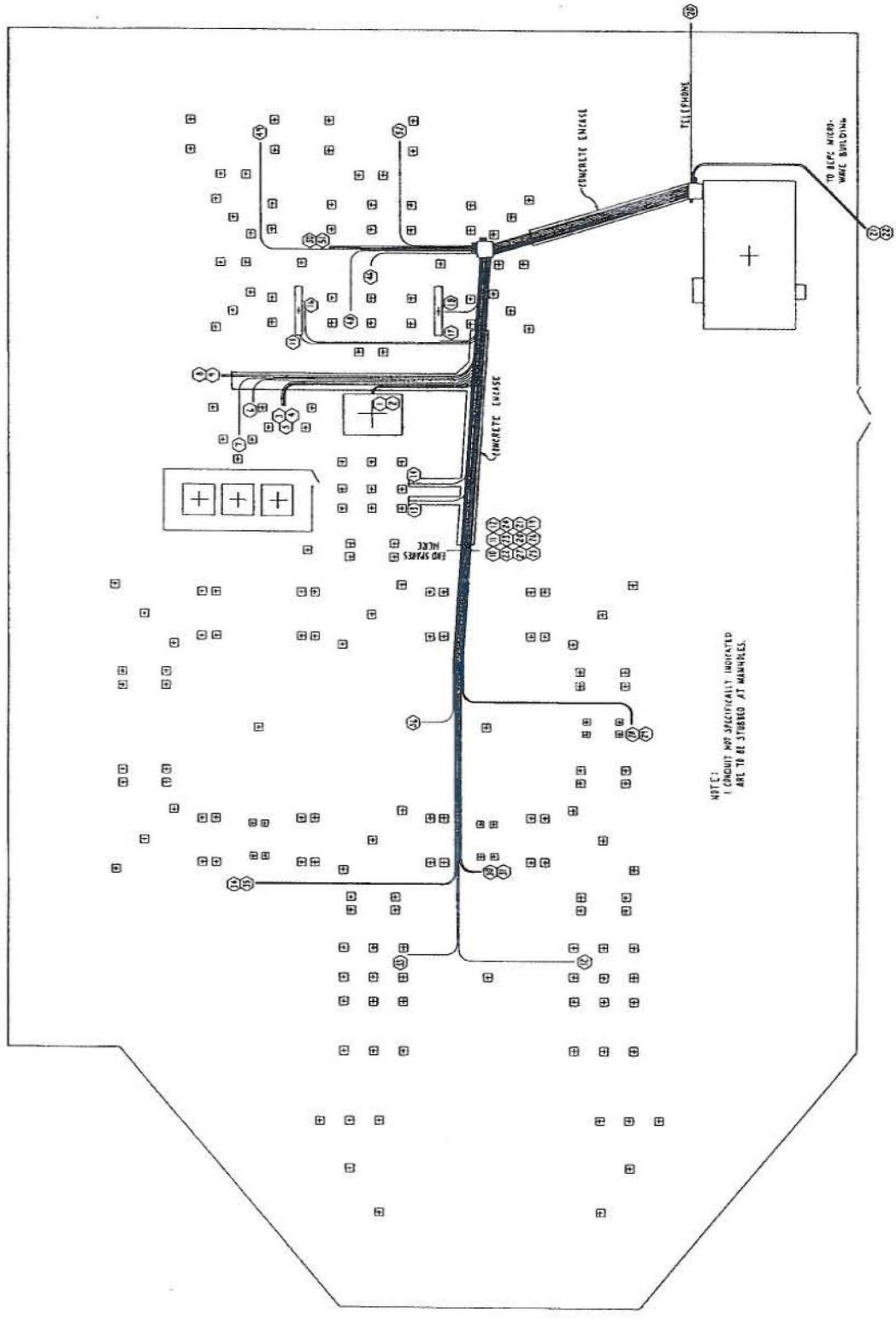
CONDUIT, 3\"/>
LIMIT AND DEPART
TERRACE
MONTANA DAPOTA UTILITIES CO.
NO. 101 101 101 101 101 101 101 101
NO. 101 101 101 101 101 101 101 101

CONDUIT LOCATION	
TABLE 2.30/US IV.518	
OWNER BY	MONTANA-DAKOTA
PROJECT NO.	1-2-D
APPROVED BY	UTILITIES CO.
DATE	4-29-83
PROJECT NO.	87-33

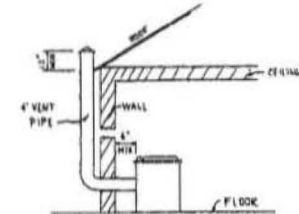
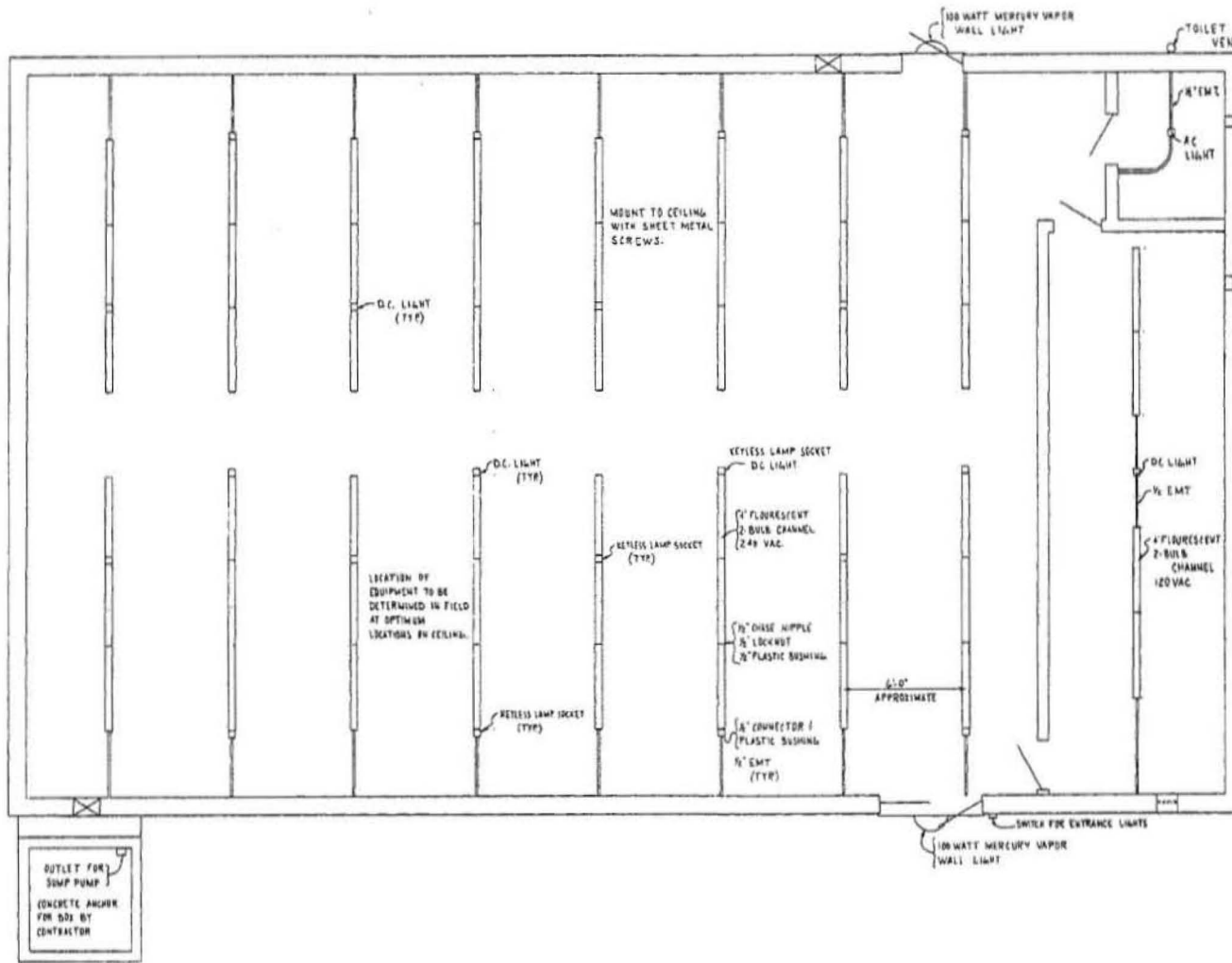
MATERIAL LIST

ITEM	QUANTITY	DESCRIPTION
1	10,000'	3" Galv. 125' DR
2	7	3" Galv. 125' DR
3	18	3" Galv. 125' DR
4	43	3" Galv. 125' DR
5	3	3" Galv. 125' DR
6	3	3" Galv. 125' DR
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10	3	3" Galv. 125' DR

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46	3	3" Galv. 125' DR
47	3	3" Galv. 125' DR
48	3	3" Galv. 125' DR
49	3	3" Galv. 125' DR
50	3	3" Galv. 125' DR



NOTE:
CONDUIT NOT SPECIFICALLY INDICATED
ARE TO BE STUBBED AT MARKERS.

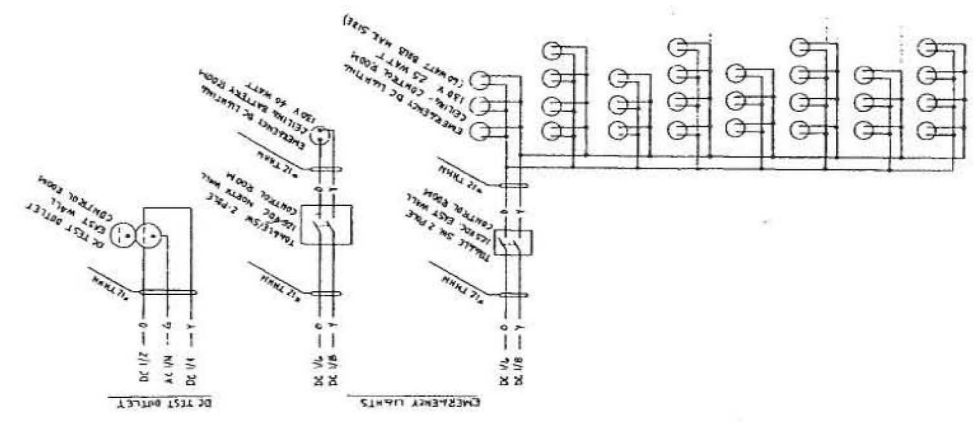
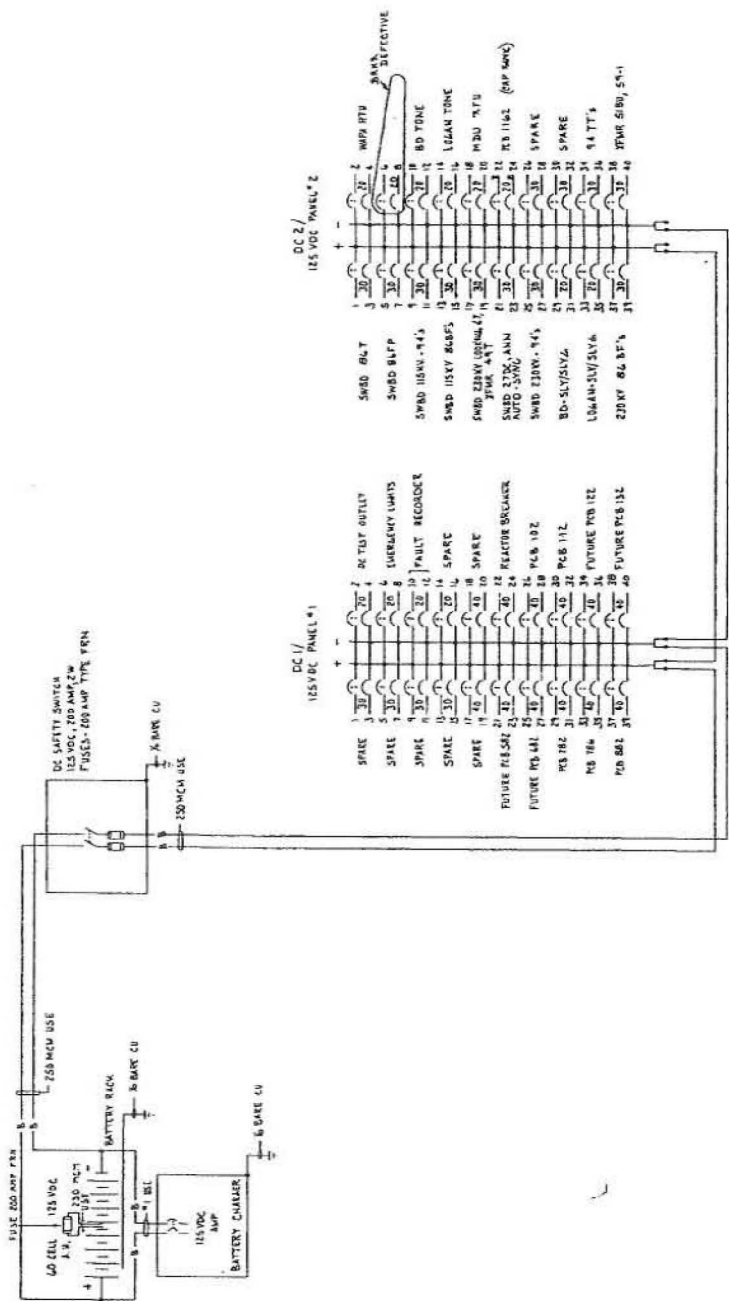


DETAIL OF TOILET VENT
 CONTRACTOR TO FURNISH ALL REQUIRED MATERIALS AND MOUNTING HARDWARE INCLUDING VENT PIPE AND CAP FOR TOILET VENT.

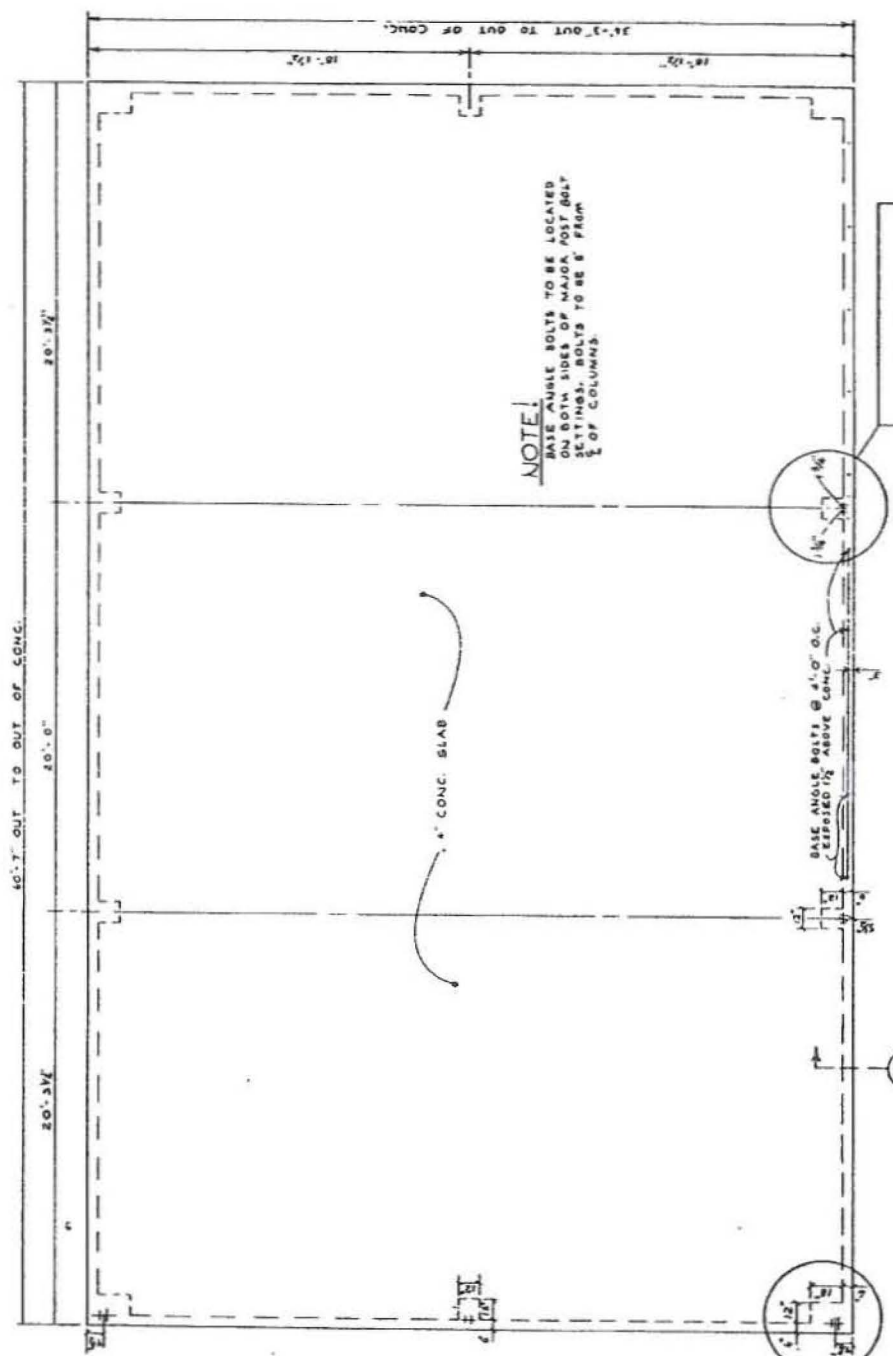
MATERIAL LIST - CEILING EQUIPMENT

- 140 3/4" x 1/2" SHEET METAL SCREWS
- 48 4' FLORESCENT FIXTURES, 2-BULB CHANNELS 240 VAC
- 20 KEYLESS LAMP SOCKETS
- 22 4' OCTAGON HANDY BORES
- 23 1/2" SET SCREW CONNECTORS
- 77 1/2" PLASTIC BUSHINGS
- 8 10' LENGTHS 1/2" EMT
- 5 1/2" STAND OFF CONDUIT CLAMPS
- 20 25 WATT 120 VAC BULBS
- 1 40 WATT 120 VAC BULB
- 104 4' RAPID START FLORESCENT BULBS
- 1 INTERREPTER DUPLEX RECEPTACLE 15A, 120 VAC W/ RAINPROOF COVER
- 2 RAINPROOF HANDY BOX 2 1/2" x 4 1/2"
- 1 1/2" ROMEX CONNECTOR
- 4 4' FLORESCENT FIXTURES, 2 BULB CHANNELS 120 VAC
- 54 1/2" CHASSIS HIPPLES
- 54 1/2" PLASTIC BUSHINGS
- 1 RAINIGHT TGGLE SWITCH COVER
- 2 100 WATT MERCURY VAPOR WALL LIGHT

CONTROL HOUSE CEILING - DETAIL T104A 230/15KV SUB.		
DESIGNED BY NPIW	MONTANA - DAKOTA UTILITIES CO.	SCALE 3/8" = 1'
APPROVED BY DATE 9-3-63	PROJECT NO. 67-62	

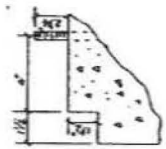
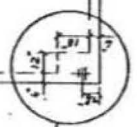
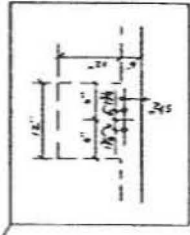


CONTROL HOUSE DE WINDMILL LARAH TULSA DISTRICT SUB.	
DATE BY 10/14	DATE BY 10/14
BY MONTANA - DAKOTA UTILITIES CO.	BY MONTANA - DAKOTA UTILITIES CO.
PROJECT NO. 113 3100 13 13 13	PROJECT NO. 113 3100 13 13 13
REV. NO. 07-05	REV. NO. 07-05



NOTE!
BASE ANGLE BOLTS TO BE LOCATED ON BOTH SIDES OF MAJOR POST BOLT SETTINGS. BOLTS TO BE 8" FROM 1/2" OF COLUMNS.

FOUNDATION PLAN
SCALE: 1/4" = 1'-0"



DETAIL
SCALE: 1/4" = 1'-0"

A&A METAL BLDGS, INC.	
SCALE:	APPROVED BY:
DATE: 3/10/23	LMD
MONTANA DAKOTA UTILITIES COMPANY	
TIOGA SUBSTATION	
ACQUISITION NO. 0221	
REVISION	DATE
1	

CONTROL HOUSE FOUNDATION CURTAIN WALL (MANHOLE DETAILS)	
DATE	6/7-53
BY	W. J. HARRIS
FOR	MONTANA-DAKOTA UTILITIES CO.
PROJECT NO.	5-483
DATE	2/15/53

CONTROL HOUSE REBAR

BAR	SIZE	LAN.	DESCRIPTION
A-B	1/4"	1/4"	3' 11/8" 3"
L-1	3/8"	1/4"	5' 1/4" 6' 3/8"
S-4	100	3/8"	3' 1/2" 3' 1/2"
S-6	98	3/8"	10' 0" 12' 0"
S-8	4	1/2"	5' 4" 5' 4"
L-2	1/4"	1/4"	4' 4" 6' 4' 1/2"
S-1	4	1/2"	9' 4" 9' 4"

MANHOLE # 1

A-7	1/4"	1/4"	3' 11/8" 3"
L-4	1/4"	1/4"	11' 3" 11' 3"
L-5	1/4"	1/4"	1' 0" 1' 0"

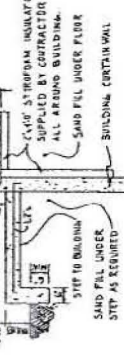
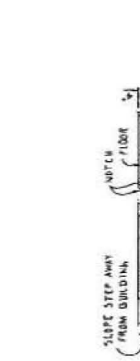
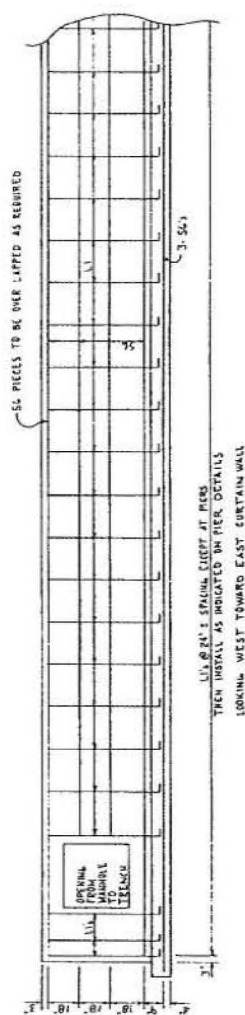
MANHOLE # 2

A-7	1/4"	1/4"	3' 11/8" 3"
L-3	1/4"	1/4"	7' 1/2" 7' 1/2"

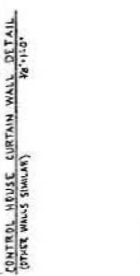
SECTIONAL
MANHOLE

CONTROL HOUSE
MANHOLE FLOORS

CONTROL HOUSE ESTIMATED
CONCRETE 110 CU YDS.
FLOORS TO BE FLAT LEVEL, AND HAVE
STEEL TRAVEL FINISH. POWER TRAVEL
BUILDING FLOOR TO BE 1' ABOVE GRADE-MIN.

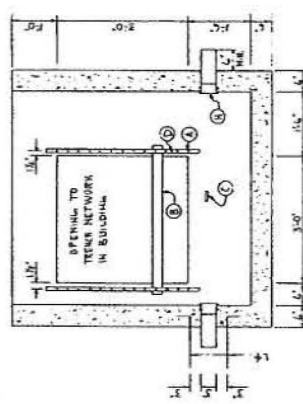


STEP INSTALLATION DETAIL
1/4" x 10"

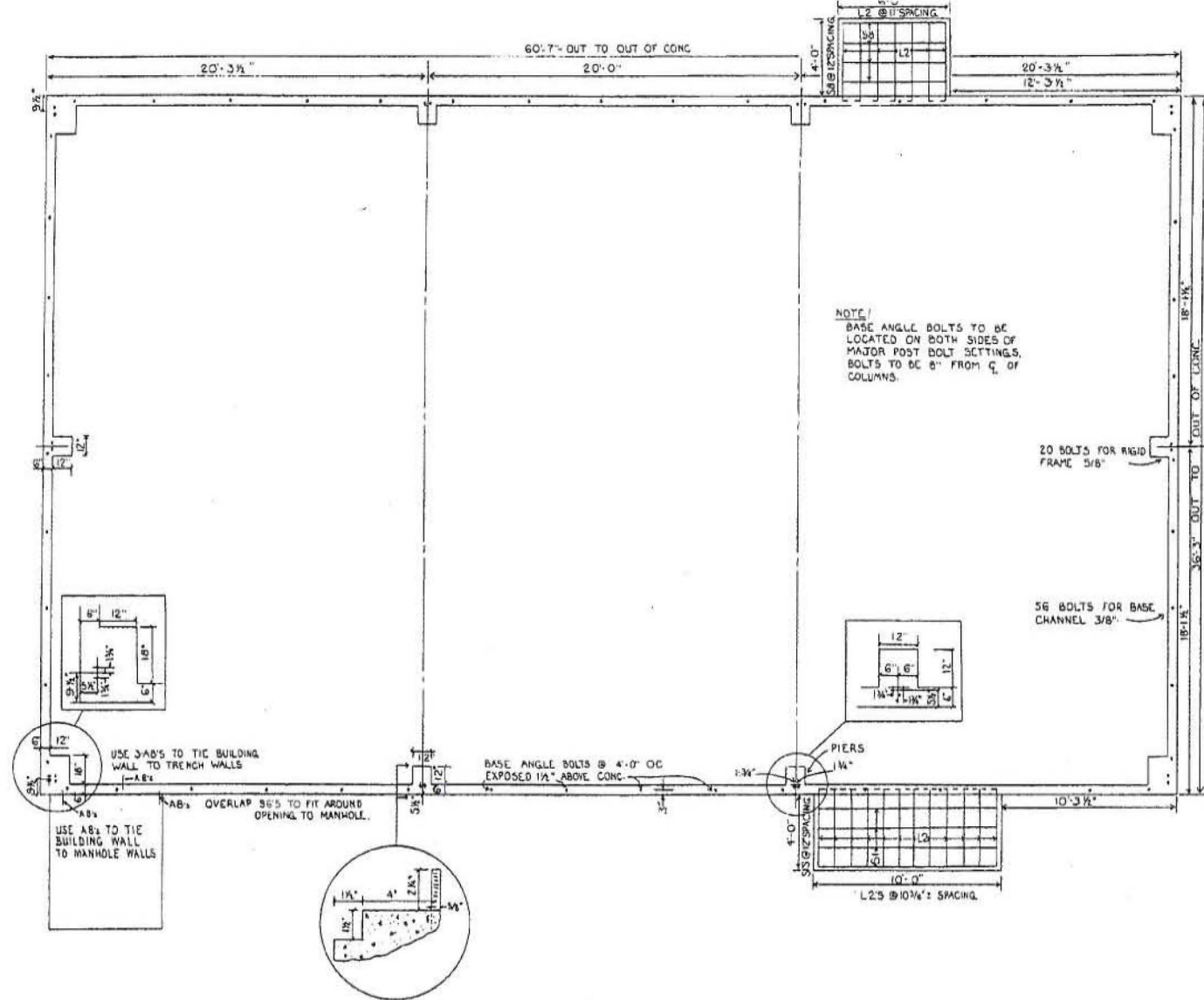


CARBON INSTALLATION DETAIL
1/4" x 10"

- MATERIALS BY CONTRACTOR
- 11-16" x 1/2" MACHINE BARS W/WRITS. BARS ANCHORED IN CONCRETE. BARS TO BE SET IN CONCRETE 1/4" (7 BARS) ON EACH SIDE OF OPENING.
 - 4-1/2" x 3/4" OAK BANDS
 - 3-7/8" STEEL BARS W/WRITS ANCHORED IN CONCRETE. BARS TO BE SET 1/4" FROM TOP OF MANHOLE.
 - 2-1/4" x 1/4" STEEL STRAP USED TO HOLD THE BANDS IN PLACE.
 - FLOORS OF MANHOLES TO HAVE WIRE MESH AREA BY MANHOLE.
 - OUTSIDE OF MANHOLE WALLS TO BE SEALED BELOW GRADE. SEAUME SUPPLIED BY CONTRACTOR.
 - ESTIMATED CONCRETE 110 CU YDS.
 - MANHOLE # 2 - 4.5 CU YDS.
 - 3" CARBON CONDUIT W/BELL END INSTALL AS INDICATED ON MANHOLE DETAIL DRAWING.
 - U.S. TO EXTEND OUTWARD FROM BAY WALL OF MANHOLE #1 ONLY. INSTALLATION AS SHOWN ON LEFT IS TYPICAL.



CONTROL HOUSE MANHOLE #1
INTERIOR DETAIL
1/4" x 10"



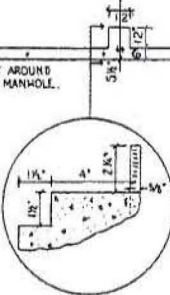
NOTE:
 BASE ANGLE BOLTS TO BE
 LOCATED ON BOTH SIDES OF
 MAJOR POST BOLT SETTINGS.
 BOLTS TO BE 8" FROM C. OF
 COLUMNS.

20 BOLTS FOR RIGID
 FRAME 5/8"

56 BOLTS FOR BASE
 CHANNEL 3/8"

USE 3-A8'S TO TIE BUILDING
 WALL TO TRENCH WALLS

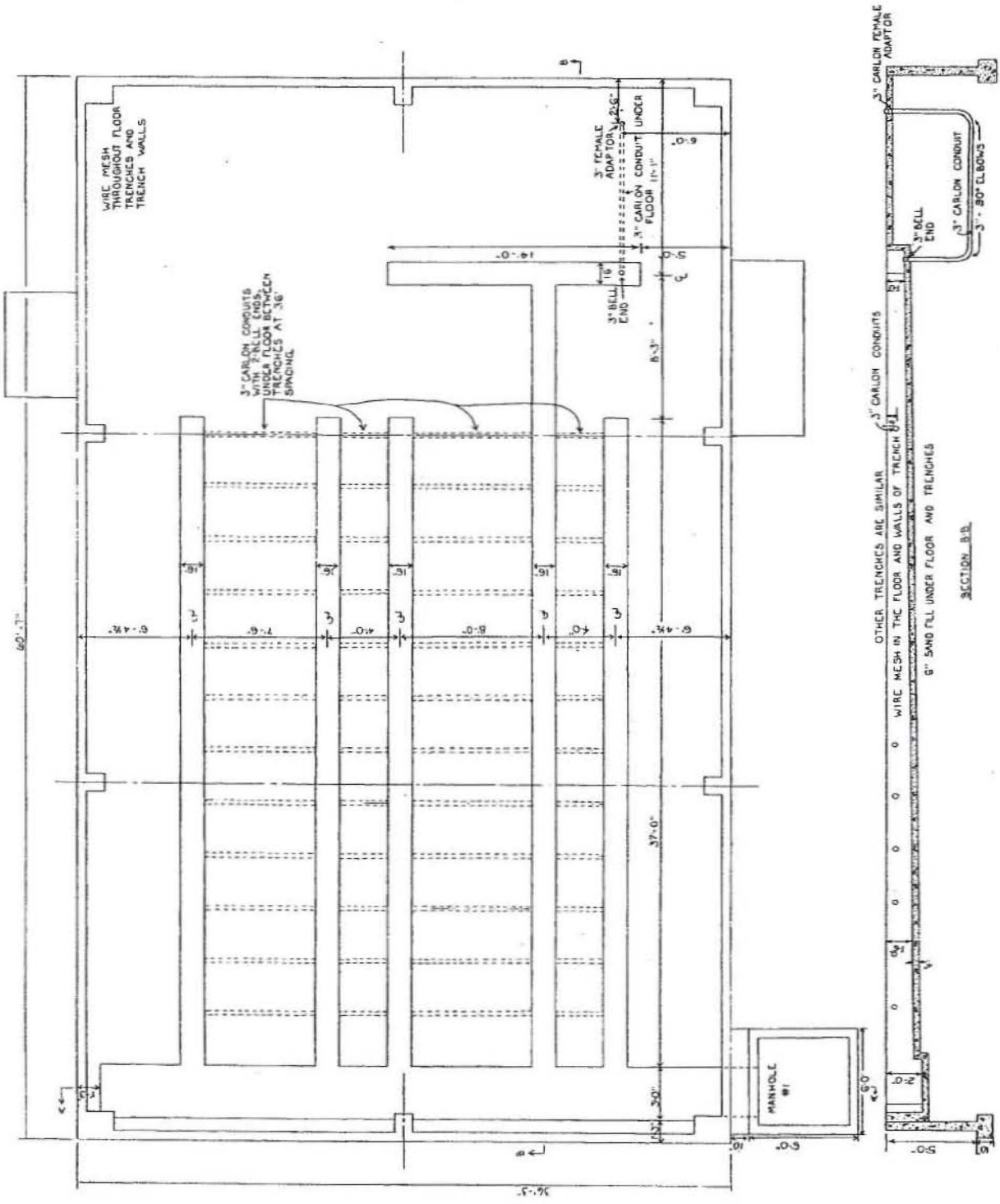
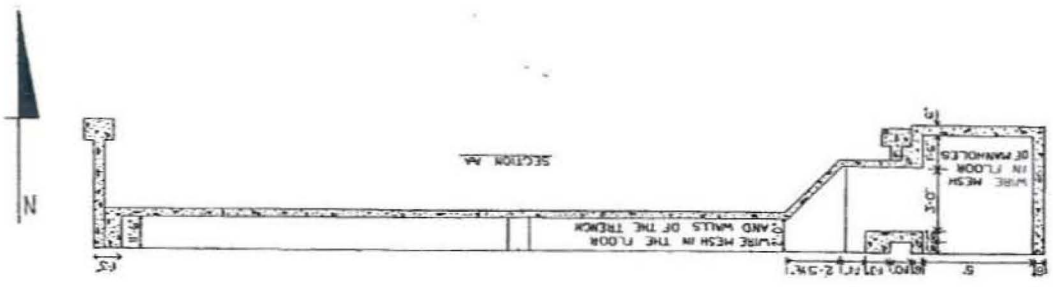
USE A8'S TO TIE
 BUILDING WALL
 TO MANHOLE WALLS

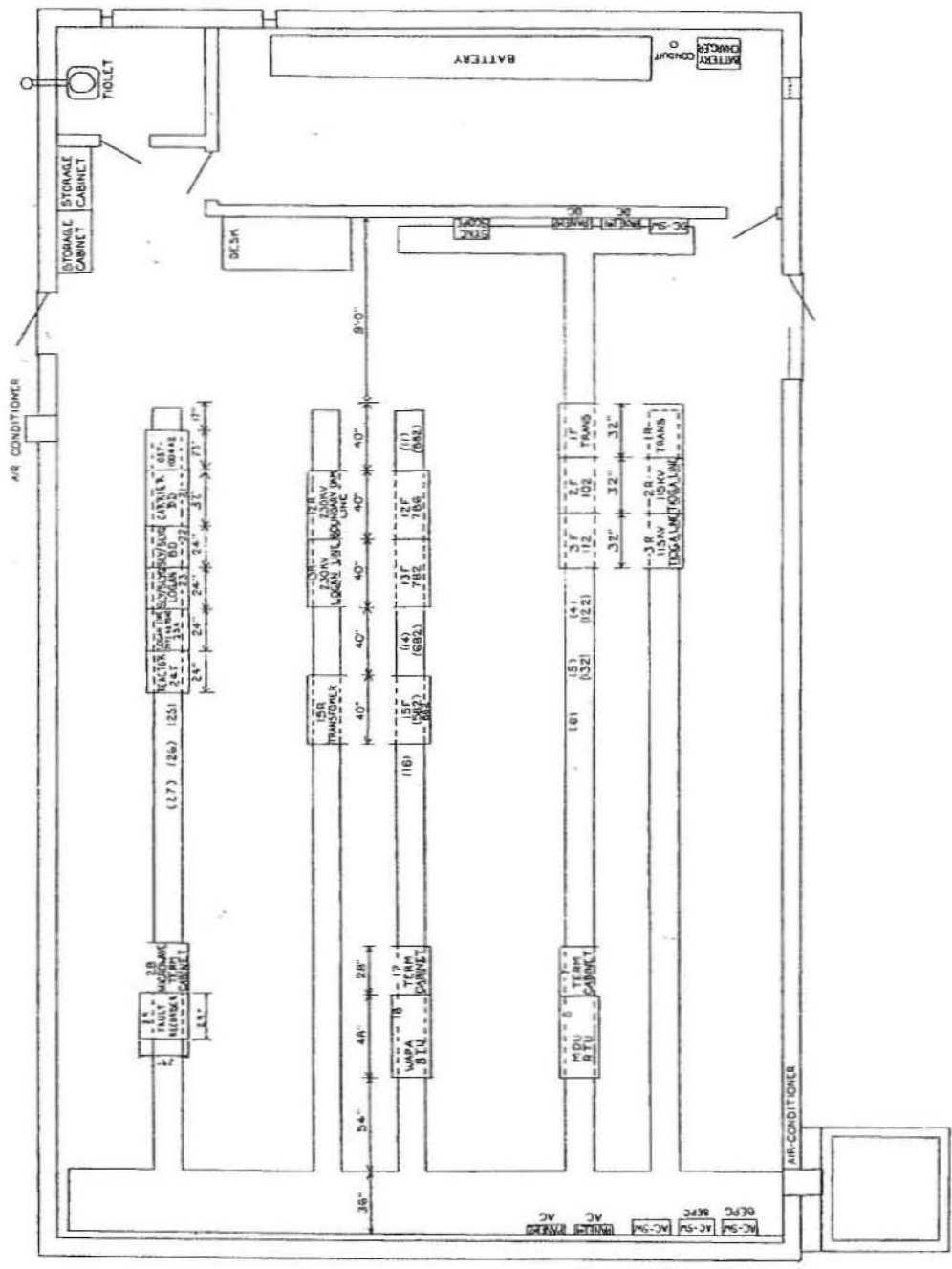


DETAIL
 SCALE 3/4" = 1"

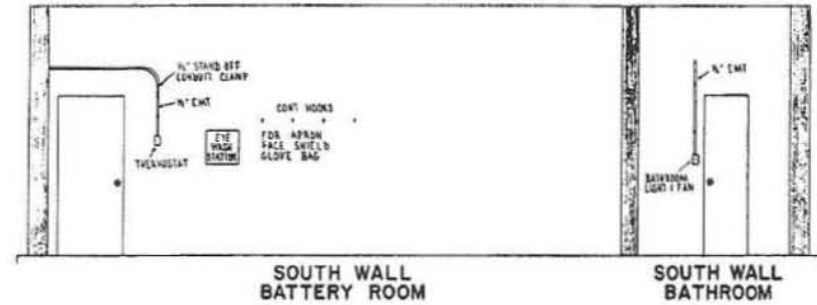
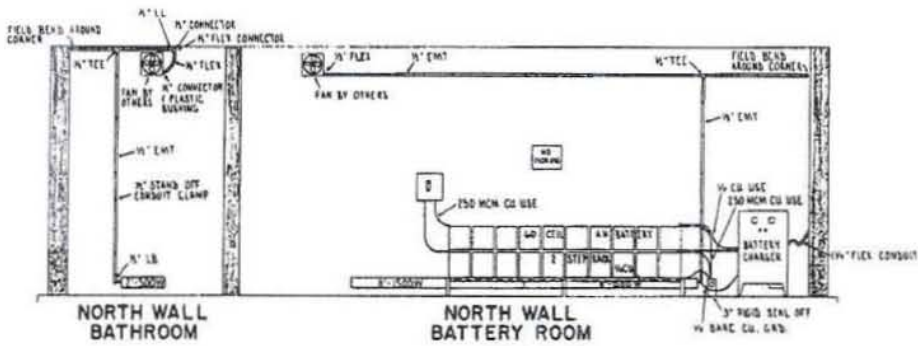
FOUNDATION CURTAIN WALL DETAIL			
CONTROL HOUSE			
TIOGA 230/115 KV SUB			
DESIGNED BY JRS	MONTANA-DAKOTA UTILITIES CO.	SCALE 3/8" = 1"	SHEET 67-52
APPROVED BY		DATE 4-21-85	

FOUNDATION FLOOR DETAIL		SCALE
CONTROL HOUSE		3/8" = 1'
TIOGA 230/115 KV SUB		DATE
MONTANA-DAKOTA		11/19/77
UTILITIES CO.		PROJECT NO.
SHEET NO. 67-54		

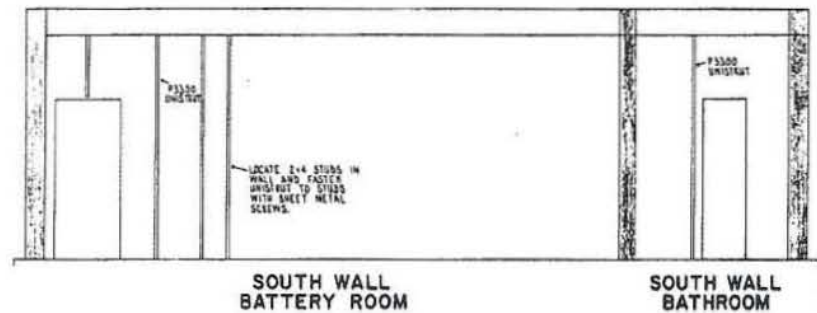
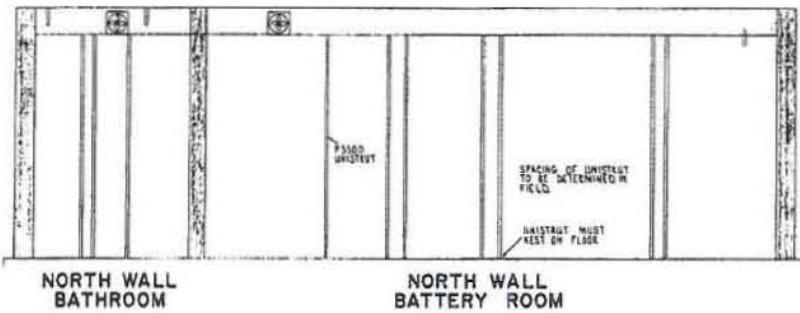




MAJOR EQUIPMENT DETAIL			
CONTROL HOUSE			
TIOGA 230/115 KV SUB			
MONTANA - DAKOTA			
UTILITIES CO.			
REV. 67-56			
NO.	DATE	BY	REVISION
1	1-10	JAS	INITIAL
2	2-11	JAS	REVISED



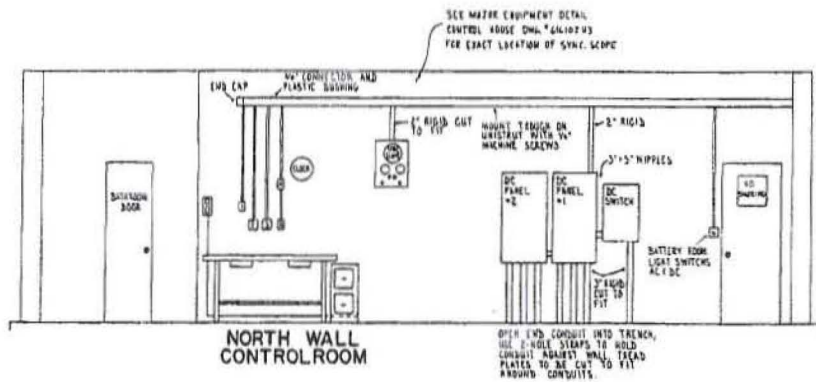
- COMPONENT LIST**
- 2 Exhaust Fans 80 CFM by others
 - 1 Battery Charger, 2ND FAC 36 125 VDC
 - 40 Cells Battery, 128 VDC
 - 1 2-Step Battery Rack
 - 1 No-Smoking Sign



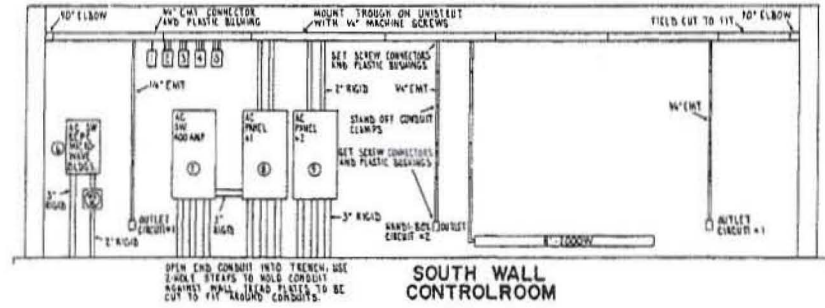
- MATERIAL LIST NORTH WALL**
- 11 10' Length P3300 Unistrut
 - 33 1/2" x 12 Sheet Metal Screws
 - 40 1/4 x 3/4 Machine Screws
 - 40 1/4" Nuts for P3300
 - 2 #1-1500 Watt Heater 240VAC
 - 1 2'-000 Watt Heater 120VAC w/Thermistor
 - 1 1/2" Plastic Bushings
 - 10 1/4" Flex Conduits
 - 1 1/4" Flex Connector
 - 8 10' Length 1/2" EMT
 - 1 1/2" 18 Conduit Baffle
 - 1 1/2" 18 Conduit Body
 - 20 1/2" Conduit Bodies
 - 4 1/2" Connectors
 - 16 1/2" Stand Off Conduit Clamps
 - 4 1/2" Plastic Bushings
 - 8 1/2" Flex Conduits
 - 8 1/2" Flex Connectors
 - 2 1/2" Plastic Bushings
 - 1 3" Seal Off Vertical Quick-Clamp Solder
 - 1 3" x 6" Nipple
 - 1 3" Grounding Bushing
 - 1 1/4" x 1/2" x 6" JIC Box w/Pan
 - 1 Fuse Block 250 Amp 1P

- MATERIAL LIST SOUTH WALL**
- 4 10' Length P3300 Unistrut
 - 10 1/2" x 12 Sheet Metal Screws
 - 12 1/4 x 3/4 Machine Screws
 - 12 1/4" Nuts for P3300
 - 2 2 1/8 x 4 Handy Boxes
 - 1 810w Consp, 2 1/8 x 4
 - 1 Toggle Sw. Cover 2 1/8 x 4
 - 1 Toggle Sw. 993
 - 2 10' Length 3/4" EMT
 - 2 1/2" Set Screw Connectors
 - 2 1/2" Plastic Bushings
 - 6 1/2" Stand Off Conduit Clamps
 - 1 1/2" 18 Conduit Body
 - 1 Eye Wash Station
 - 1 Conk Hooks

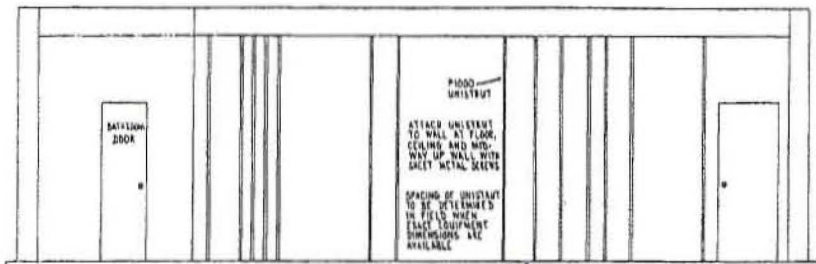
CONTROL HOUSE WALL DETAILS		
NORTH AND SOUTH BATTERY ROOM WALLS		
NORTH AND SOUTH BATHROOM WALLS		
TIOGA 230/115KV SUB		
DESIGNED BY	MONTANA-DAKOTA UTILITIES CO.	SCALE 3/8"=1'
APPROVED BY	DATE 4-1-53	FILE NO. 67-58



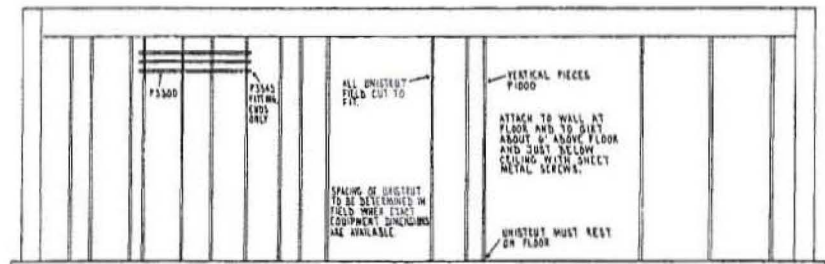
- EQUIPMENT LIST**
- | | |
|---|---|
| 1 DC Panel #1, 125 VDC
2-Pole, 225 A | 1 30 Test Outlet |
| 1 DC Panel #1, 125 VDC
2-Pole, 225 A | 1 120 VAC, 30 Amp Test
Outlet |
| 36 Amp, 125 VDC, 2-Pole
200 A | 1 120 VDC, 20 Amp Test
Outlet |
| 30 x 72 Table w/2 Drawers | 1 Clock Outlet, 120 VAC
10 A HOUR CIRCUIT #1 |
| 2-Drawer File Cabinet | 1 Outlet, 120 VAC, 20 A
House (Circuit #2) |
| | Non-Breaking Sign |
| | Telephone |



- EQUIPMENT LIST - SOUTH WALL**
- | | |
|------------------------------------|---|
| 1 Time Clock | 1 1/8\" 700 Watt Baseboard
Heater |
| 1 Battery Room Fan | 1 Water Jacket and 1/2 HP
Water-Hour Meter |
| 1 Contactor
Control Room Heat | 1 AC SW, 240V, 16, 800A |
| 1 Contactor
Battery Room Heat | 1 AC SW, 240V, 36, 650A |
| 1 Contactor
Air Conditioner | 1 AC Panel #1, 240V, 36 225A |
| 1 Contactor
Control Room Lights | 1 AC Panel #2, 240V, 16 225A |



- MATERIAL LIST NORTH WALL**
- | | |
|---------------------------------------|---------------------------------|
| 14 10\" Length P3300 Unistrut | 1 10\" Length 2\" Rigid Conduit |
| 47 1 1/2\" x 1/2\" Sheet Metal Screws | 2 2\" Conduits |
| 16 1/2\" Nut for P3300 | 4 2\" Grounding Bushings |
| 11 1/8\" x 3/16 Machine Screws | 2 3\" x 1/2\" x 3\" Long |
| 37 1/4\" Nut for P3300 | 2 10\" Length 3\" Rigid Conduit |
| | 27 3\" Conduits |
| | 16 3\" Bushings |
| 1 2 1/8\" x 4 Hand Boxes | 14 3\" Rigid 2-Hole Straps |
| 1 Black Handy Box Cover | 1 1/4\" Red Head Anchors |
| 1 Duplex Receptacle Cover | 1 4 x 4 x 3\" Truss Length |
| 1 4 x 4 Hand Boxes | 1 4 x 4 U-Connectors |
| 1 Single Receptacle Cover | 1 4 x 4 90\" Elbow |
| 1 4 x 4 1 9/16 | 1 4 x 4 End Cap |
| 1 Two Duplex Receptacle Cover 4 x 4 | |
| 1 Two Toggle Switch Cover 4 x 4 | |
| 1 Thermocut with Heat-Cool Switches | |
| 1 24 Receptacle | |
| 1 DC Duplex Receptacle - Tandem Slots | |
| 1 Duplex Receptacle | |
| 1 Toggle Sw. 1PST | |
| 1 Toggle Sw. 2PST - DC | |
| 2 10\" Length 3/4\" ODF | |
| 12 3/4\" EMT Connectors | |
| 12 3/4\" Plastic Bushings | |
| 10 3/4\" EMT Stand-Off Clamps | |

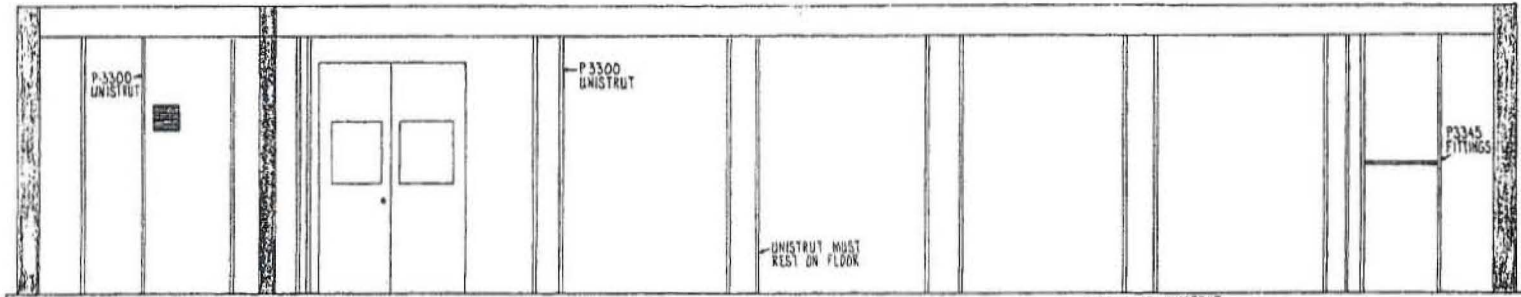
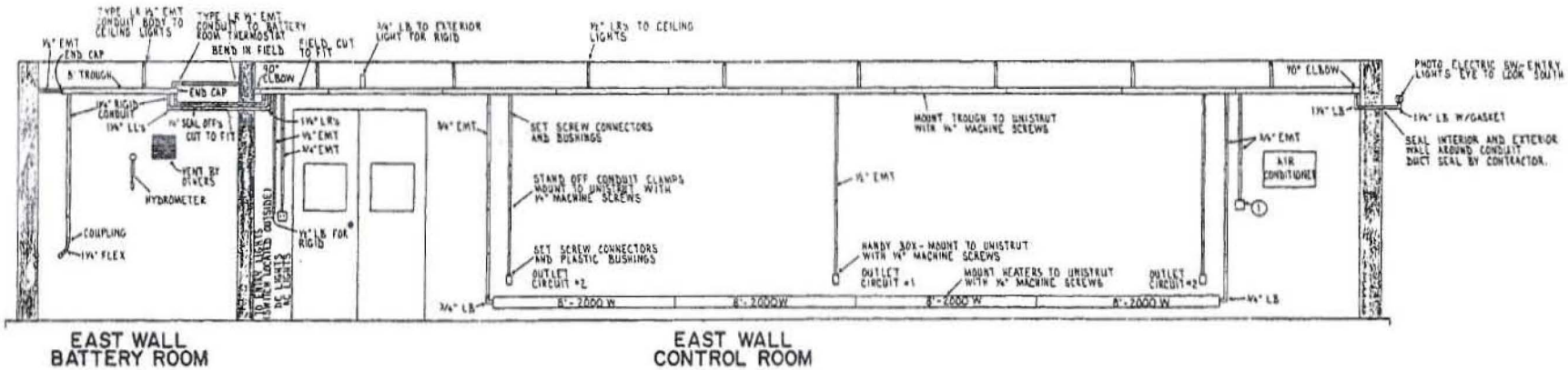


- MATERIAL LIST SOUTH WALL**
- | | |
|---------------------------------------|---------------------------------------|
| 14 10\" Length P3300 Unistrut | 2 10\" Length 2\" Rigid Steel Conduit |
| 2 10\" Length P3300 Unistrut | 22 2\" Conduits |
| 3 P3345 Unistrut Fittings | 12 2\" Plastic Bushings |
| 46 1 1/2\" x 1/2\" Sheet Metal Screws | 1 2\" Rigid 2-Hole Strap |
| 23 1/8\" x 3/16 Machine Screws | 7 4 x 4 x 3\" Truss Length |
| | 8 4 x 4 U-Connectors |
| | 2 4 x 4 90\" Elbow |
| 24 1/2\" Nut for P3300 | |
| 100 1/4\" x 3/4 Machine Screws | |
| 20 1/4\" Nut for P3300 | |
| 80 1/4\" Nut for P3300 | |
| 1 3/4\" LB Hex Screw Type w/cover | |
| 1 1/8\" x 4 Hand Boxes | |
| 1 Duplex Receptacle Covers | |
| 1 Duplex Receptacle 3-wire | |
| 10 3/4\" EMT Connectors | |
| 18 3/4\" EMT Stand-Off Clamps | |
| 4 10\" Length 3/4\" ODF | |
| 4 10\" Length 3\" Rigid Conduit | |
| 1 3\" Rigid Nipple 10\" Long | |
| 24 3\" Conduits | |
| 12 3\" Bushings | |
| 10 3\" Rigid 2-Hole Strap | |
| 12 1/4\" Red Head Anchors | |
| 26 3/4\" Plastic Bushings | |



CONTROL HOUSE WALL DETAILS
NORTH AND SOUTH CONTROL ROOM WALLS
TIOGA 230/115KV SUB

DESIGNED BY	MONTANA-DAKOTA	SCALE	3/8\" = 1\"
APPROVED BY	UTILITIES CO.	FILE NO.	
		DATE	87-80



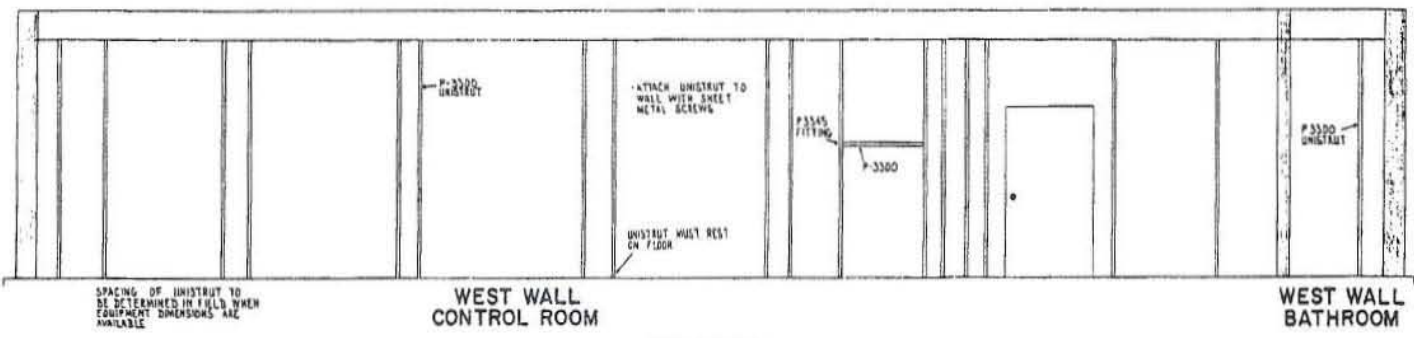
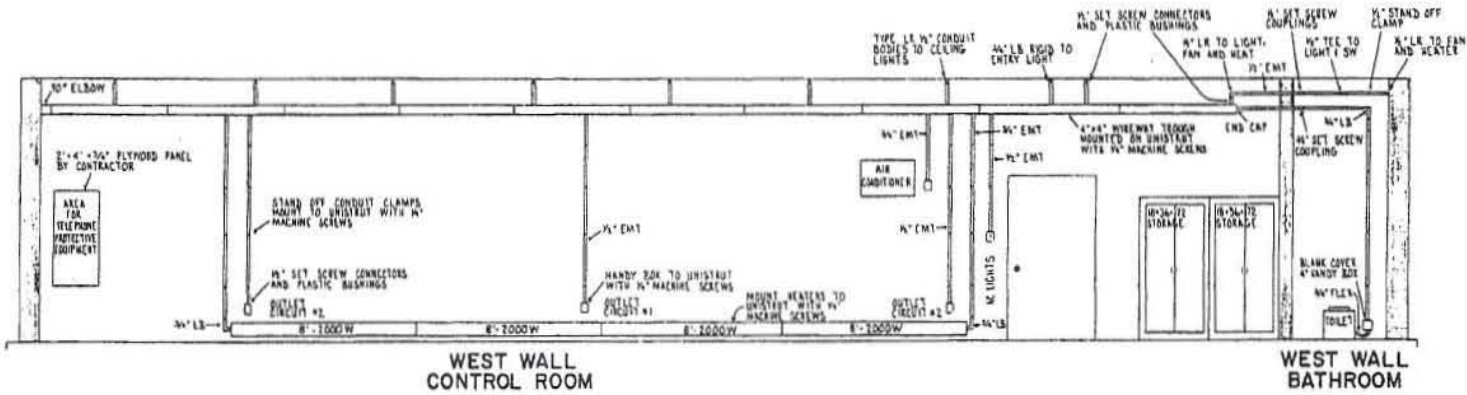
EAST WALL BATTERY ROOM

- MATERIAL LIST EAST WALL
- 10 10' Lengths P3300 Unistrut
 - 50 1 3/2 x 1/2 Sheet Metal Screws
 - 80 1/4 x 3/4 Machine Screws
 - 80 1/4" Nuts for P3300
 - 7 P3345 Unistrut Fittings
 - 4 1/2" x 15/16 Machine Bolts
 - 4 1/2" Nuts for P3300
 - 4 8"-2000 Volt Heaters 240 VAC
 - 2 4" x 4" Handy Boxes
 - 1 1-Toggle Sw, Cover Plate
 - 1 2-Toggle Sw, Cover Plate 4x4
 - 1 Toggle Sw, SPST 120VAC Easy Lights
 - 1 Toggle Sw, DPST 120VAC DC Lights
 - 1 Toggle Sw 3-way Control Room Lights
 - 4 2 1/2 x 4" Handy Boxes
 - 1 Duplex Receptacle Cover 2 1/2 x 4
 - 2 Duplex Receptacle 120VAC 3-wire
 - 1 Photo Electric SW, SPST 120VAC 1500W
 - 1 Photo Sw, Socket to 1 1/4" Conduit
 - 2 1 1/4 LB Conduit Baskets 1-w/Gasket
 - 2 1 1/4" Ripples 3' Long
 - 1 1 1/4" Ripple 4' Long
 - 1 1 1/4" Ripple 9' Long

EAST WALL CONTROL ROOM

- 1 1 1/4" Ripple 10' Long
- 1 1 1/4" Ripple 12' Long
- 1 1 1/4" Rigid Conduit 10' Length
- 2 1 1/4 LB Conduit Body
- 2 1 1/4 LB Conduit Body
- 2 1 1/4" Conduit Seal Horizontal
- 1 1 1/4" Conduit Seal Horizontal
- 1 1 1/4" Locknuts
- 6 1 1/4" Plastic Bushings
- 5 1 1/4" Rigid Stand Off Conduit Clamps
- 4 3/4" EMT 10' Lengths
- 3 2 1/4" LB Conduit Baskets
- 8 1/2" LB Conduit Baskets
- 8 3/4" EMT Connectors
- 8 3/4" Plastic Bushings
- 12 3/4" EMT Stand Off Conduit Clamps
- 10 1/2" EMT Conduit 10' Length
- 10 1/2" EMT Connectors
- 10 1/2" Plastic Bushings
- 16 1/2" EMT Stand Off Conduit Clamps
- 1 30 Amp Receptacle 3-wire Tandem Slots
- 1 4" No. Receptacle Cover for 30A
- 1 Bell Haulights Box for Toggle Sw.
- 1 1/2" LB for Rigid
- 1 1/4" LB for Rigid
- 11 4 x 4 x 8' Runway Trough Lengths
- 4 4 x 4 90° Elbow
- 13 4 x 4 1/2-Connectors
- 2 4 x 4 End Caps

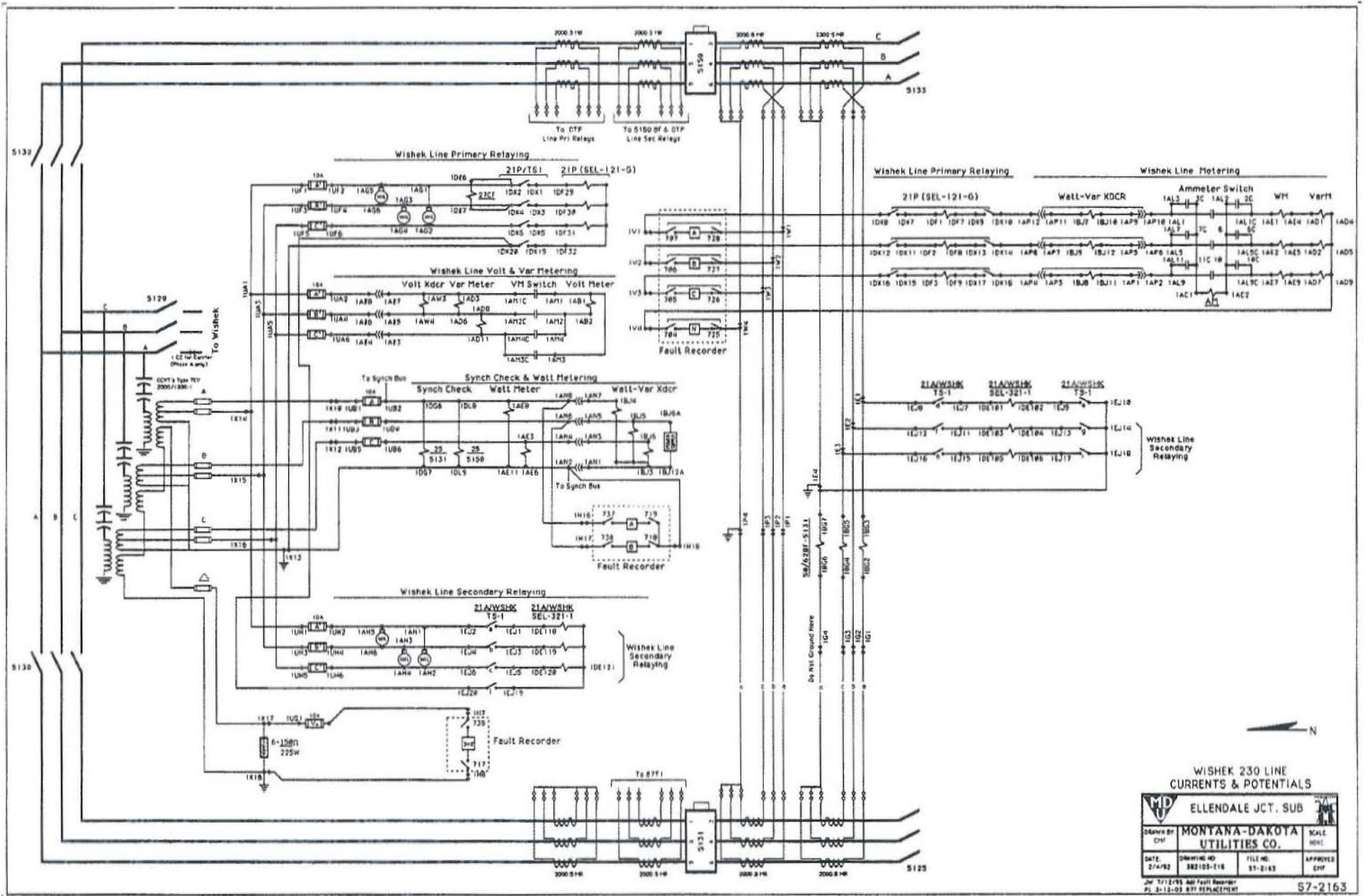
CONTROL HOUSE WALL DETAILS			
EAST WALL			
TIOGA 230/115KV SUB.			
DESIGNED BY	MONTANA-DAKOTA	SCALE	3/8" = 1'
APPROVED BY	UTILITIES CO.	FILE NO.	67-61
DATE	3-28-63	PROJECT NO.	



MATERIAL LIST WEST WALL

- | | | | |
|----|--------------------------------------|----|--|
| 10 | 10' Lengths P3300 Unistrut | 16 | 1/2" Stand Off Conduit Clamps |
| 54 | 1 1/2" x 12 Sheet Metal Screws | 14 | 3/4" Stand Off Conduit Clamps |
| 91 | 1/4" x 3/4 Machine Screws | 1 | 1/2" Set Screw Couplings |
| 91 | 1/4" Nuts for P3300 | 16 | 1/2" Set Screw Connectors |
| 2 | P3300 Unistrut Fittings | 16 | 1/2" Plastic Bushings |
| 4 | 1/2" x 1 1/8 Hexcrete Nuts | 1 | 20 Amp Receptacle Tension Sloss |
| 4 | 1/2" Nuts for P3300 | 1 | 4" Square Box Cover for 30A Receptacle |
| 4 | 8" x 2000 Wall Hangers 740 VAC | 1 | 3/4" LB for R-104 |
| 2 | 4" x 4" Handy Boxes | 10 | 6" x 4" x 5' Hfrway Trough Lengths |
| 1 | 4" x 4" Blank Cover Plate | 11 | 4 x 4 U-Connectors |
| 1 | Toggle Sw. Cover Plate | 1 | 4 x 4 End Cap |
| 1 | Toggle Sw. 3-way Control Room Lights | 1 | 4 x 4 90° Elbow |
| 4 | 2 1/8 x 4 Handy Boxes | | |
| 3 | Duplex Receptacle Cover 2 1/8 x 4 | | |
| 3 | Duplex Receptacle 120 VAC 3-wire | | |
| 2 | 3/4" Flex Conduit | | |
| 2 | 3/4" Flex Connectors | | |
| 5 | 10' Lengths 3/4" EMT | | |
| 4 | 2 1/2" LB Conduit Baffles | | |
| 10 | 1/2" LB Conduit Baffles | | |
| 1 | 1/2" T Conduit Bldg | | |
| 8 | 2 1/2" Set Screw Connectors | | |
| 1 | 3/4" Set Screw Couplings | | |
| 9 | 3/4" Plastic Bushings | | |

CONTROL HOUSE WALL DETAILS		
WEST WALL		
TIOGA 230/115KY SUB.		
DRAWN BY	MONTANA-DAKOTA	SCALE
ENGR'D BY	UTILITIES CO.	3/8" = 1'
DATE	4-2-83	FILE NO.
	PARSONS	67-59

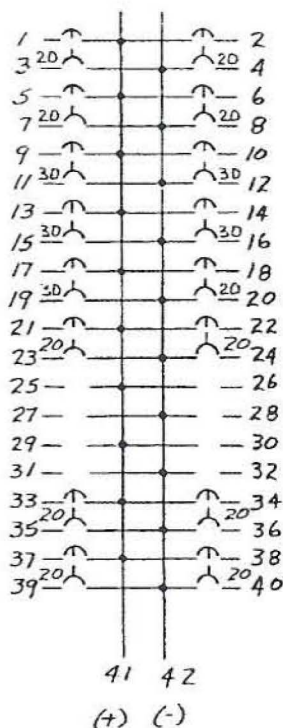


WISHEK 230 LINE
CURRENTS & POTENTIALS

ELLENDALE JCT. SUB		MONTANA-DAKOTA UTILITIES CO.	
DESIGNED BY CHF	DATE 2/4/92	SCALE NONE	APPROVED CHF
DRAWING NO. S82105-118	FILE NO. S1-2163	JW 7/12/95 Add Fault Recorder PL 2-12-95 871 REPLACEMENT	

S7-2163

BAKER PRI. RELAYING	BAKER SEC. RELAYING
NEW UNDERWOOD PRI. RELAYING	NEW UNDERWOOD SEC. RELAYING
86BF/ 86TTBF-2	86BF/ 86TTBF-1
86BF/ 86FP.63FPX	86T-1.49TX 943/62X-3
90.59N1.81 59B.59N2	ANNUNCIATOR
SPARE	SPARE
SPACE	SPACE
SPACE	SPACE
CONTROL RM LIGHTS	BATTERY RM LIGHTS
MDU RTU	WESTERN RTU



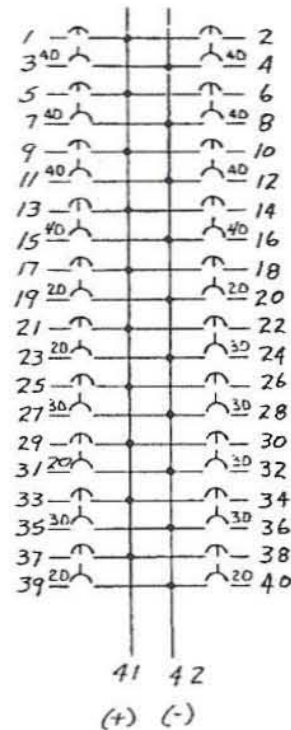
125VDC - 225 AMP, 1Ø 2W
10000 AMP INTERRUPTING
NEMA TYPE 1 ENCLOSURE
MAIN BUS TO HAVE FEED
THROUGH LUGS.
40-1 POLE SPACERS WITH
THE FOLLOWING BREAKERS:
5-30AMP-2 POLE
11-20AMP-2 POLE

SAMPLE DRAWING

DC PANEL # 1 HETTINGER JCT SUB.		
DRAWN BY DLG	MONTANA-DAKOTA UTILITIES CO.	SCALE
APPROVED BY	DATE 4-1-81	FILE No.
	DRAWING No. 040181-5	


230 PCB =	230 PCB =
FUTURE PCB =	230 PCB =
FUTURE PCB =	REACTOR PCB =
SPARE	SPARE
SPARE	SPARE
SPARE	FUTURE MDS
FUTURE MDS	FUTURE MDS
TEST OUTLET	SPARE
NEW UNDERWOOD PRI BKR TONE	NEW UNDERWOOD SEC. TONE
BAKER PRI. BKR. TONE	BAKER SEC TONE

125VDC - 225 AMP, 1# 2W
10000 AMP INTERRUPTING
NEMA TYPE 1 ENCLOSURE
MAIN BUS TO HAVE FEED
THROUGH LUGS
40-1 POLE SPACERS WITH
THE FOLLOWING BREAKERS:
8-40 AMP - 2 POLE
6-30AMP - 2 POLE
6-20 AMP - 2 POLE

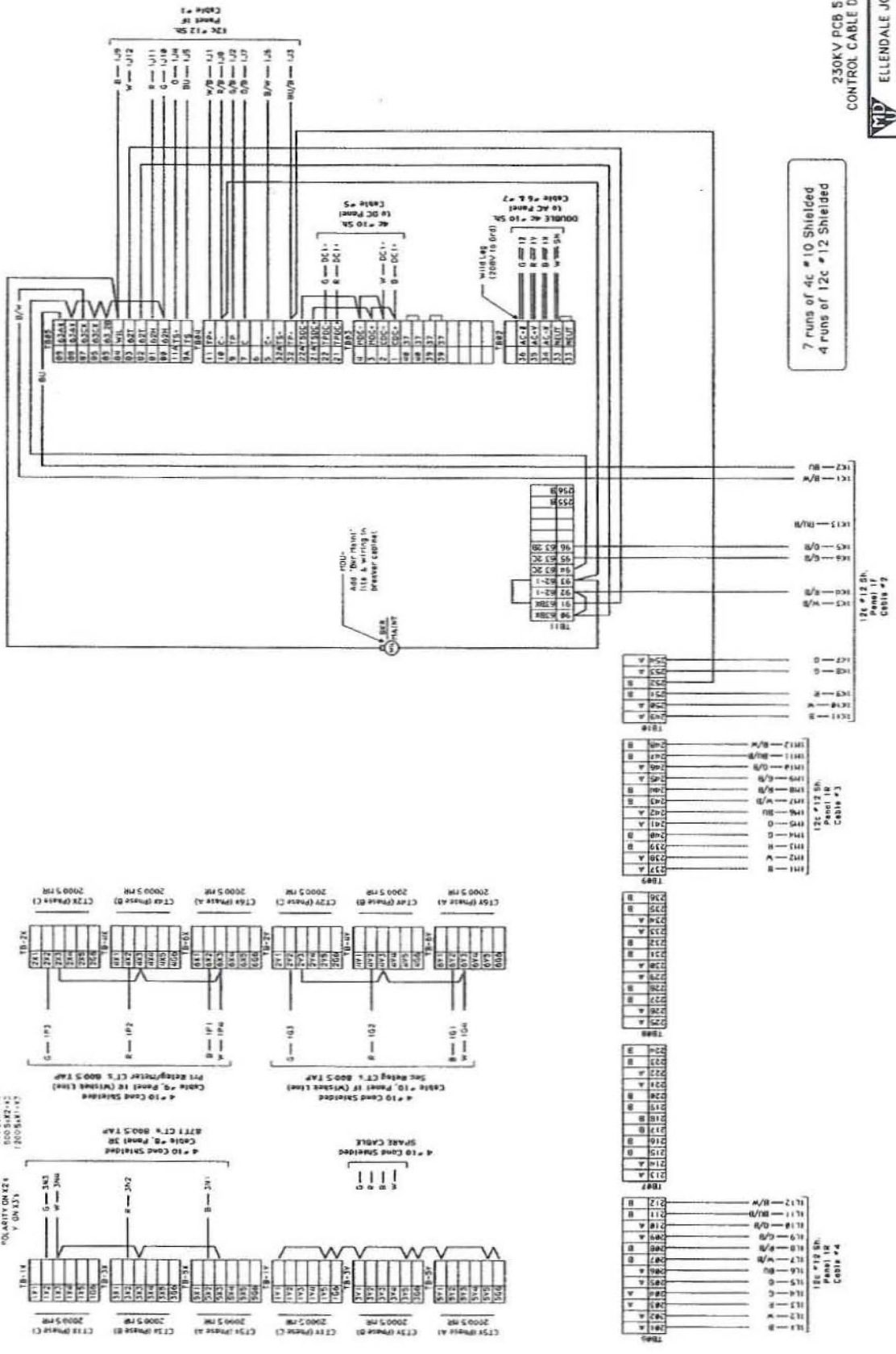


SAMPLE DRAWING

DC PANEL #2 HETTINGER JCT SUB.			
DRAWN BY DLG	MONTANA-DAKOTA UTILITIES CO.		SCALE
APPROVED BY	DATE 4-1-81	DRAWING No. 040181-6	FILE No.


ELLENDALE JCT SUB
 DRAWN BY: MONTANA-DAKOTA UTILITIES CO.
 DATE: 4/25/92
 CHECKED BY: 12/12/92
 FILE NO: 57-2408
 SHEET NO: 57-2408
 PROJECT: PL. 2-24-03 BIT REPLACEMENT
 P. 5-10-93 Correction

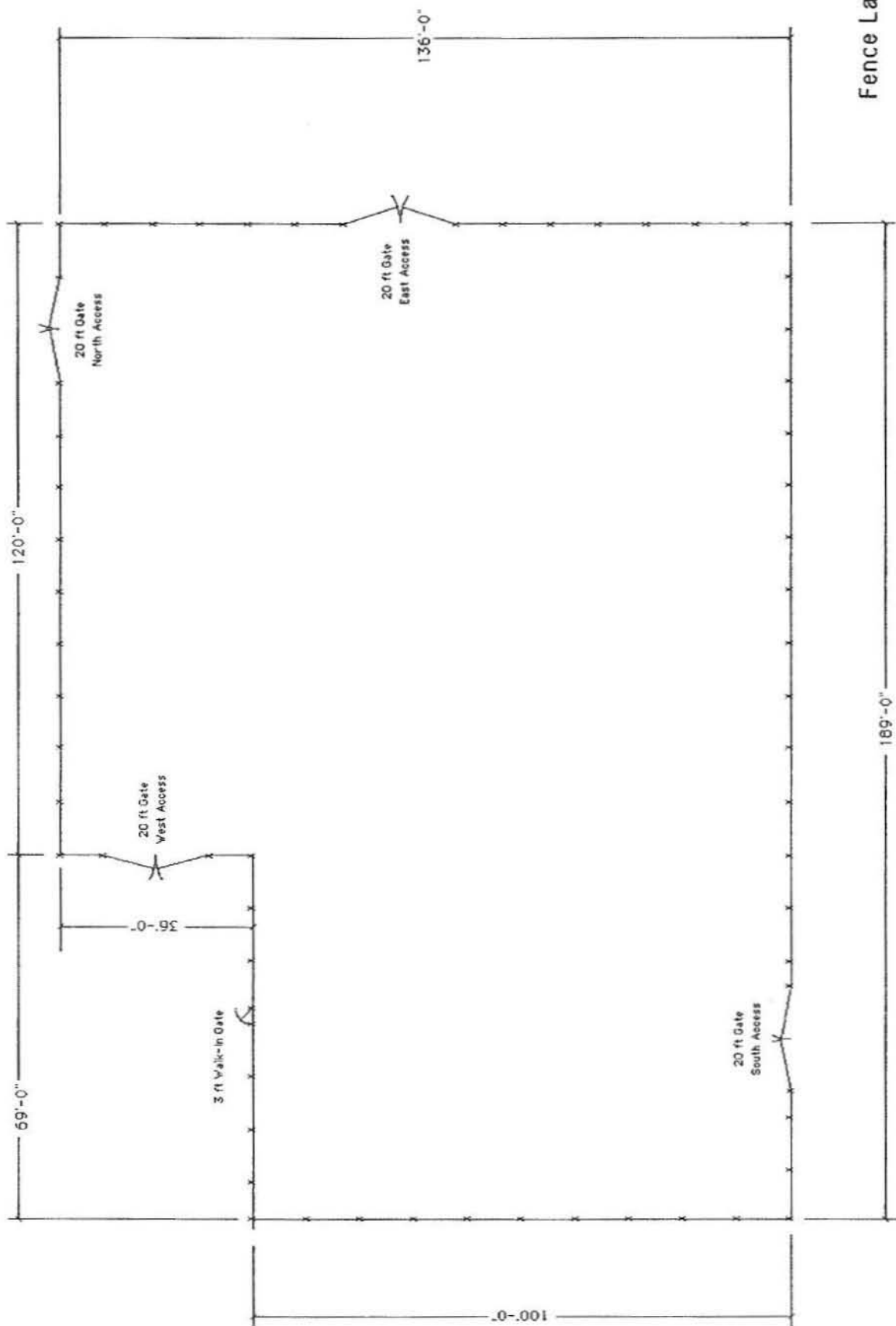
230KV PCB 5131
CONTROL CABLE DRAWING



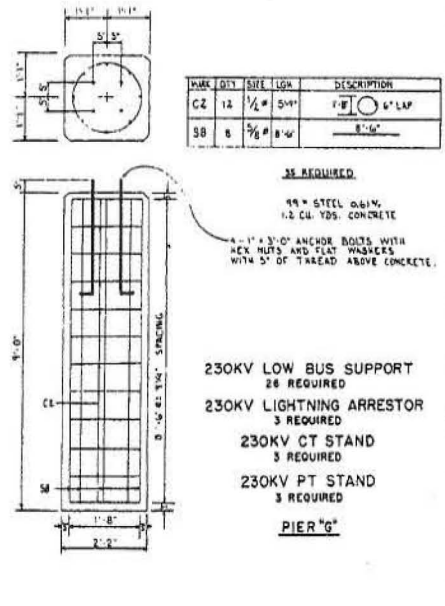
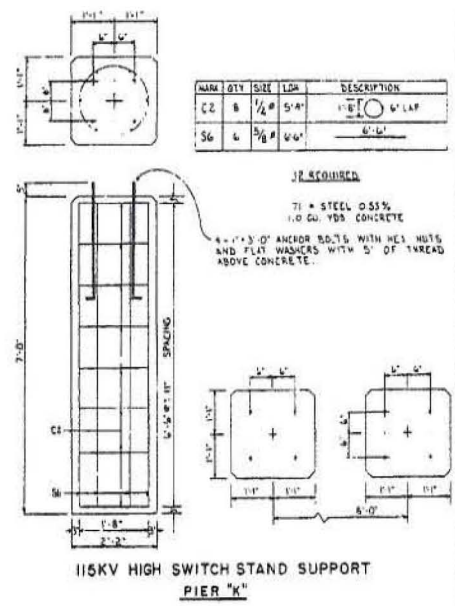
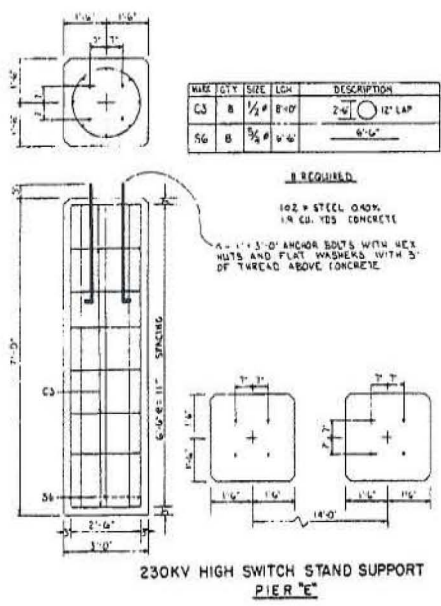
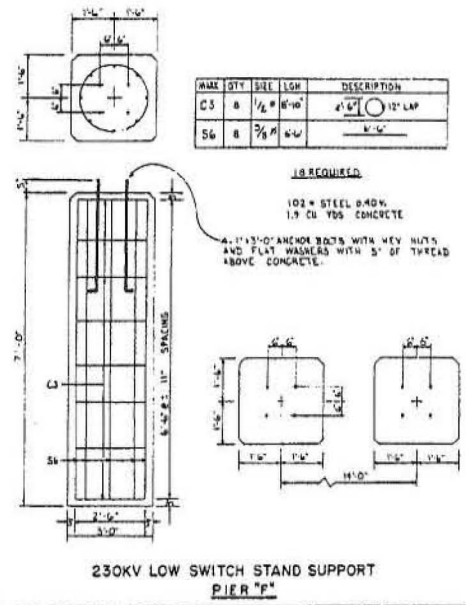
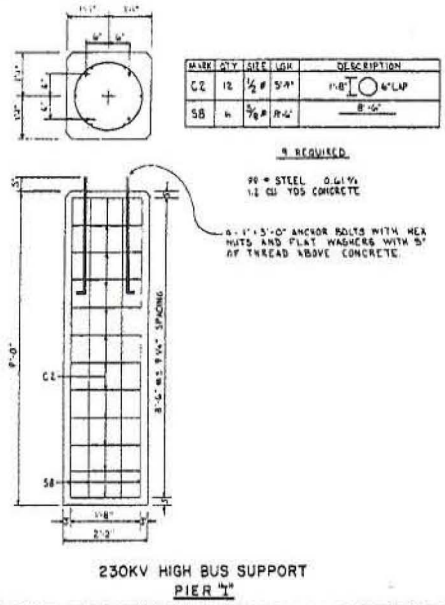
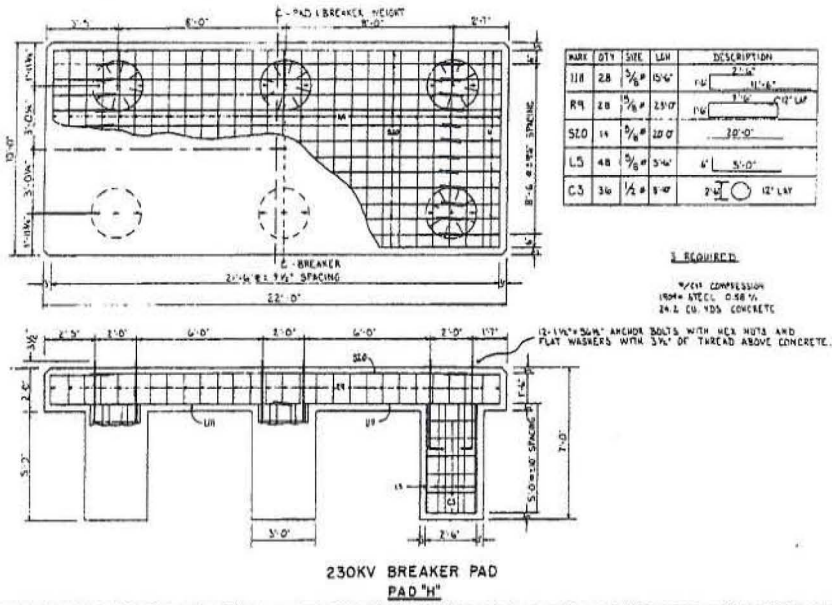
55004600-11
 18005400-11
 18005400-15

12c #12 SH. Cable # 1
 12c #12 SH. Cable # 2
 12c #12 SH. Cable # 3
 12c #12 SH. Cable # 4

12c #12 SH. Cable # 1
 12c #12 SH. Cable # 2
 12c #12 SH. Cable # 3
 12c #12 SH. Cable # 4



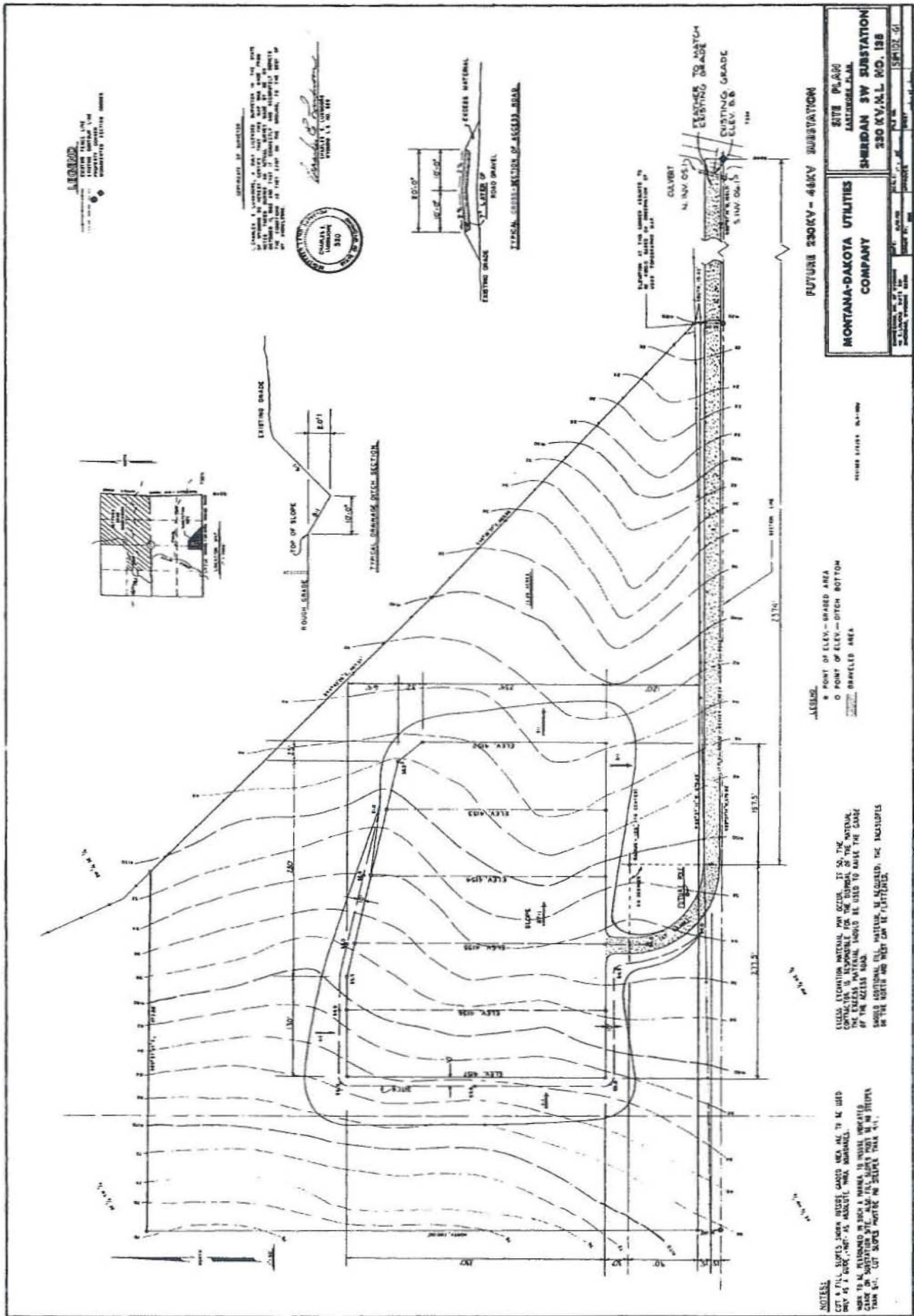
Fence Layout



NOTES
 REINFORCING STEEL TO HAVE MINIMUM OF 3" CONCRETE COVER
 ALL EXPOSED EDGES AND CORNERS TO HAVE 1" CHAMFER
 ALL FOUNDATION TO HAVE SMOOTH STEEL TROWEL FINISH

FOUNDATION DETAILS
 BAKER 230/115 KV SUB
 BAKER 130/115/60KV SUB
 MONTANA-DAKOTA UTILITIES CO.
 DRAWN BY DATE CHECKED DATE DWG NO FILE NO
 BAW 0-3-56 JDAK 10/18/54 58-226

IDENTICAL LUGS W/NO 1-50-01-100 (1)



FUTURE 230KV - 48KV SUBSTATION SITE PLAN SHERIDAN SW SUBSTATION 230 KV, A.L. NO. 128	
MONTANA-DAKOTA UTILITIES COMPANY	SHEET NO. 128 OF 128

PROJECT NO.	4-3591	DATE	07-30
CITY	BOZEMAN	BY	
MONTANA-DAKOTA UTILITY CO.			
SCALE	1" = 20'	PROJECT NO.	4-3591
TBL. A 210/10 R 5/8			
L23000 4 R10			

MATERIALS:

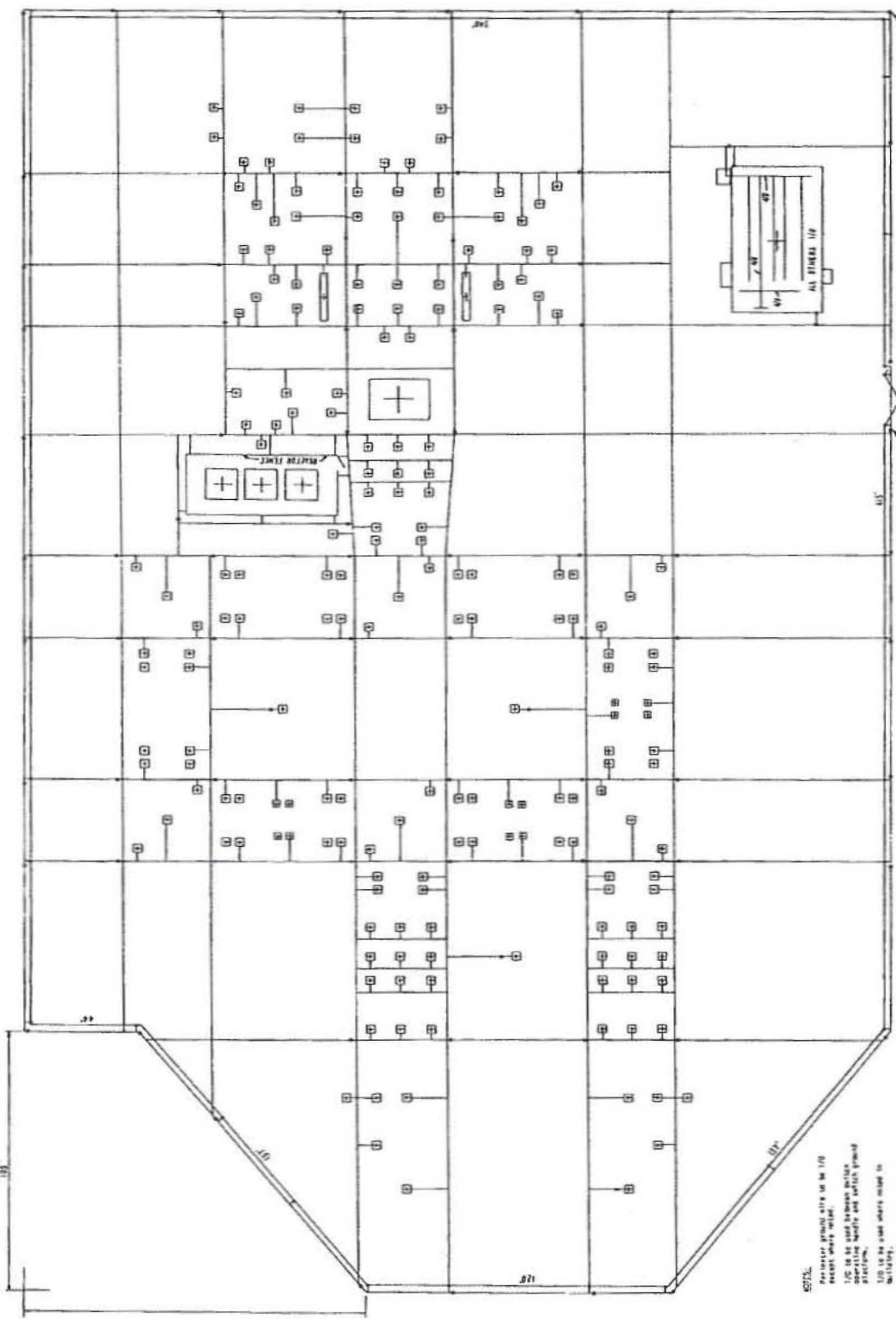
1. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
2. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
3. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
4. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
5. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
6. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
7. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
8. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
9. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
10. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
11. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
12. 1/2" x 1/2" x 1/2" Steel, Heavy Co.

REVISIONS:

1. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
2. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
3. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
4. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
5. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
6. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
7. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
8. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
9. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
10. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
11. 1/2" x 1/2" x 1/2" Steel, Heavy Co.
12. 1/2" x 1/2" x 1/2" Steel, Heavy Co.

NOTES:

1. See general notes on this project.
2. All work shall be done in accordance with the structure or equipment with this set of plans, and no other matter, top of structure or side of structure.
3. Continuity of structure to ground shall be maintained.
4. If a structure is to be enclosed in a manner similar to that shown on drawings, it shall be done in accordance with the structure or equipment with this set of plans, and no other matter, top of structure or side of structure.
5. All structural, metal, steel, or iron, shall be in accordance with the structure or equipment with this set of plans, and no other matter, top of structure or side of structure.
6. All connections, corners, elbows, and joints, shall be in accordance with the structure or equipment with this set of plans, and no other matter, top of structure or side of structure.
7. Details shall be in accordance with the structure or equipment with this set of plans, and no other matter, top of structure or side of structure.
8. Other details shall be in accordance with the structure or equipment with this set of plans, and no other matter, top of structure or side of structure.



SEE PLAN
77. 1/2"

SEE PLAN
TO CORNER

SEE PLAN
TO CORNER

SEE PLAN
TO CORNER

SEE PLAN
TO CORNER

SEE PLAN
TO CORNER

SEE PLAN
TO CORNER

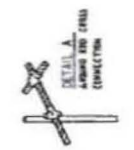
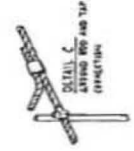
SEE PLAN
TO CORNER

SEE PLAN
TO CORNER

SEE PLAN
TO CORNER

SEE PLAN
TO CORNER

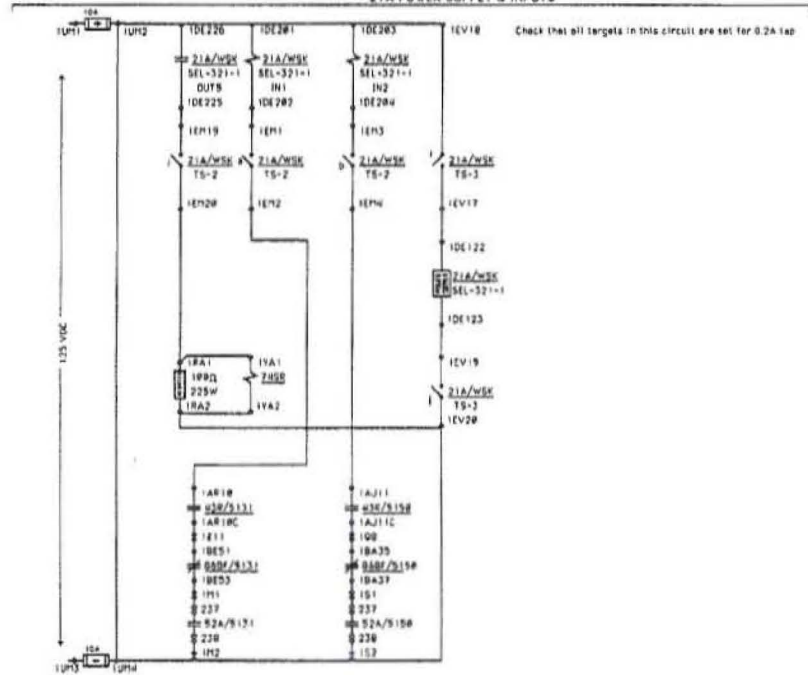
SEE PLAN
TO CORNER



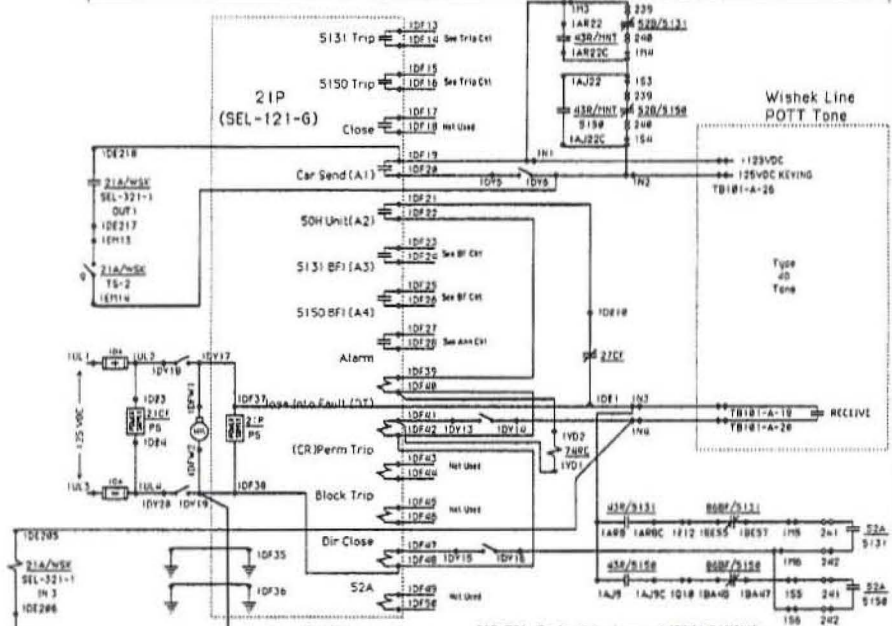
SEE PLAN
TO CORNER

SEE PLAN
TO CORNER

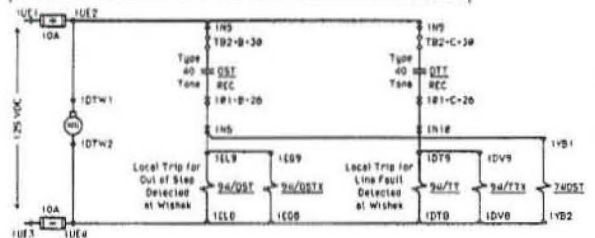
Wishek Line Secondary Relaying
21A POWER SUPPLY & INPUTS



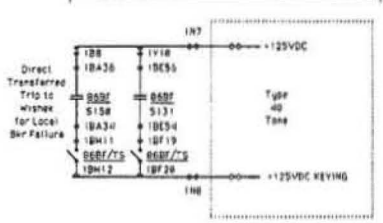
Wishek Line Primary Relaying



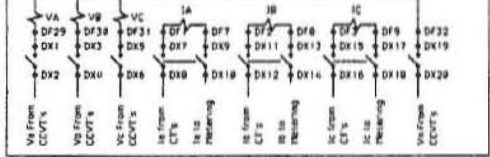
Wishek Line Incoming Direct Transfer Trip



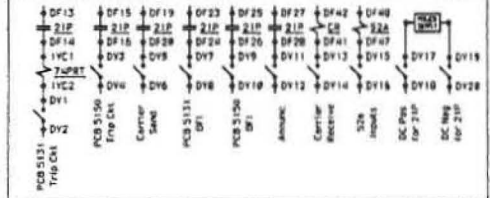
Wishek Line Outgoing Direct Transfer Trip



21P/TS1 Contact Assignment (FRONT VIEW)



21P/TS2 Contact Assignment (FRONT VIEW)



Note: There is no test switch contact for the 27CF/50H input to 21P, but 27CF test plug can be pulled

(1EL) 940ST CONTACTS		(1EG) 940STX CONTACTS		(1DT) 94TT CONTACTS	
1	10 PCB S138 PRI TRIP	1	10 PCB S150 TRIP	1	10 PCB S131 PRI TRIP
2	3 ANNUNCIATOR	2	3 INITIATE BY PCB S135	2	3 ANNUNCIATOR
3	5 PCB S148 2ND	3	5 INITIATE BY PCB S138	3	5 FAULT RECORDER
4	7 PCB S150 PRI TRIP	4	7	4	7 PCB S150 PRI TRIP

(1DV) 94TTX CONTACTS		74QST OUT OF STEP TRIP (AVR)		1YB (TR)	
1	10 PCB S131 CLOSE CKT	3	4 FAULT RECORDER	3	4 FAULT RECORDER
2	2 INITIATE BY PCB S131	5	6	5	6
3	4 INITIATE BY PCB S138				
4	6 PCB S150 CLOSE CKT				

WISHEK 21A, PS & TONE

ELLENDALE JCT. SUB


DESIGNED BY: CHV
DATE: 2/4/92

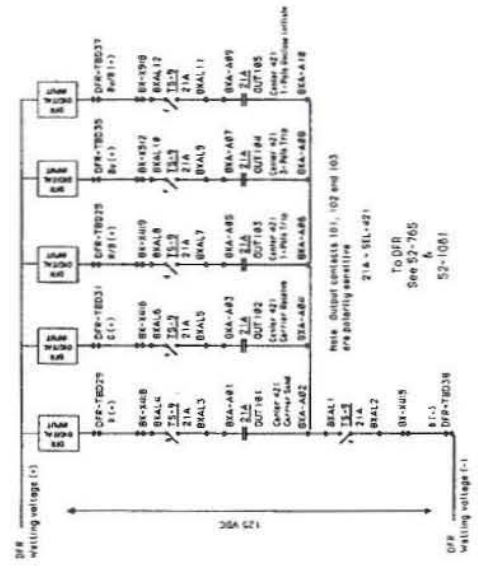
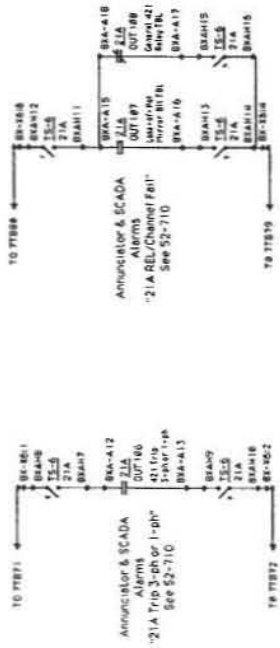
DRAWING NO: 382105-122
FILE NO: 81-2221

SCALE: NONE
APPROVED: CHV

7/24/92 400 FAULT RECORDER
PL 5-19-08 871 REPLACEMENT

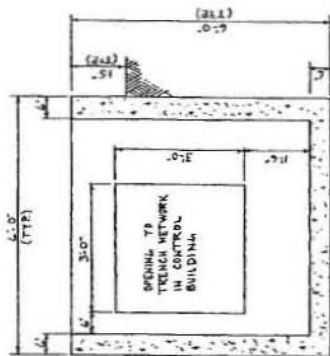
57-2221

		SUBSTATION MONTANA-DAKOTA UTILITIES CO.	
DRAWN BY DMR	DATE 6/1/03	PROJECT NO. 81810-133	SHEET NO. 52-699-2
		SCALE AS SHOWN	

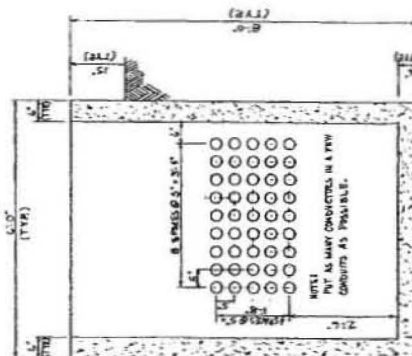


120V
To DFR
See 52-765
6
52-1001

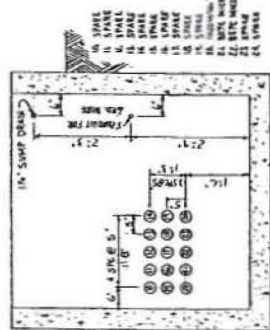
MANHOLE # 1 & 2 COURT ELEVATION DETAIL TUBA 130/18 CLASS	
Scale: 1/4" = 1'-0"	Project: MONTANA - DAKOTA
Drawn by: RPL	Company: UTILITIES CO.
Checked by: J. J. [unclear]	Date: 07/30



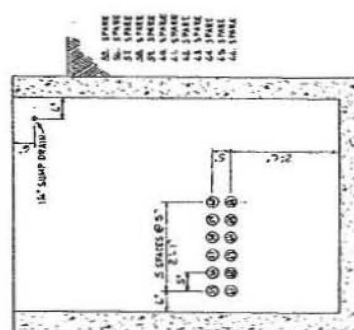
MANHOLE #1
LOOKING WEST



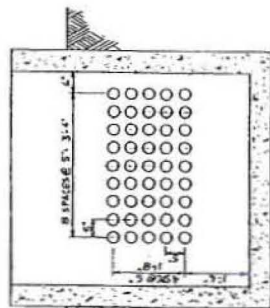
MANHOLE #2
LOOKING WEST



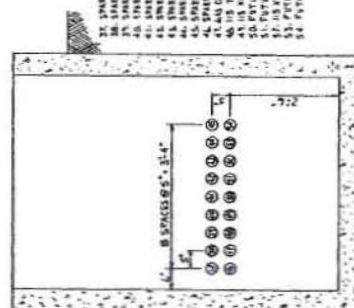
MANHOLE #1
LOOKING SOUTH



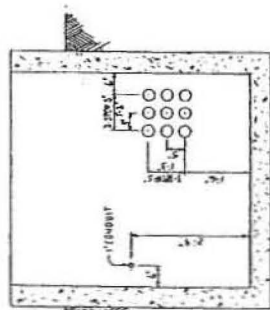
MANHOLE #2
LOOKING SOUTH



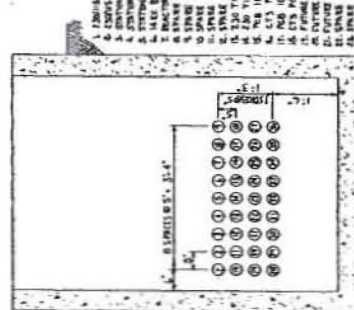
MANHOLE #1
LOOKING EAST



MANHOLE #2
LOOKING EAST



MANHOLE #1
LOOKING NORTH



MANHOLE #2
LOOKING NORTH

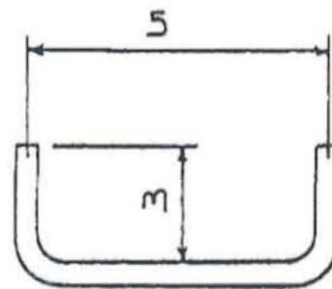
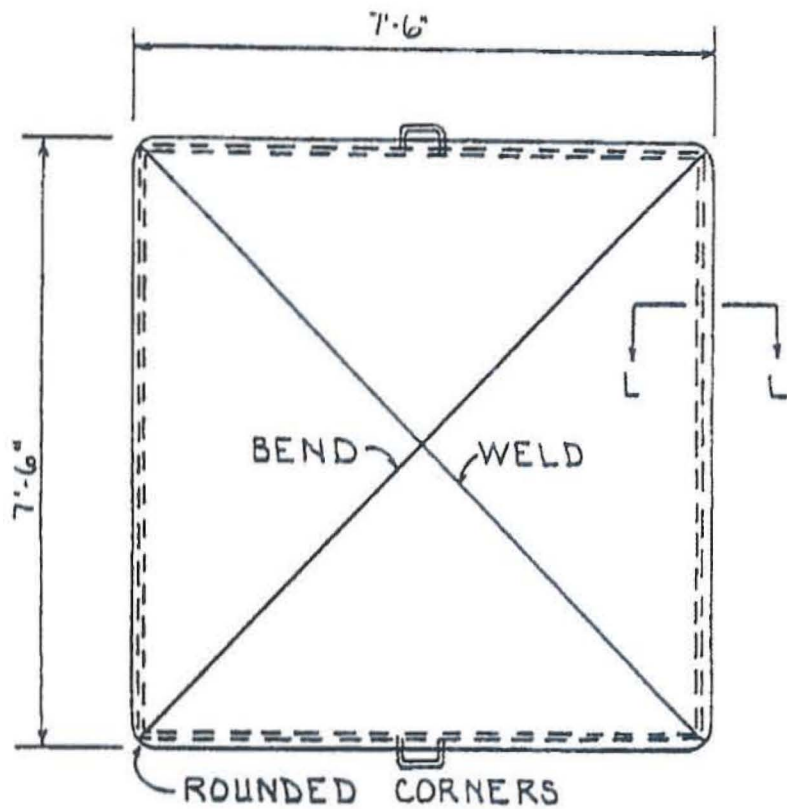
- 1. 1200V TRANSFORMER
- 2. 1200V TRANSFORMER
- 3. 1200V TRANSFORMER
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- 90. 1200V TRANSFORMER
- 91. 1200V TRANSFORMER
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- 93. 1200V TRANSFORMER
- 94. 1200V TRANSFORMER
- 95. 1200V TRANSFORMER
- 96. 1200V TRANSFORMER
- 97. 1200V TRANSFORMER
- 98. 1200V TRANSFORMER
- 99. 1200V TRANSFORMER
- 100. 1200V TRANSFORMER

NOTES:
1. NOT AS MANY CONDUCTORS IN A ROW AS USUAL

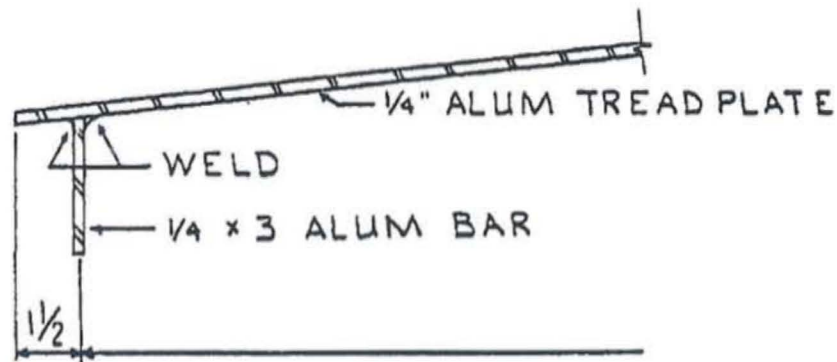


HANDLE

BAR 1/2" ϕ x 0'-11 1/2"



HANDLE -
WELDED TO CENTER
OF EDGE ON OPP SIDES



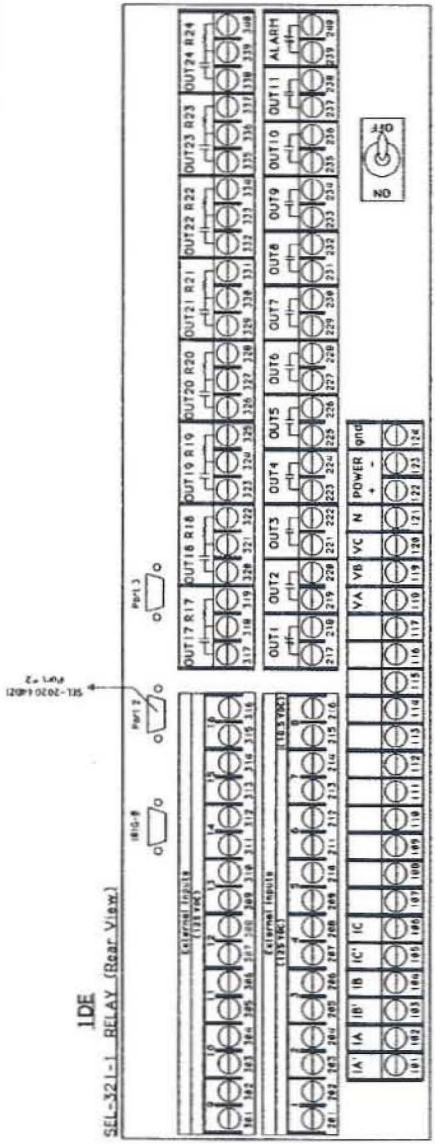
SECTION L-L

ONE MANHOLE COVER REQUIRED.

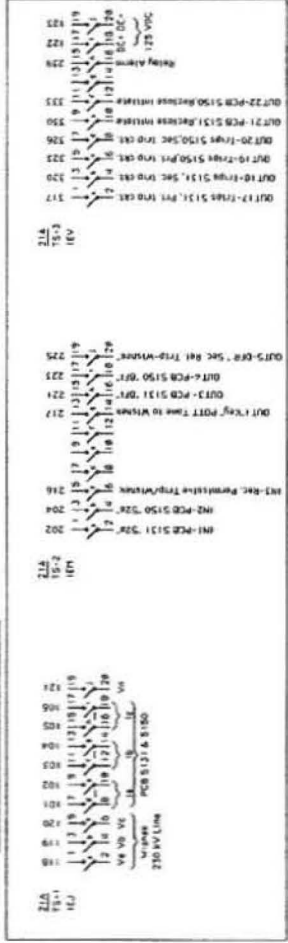
MANHOLE COVER DETAIL				
HETTINGER 230/115KV ADD.				
MONTANA-DAKOTA UTILITIES CO				
DWN BY	DATE	SCALE	DWG NO	FILE NO.
DLA	1-22-81	1/2" = 1'	012281-2	

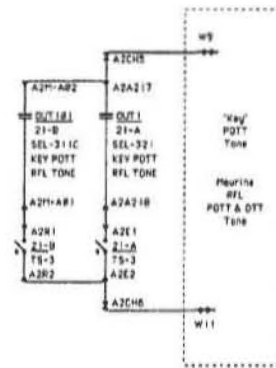
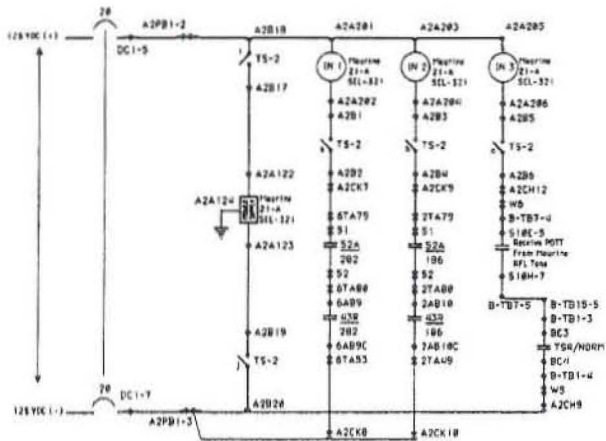
WISHEK LINE
SEL-321-1

ELLENDALE JUNCTION SUBSTATION	
DESIGNED BY JPH	DRAWN BY JPH
DATE 8/29/01	TITLE 383.05-127
SCALE NA	APPROVED BY JPH
57-2210	

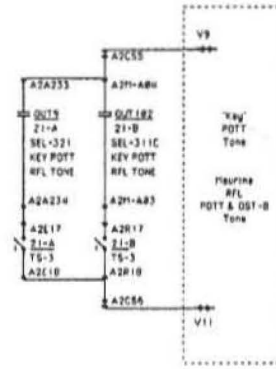
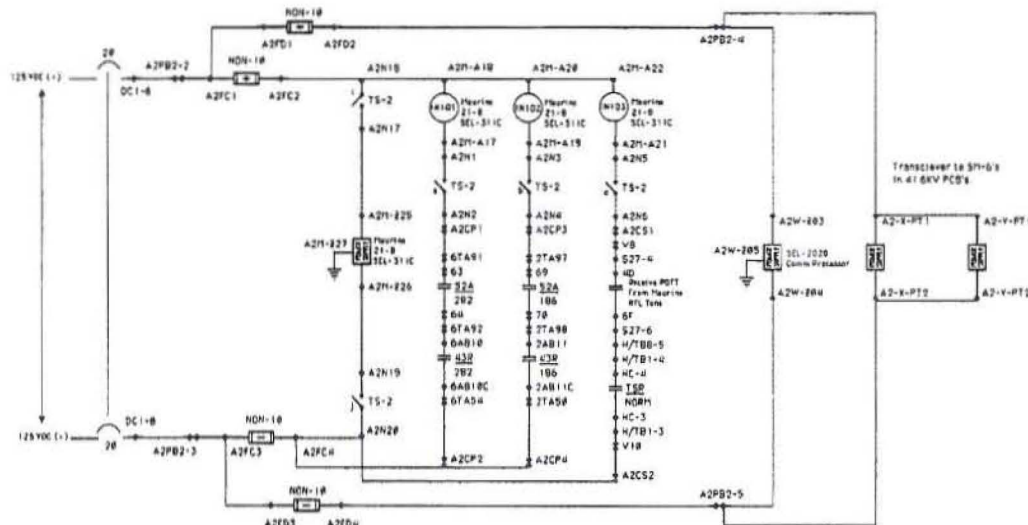


VIEWED FROM FRONT OF PANEL





NOTE
POTT uses one frequency shift
tone transmitter.
DTT for breaker failure uses
two (dual) frequency shift
tone transmitters.



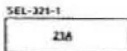
Maurine 230kV Line
21-A & 21-B & SEL-2020 Power
Carrier Send & Carrier Receive

		HETTINGER JCT. SUBSTATION	
		MONTANA-DAKOTA UTILITIES CO.	
DRAWN BY DHR	DATE 1/01	DESIGNED BY 432102-E27	FILE NO. 53-1115-A
		APPROVED 	SCALE

PL 10-25-02 NOTES ADDED 53-1115-A

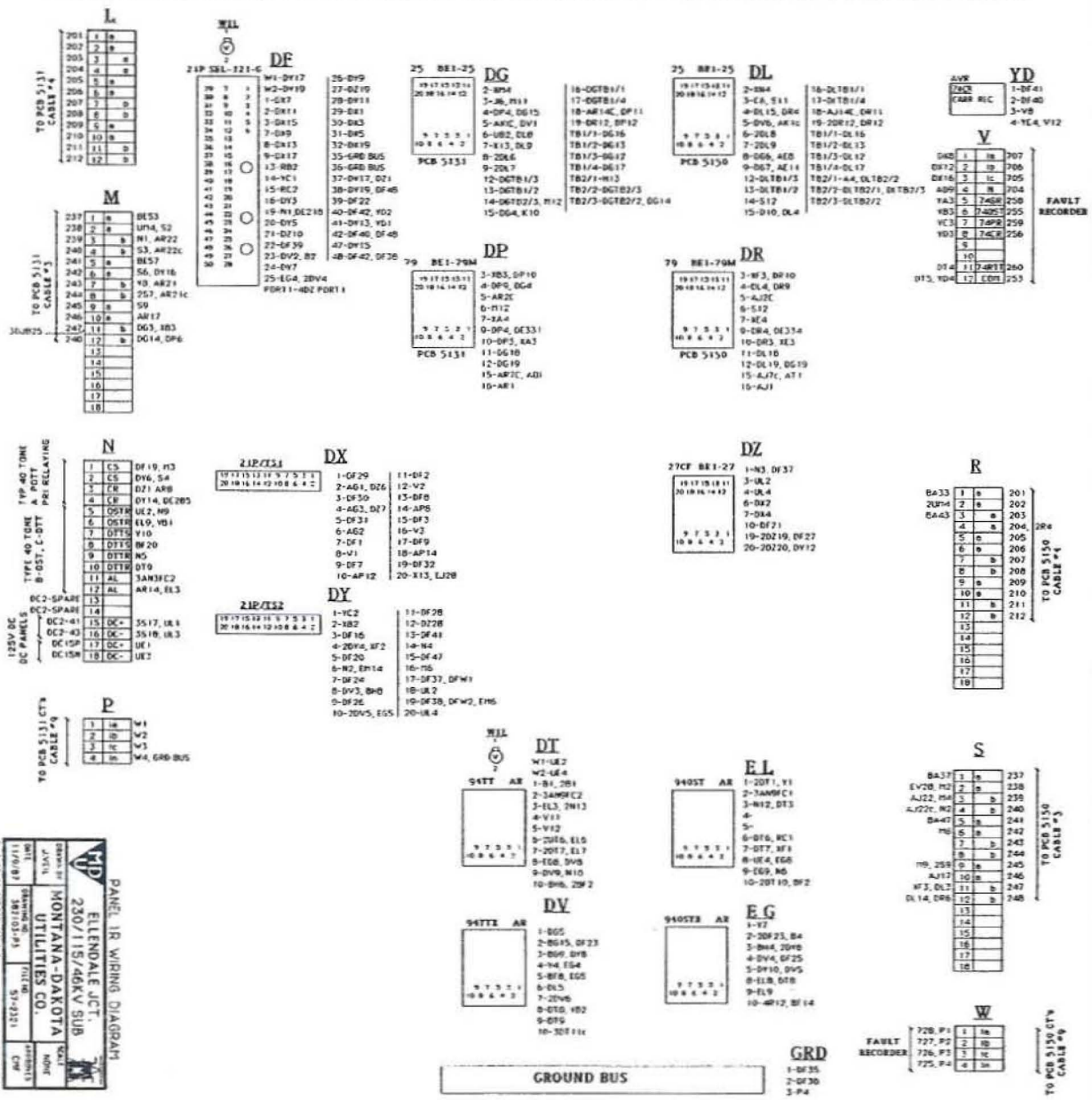
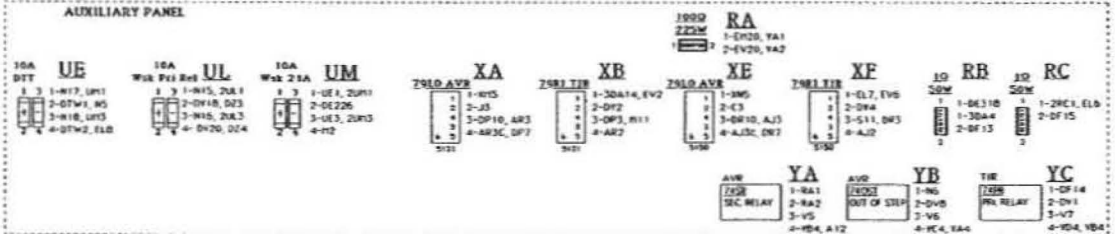
PANEL 1R

WISREX 230 EV LIRE RELATING



DE	101-EJ7	110-EJ1	201-DE2B2, DE226	221-EP15	317-EV1	327-DB11, DE327
	102-EJ9	119-EJ5	202-EP11	222-30A3	318-DB1, 40A206	329-AR3
	103-EJ11	120-EJ5	203-DE2B1, EV18	223-EP17	320-EV5	330-EV9
	104-EJ13	121-EJ19	204-EP3	224-20A, 20E224	321-EG11	331-OP9
	105-EJ15	122-EV17	205-NA	225-EP19	322-EV5	332-AJ5, 20E332
	106-EJ17	123-EV19	206-EP5	226-DE2B1, UP2	324-20C1, 20E324	333-EV11
			217-EP13	229-EV15	326-EV7	334-OP9, 20E334
			218-OP19	240-20E24E		PORT 2-402 PORT 2

EY	11-1	EM	11-1	EJ	11-1
1-DE317	11-DE333	1-DE202	11-	1-DE110	11-DE103
2-1B1, 4E6	12-AJ2, 20V12	2-AR10	12-	2-AM1	12-12
3-DE329	13-	3-DE204	13-DE217	3-DE110	13-DE104
4-BS17	14-	4-AJ11	14-EP6	4-AR3	14-E208, L116
5-DE325	15-DE239	5-DE205	15-DE221	5-DE120	15-DE105
6-1F1, 2EVS	16-2EVI6	6-DY10	16-30A13	6-AR2	16-E2
7-DE326	17-DE122	7-	17-DE723	7-DE109	17-DE106
8-BS12, 2EVS	18-DE203	8-	18-2EVI6, 20V9	8-EP1	18-EJ4, L4
9-DE330	19-DE123	9-	19-DE225	9-DE102	19-DE121
10-AR2	20-PA2, S2	10-	20-NA1	10-EJ14	20-0320

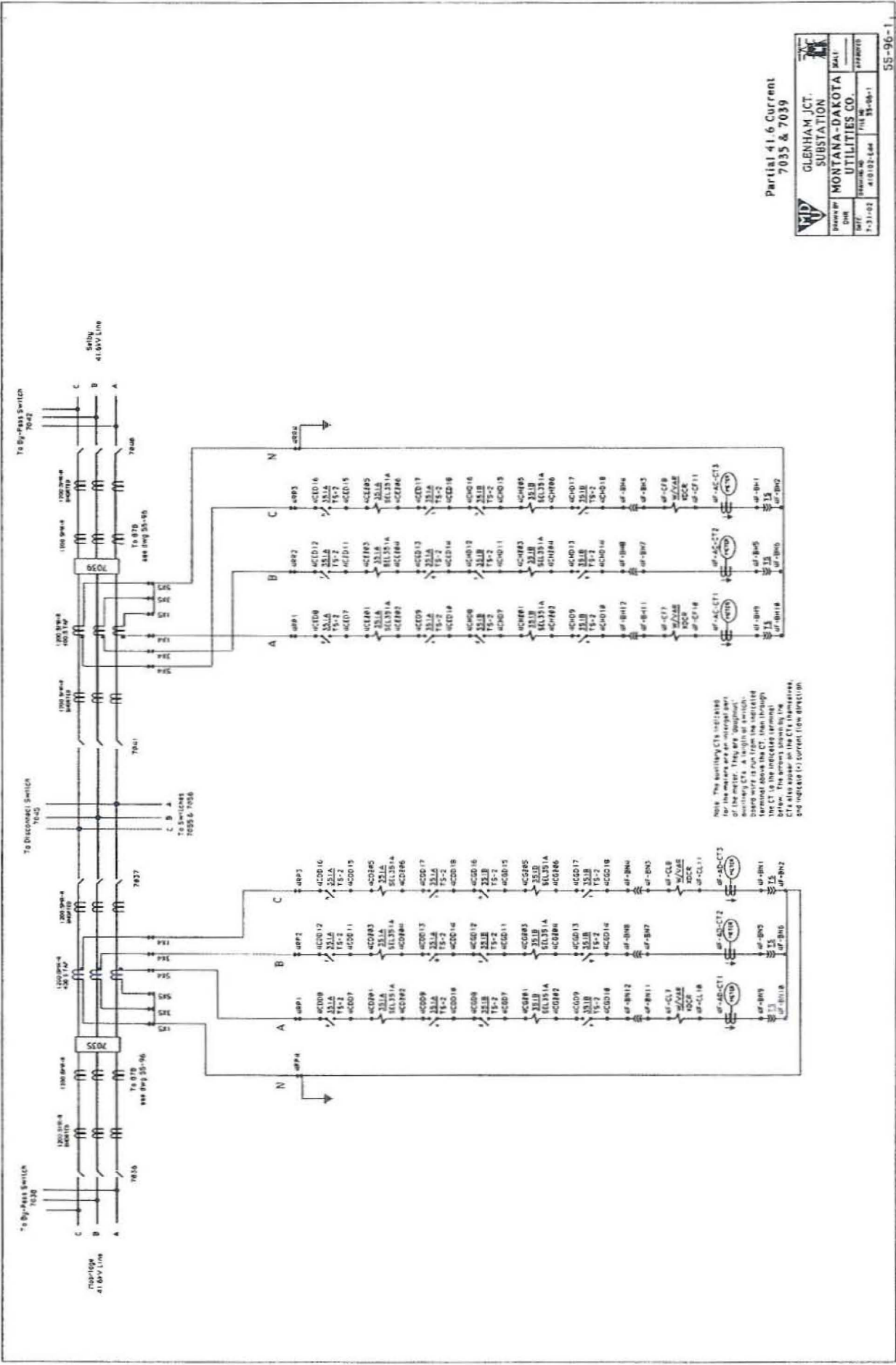


PANEL 1R WIRING DIAGRAM

ELLENDALE JCT.
230/115/46KV SUB

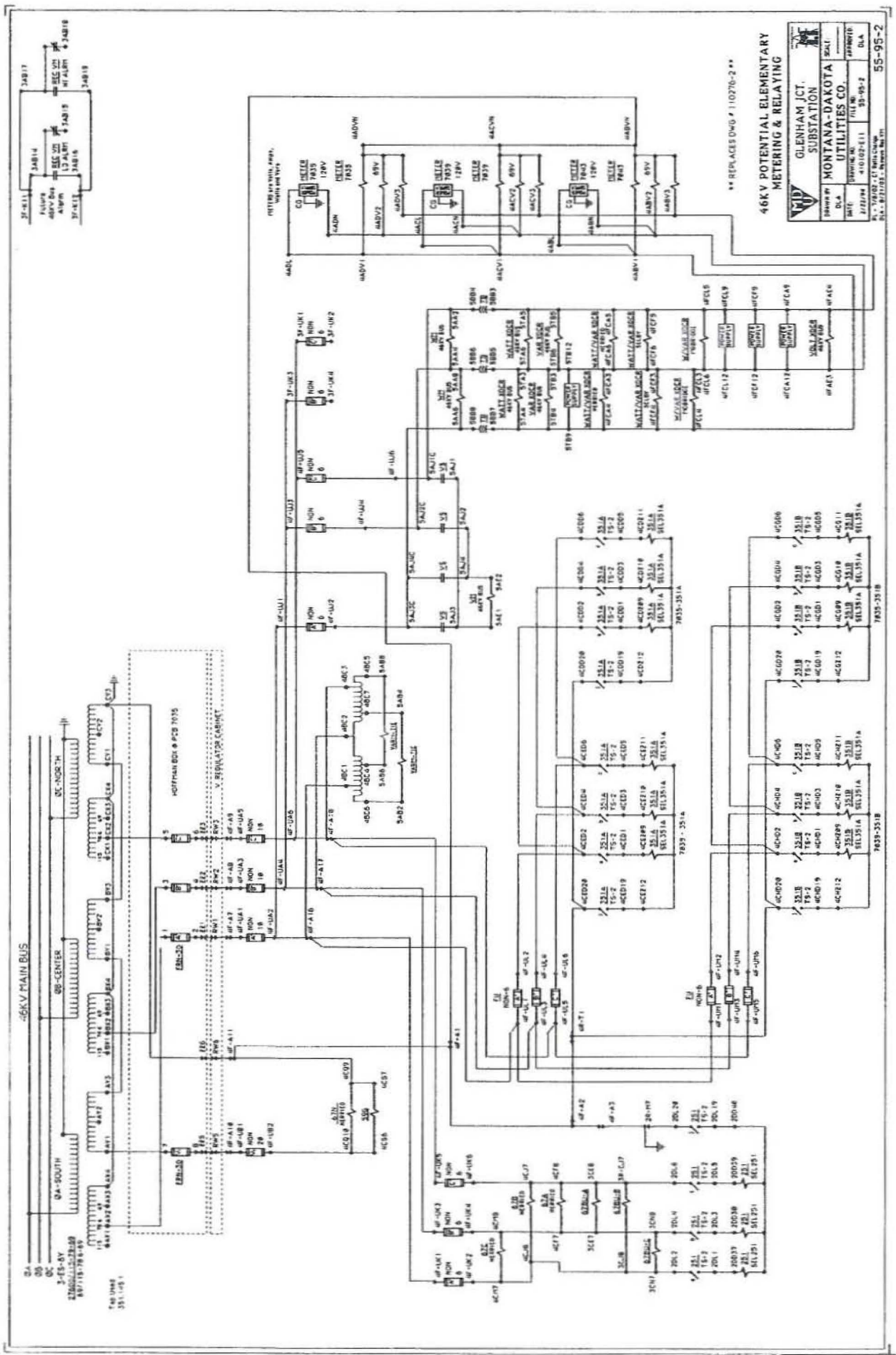
MONTANA-DAKOTA UTILITIES CO.

57-2321



Partial 41.6 Current
7035 & 7039

GLENHAM JCT. SUBSTATION	7/11/11 35-96-1
DRAWN BY DHR	SCALE
DATE 7-31-12	PROJECT NO. 41032-144

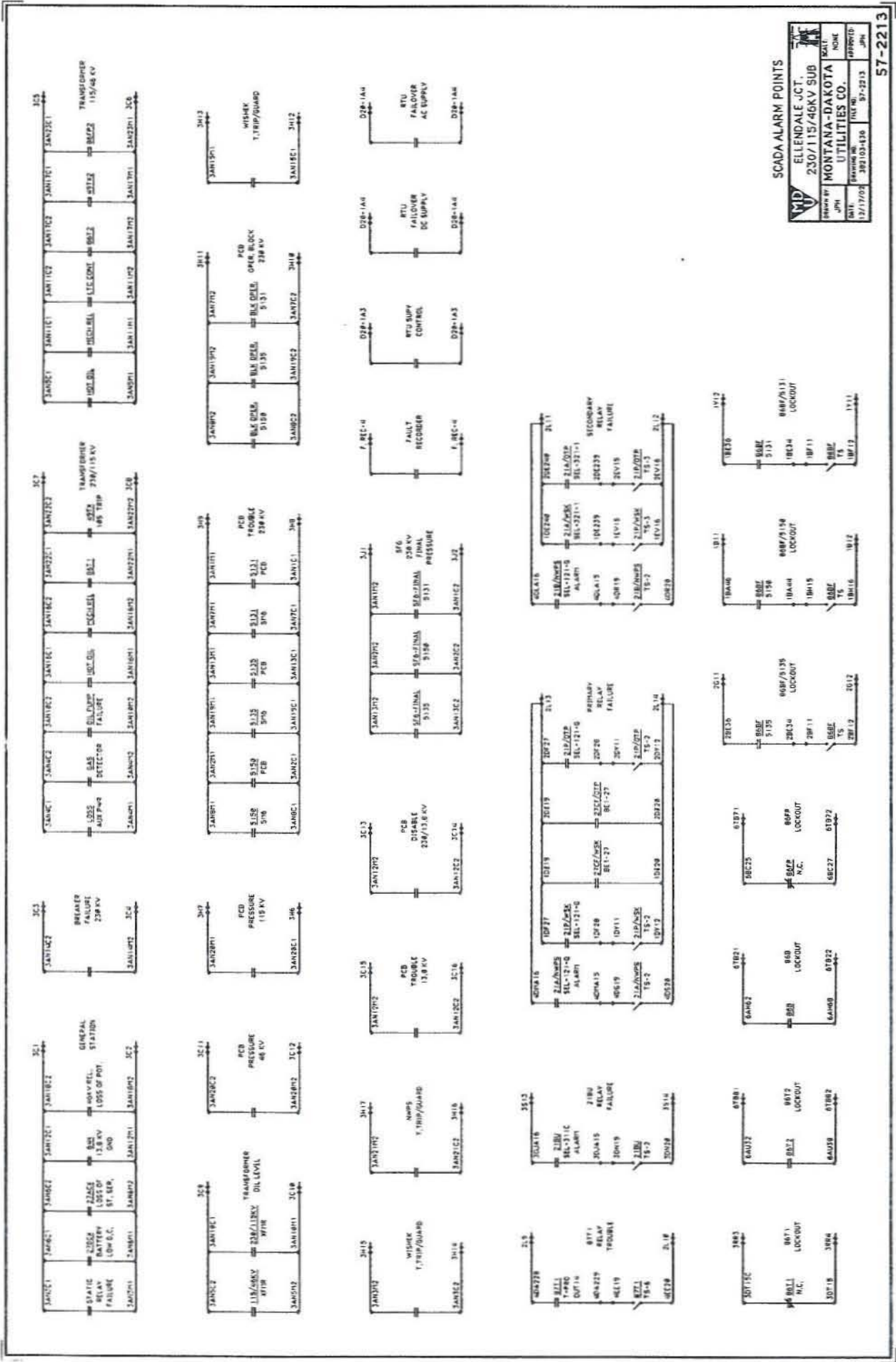


46KV POTENTIAL ELEMENTARY
METERING & RELAYING

REPLACES DWG # 11076-2

GLENHAM JCT. SUBSTATION	
DWG NO.	41010P-11
FILE NO.	10-95-2
DIA.	
DATE	
BY	
CHECKED	
APPROVED	
SCALE	

55-95-2



SCADA ALARM POINTS

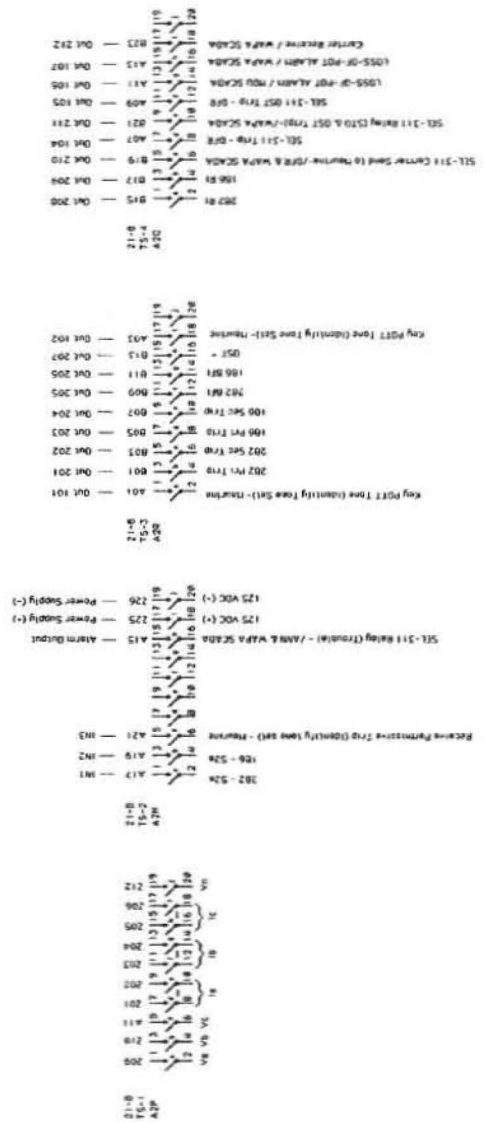
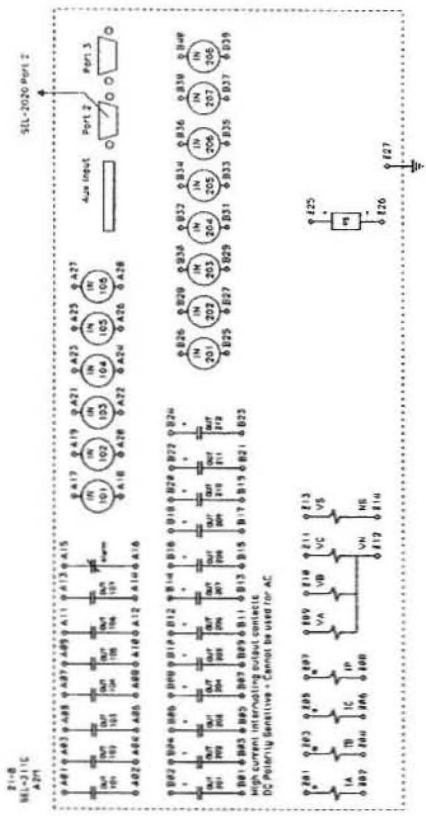
ELLENDALE JCT.
230/115/46KV SUB

DESIGNED BY: JPH
DRAWN BY: JPH
CHECKED BY: JPH
DATE: 12/17/02

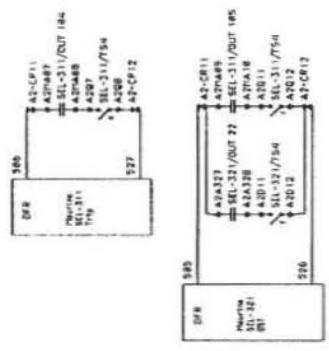
SCALE: NONE
JOB NO: 97-2213
FILE NO: 382 03-430

MONTANA-DAKOTA UTILITIES CO.
12/17/02 382 03-430 97-2213 JPH

57-2213

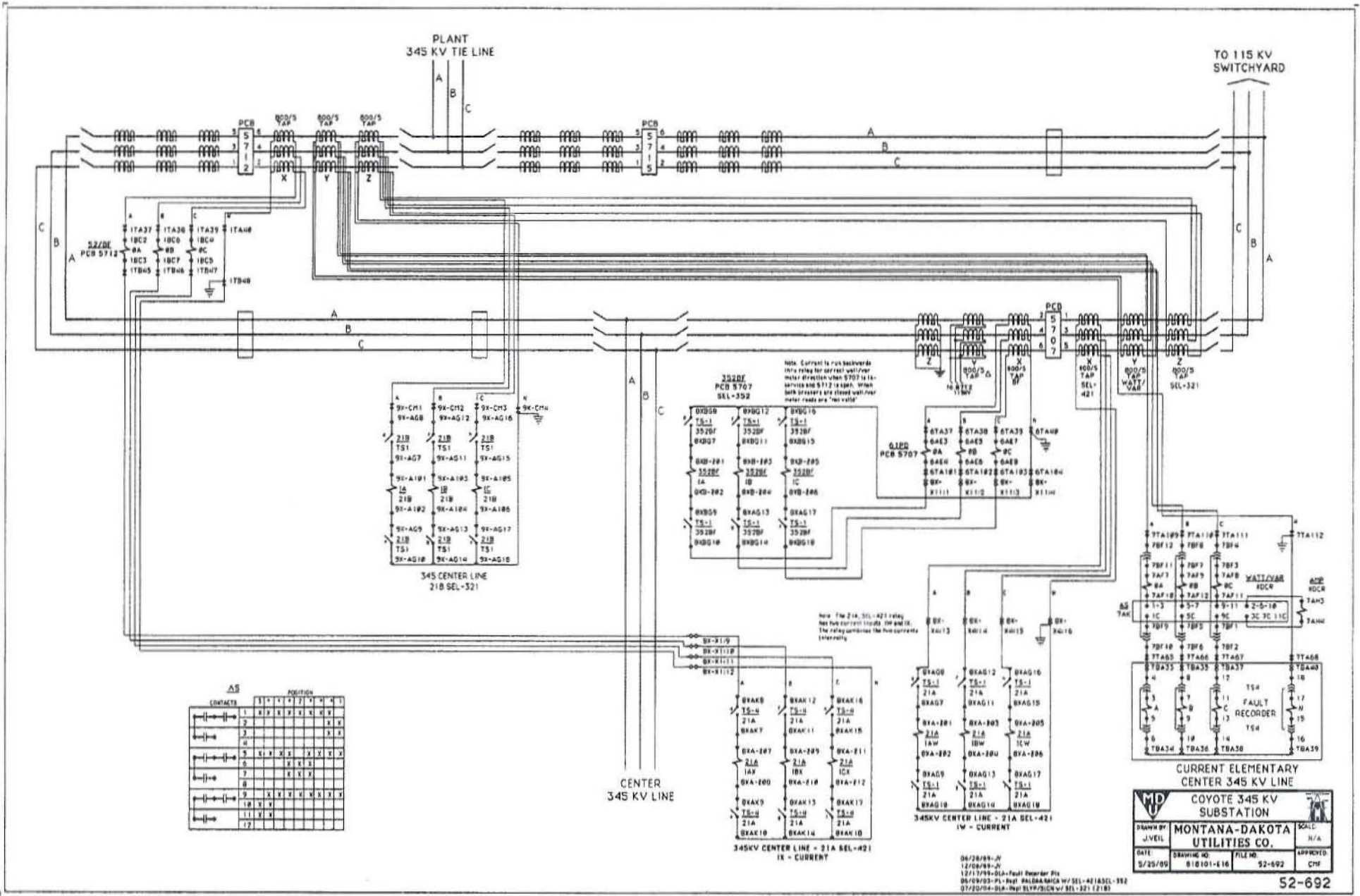


DATA - Trains 100, 101 and 102 via C&D, via Bus 7 respectively. A loop is also used to Bank - to block tripping of PCBs 102 and 103 at Bank. If the out-of-step condition continues PCB 102 at McClellan will be tripped via 9-8.



21-B
230KV MAURINE LINE
SEL-311C LINE RELAY

MONTANA UTILITIES CO.		Hettinger Jct Substation	
Drawn by	1701	Checked by	33-1155-2
Date	03/07/12	File No	
Scale		Sheet	5001



AS

CONTACTS	1	2	3	4	5	6	7	8	9	10	11	12
1	X	X	X	X	X	X	X	X	X	X	X	X
2												
3												
4												
5	X	X	X	X	X	X	X	X	X	X	X	X
6												
7												
8												
9	X	X	X	X	X	X	X	X	X	X	X	X
10	X	X	X	X	X	X	X	X	X	X	X	X
11	X	X	X	X	X	X	X	X	X	X	X	X
12												

COYOTE 345 KV SUBSTATION

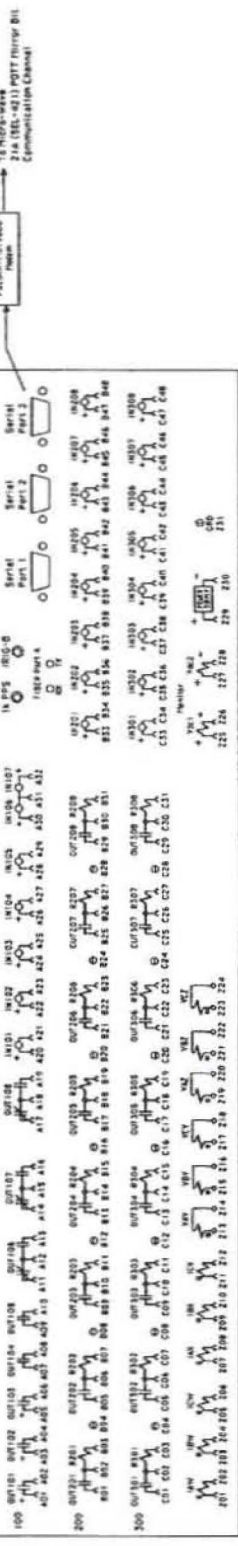
DRAWN BY: JVEIL
DATE: 5/25/05

SCALE: N/A
APPROVED: CMF

FILE NO: 816101-E16
52-692

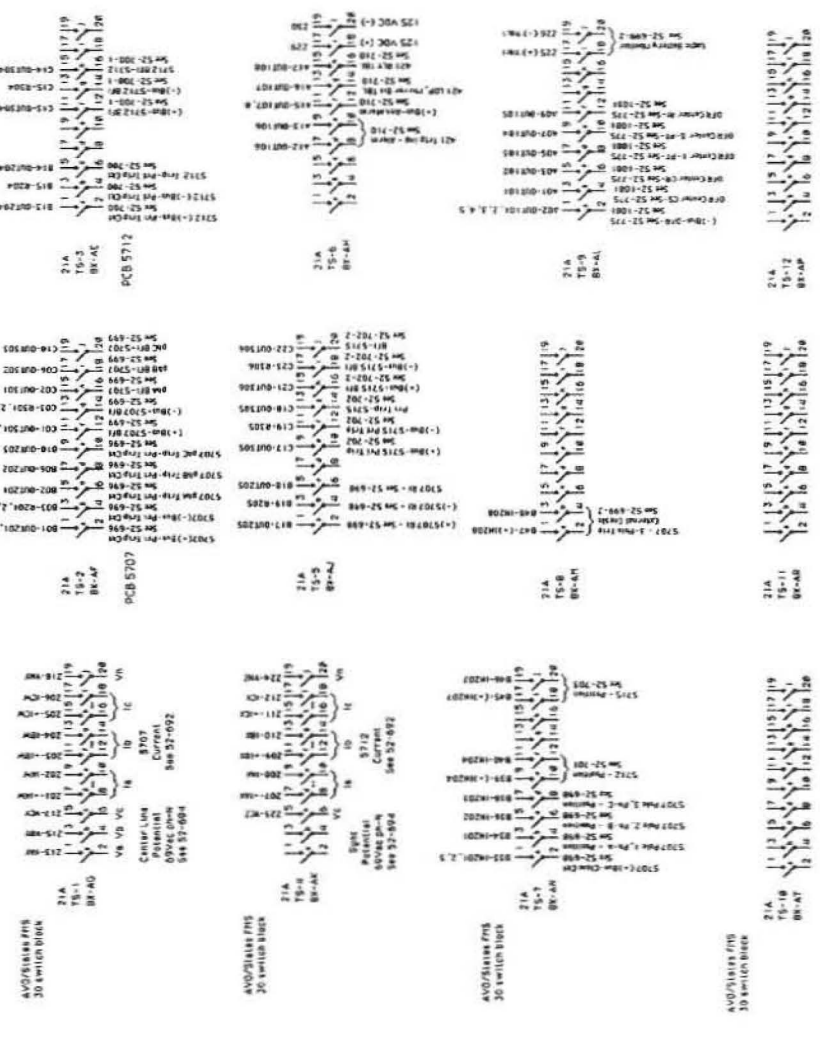
52-692

8X-A
21A - 345KV Center Line
SEL-421
04210415X1055HX



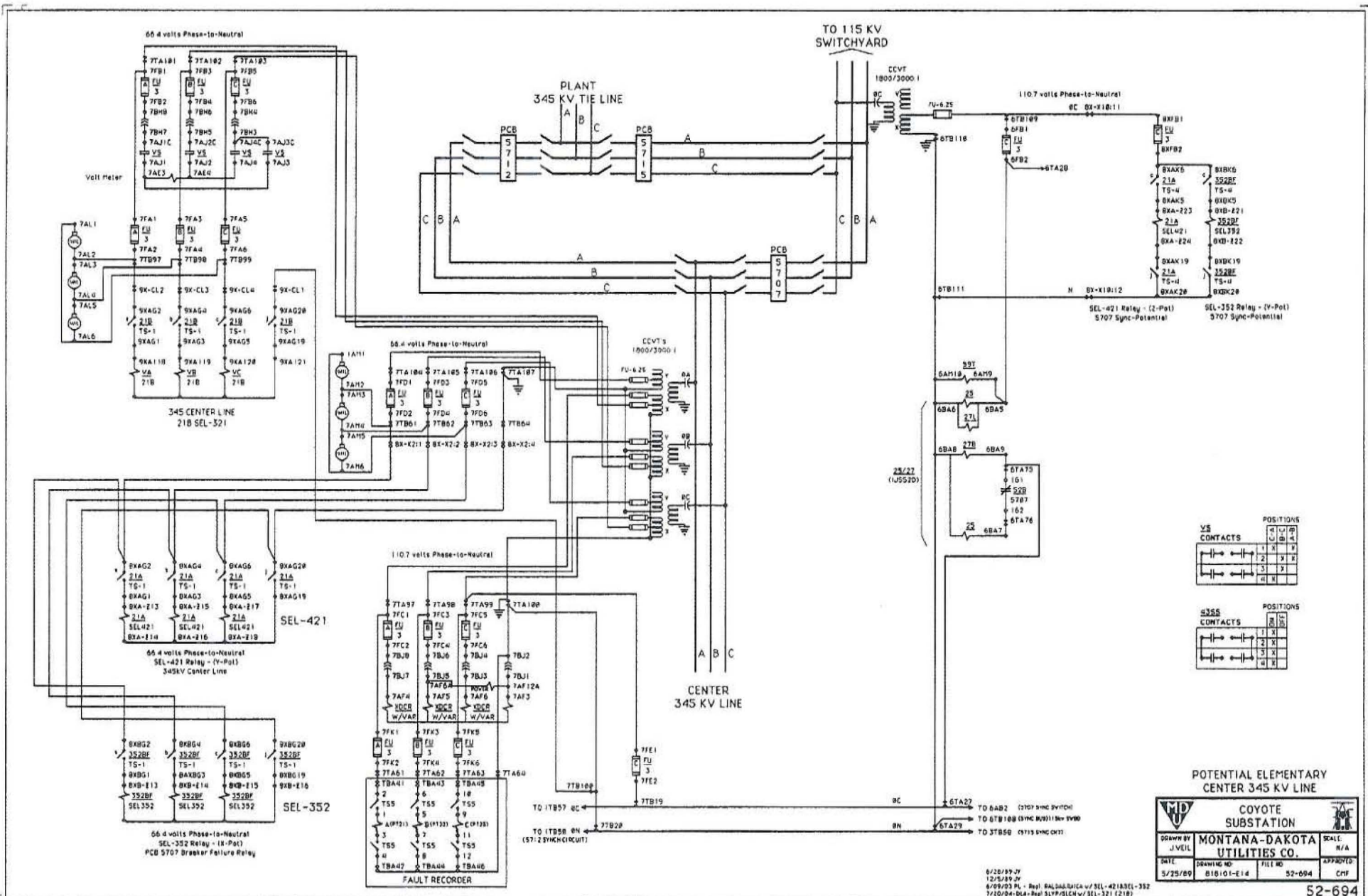
Relay Rear View

Test Switch Front View



21A
Coyote-Center 345kV Line
SEL-421 Detail

MID
COYOTE
SUBSTATION
MONTANA-DAKOTA
UTILITIES CO.
DATE: 6/10/93
SCALE: AS SHOWN
PROJECT NO.: 018101-452
SHEET NO.: 52-699-1
PL 8/17/04 8888 SUPP/ALCEN w/ SEL-231(12)B 52-699-1



VS POSITIONS

CONTACTS	1	2	3	4
	X	X	X	X
	X	X	X	X
	X	X	X	X

SSS POSITIONS

CONTACTS	1	2	3	4
	X	X	X	X
	X	X	X	X
	X	X	X	X

POTENTIAL ELEMENTARY CENTER 345 KV LINE

		COYOTE SUBSTATION			
		MONTANA-DAKOTA UTILITIES CO.			
DRAWN BY JVEL	DATE 5/25/89	DRAWING NO. 818101-E14	FILE NO. 52-694	SCALE N/A	APPROVED CMF

8/28/89-JV
12/5/89-JV
8/09/83 PL - Rev1 BALDWIN/UTICA w/ SEL-421/SEL-352
7/20/84-DK-Rev1 SLYP/SLC/W/SEL-321 (218)

52-694

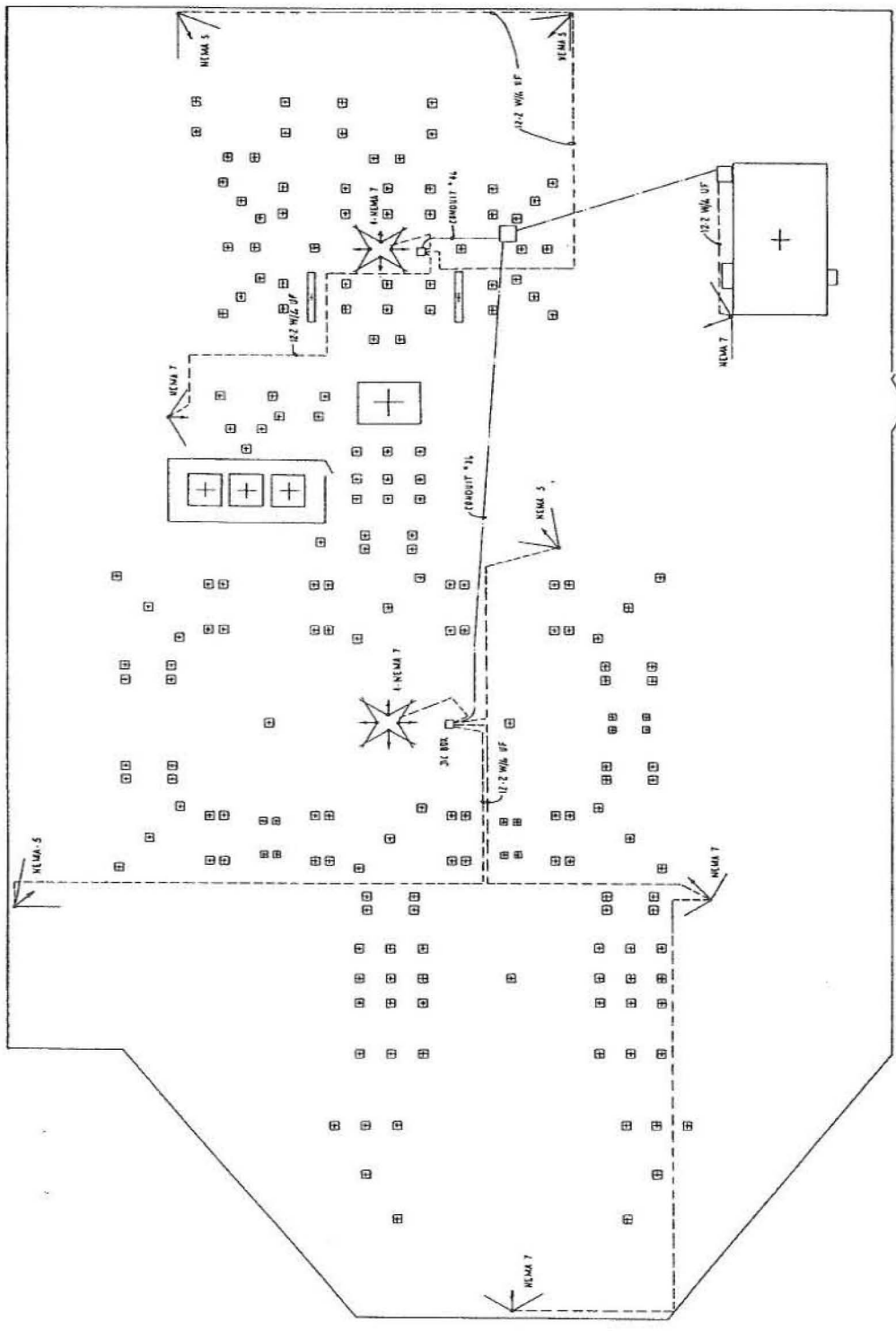
STATION LIGHTING LOCATION TULSA 230/715 KV SUB.	
SCALE	1" = 20'
DATE	11-2-03
PROJECT NO.	67-339
DESIGNED BY	MONTANA-DAKOTA UTILITIES CO.
APPROVED BY	

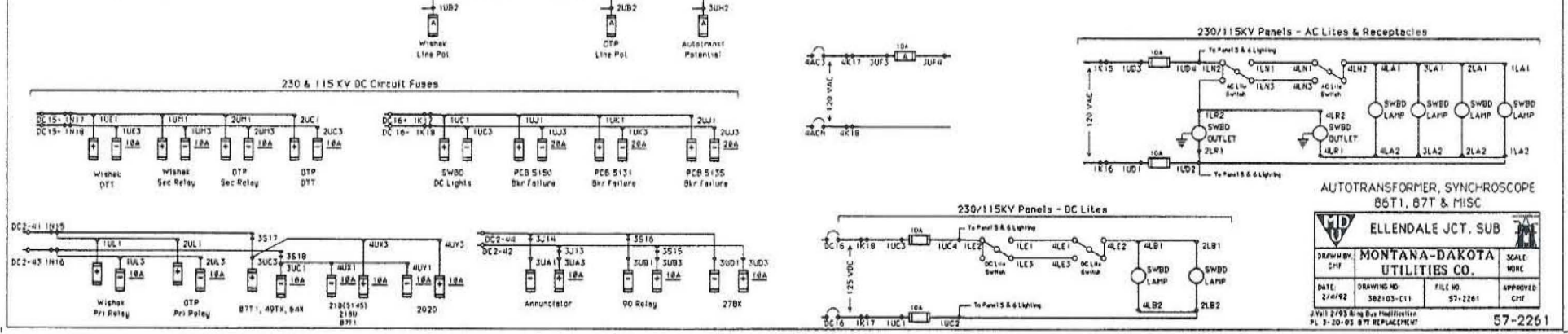
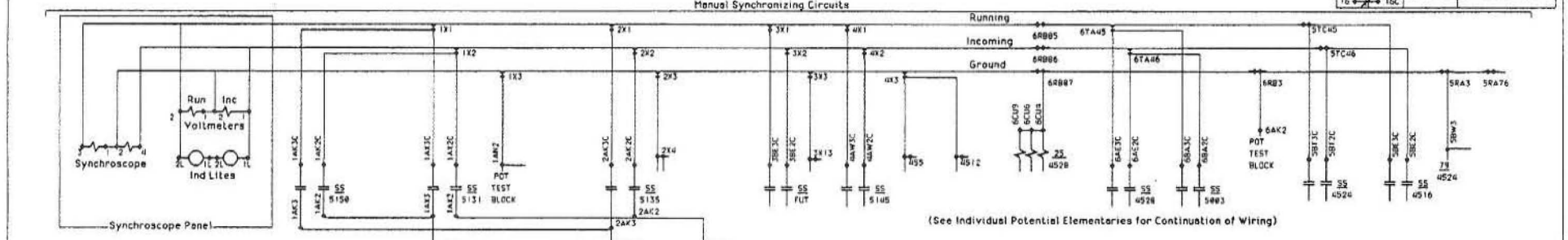
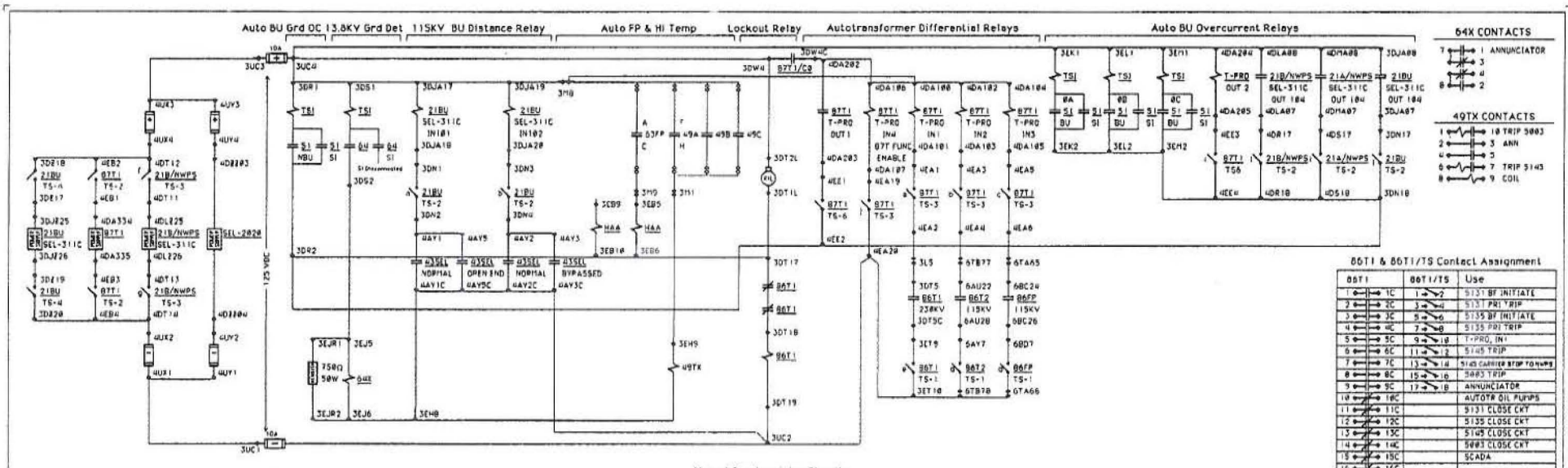
MATERIAL LIST

QTY	DESCRIPTION
18	400' 1/2" Floodlights
4	400' 1/2" Floodlight
320'	24" 1/4" Steel Conduit
18	24" 1/4" 90° Elbows
18	24" 1/4" Plastic Bushings
400'	4-2 W/A Type UF
11,500'	12-2 W/A Type UF
22	24" Couplings

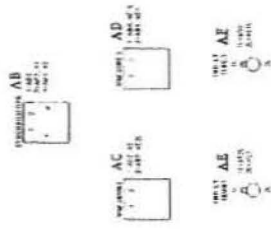
--- DIRECT BURNAL CONDUIT
--- CONDUIT IN CHASIT

NOTE:
1. TIC BONES ARE SHOWN IN
CONDUIT LOCATION DRAWING.





Synchronizing Panel



X	Y
0	0
10	10
20	20
30	30
40	40
50	50
60	60
70	70
80	80
90	90
100	100

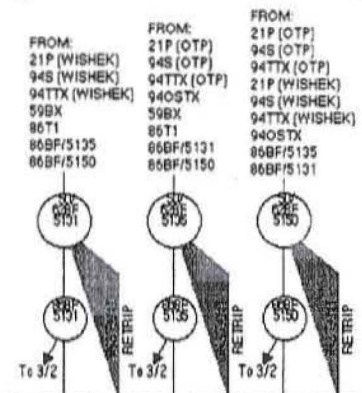
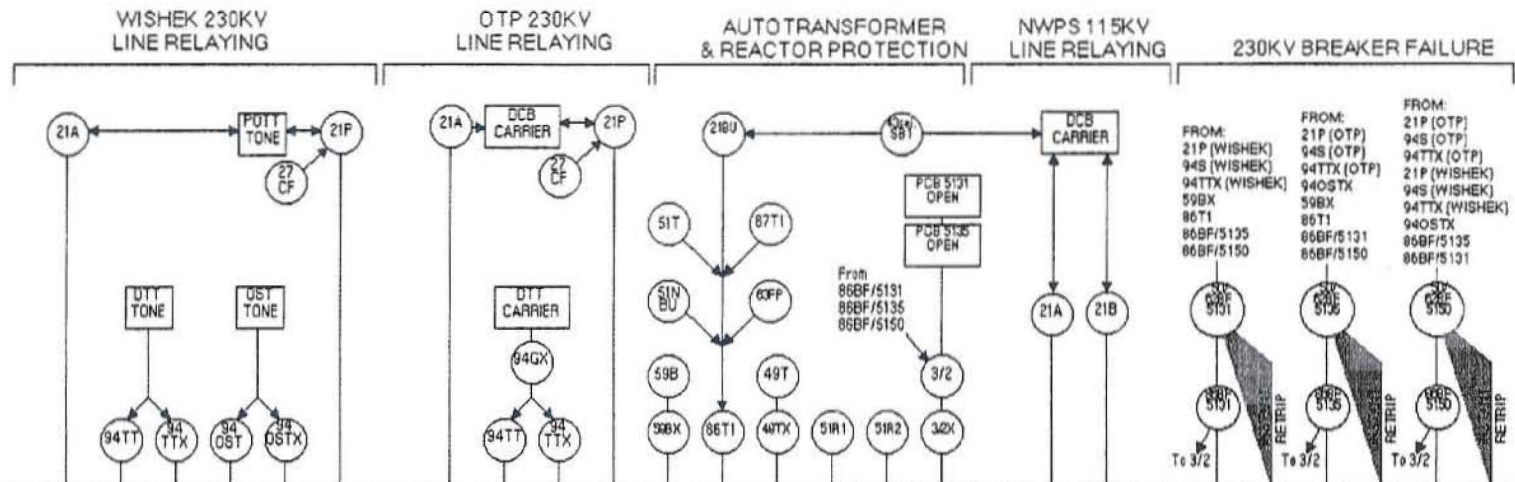
SYNCHRONIZING PANEL, SERIES 245-247

STATE	FLORIDA	CT
CITY	MONTANA	SAKOTA
COMPANY	UTILITIES CO.	
NO.	57	215

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Revised 10/11/11

Ellendale Jct Substation 230 & 115 KV Protective Relay Tripping Schedule



230 PCB 5131	P,I	P	I,B		P,I					P,I	P,I,B							S	P,I,B		P,I,B		
230 PCB 5135				P	I			P,I	P	I,B	P,I	P,I,B							P,I,B		S	P,I,B	
230 PCB 5150	P,I	P	I,B	P	I	P,I		P,I	P	I,B	P,I								P,I,B		P,I,B		S
115 PCB 5003											T,B	T							T,B		T,B		
115 PCB 5145				X	T										T	T			TXB		TXB		
13.8 PCB 5137											T,B												
13.8 PCB 5138											T,B												
DTT TO WISHEK																			TT			TT	
DTT TO FORMAN																						TT	TT

21A-SEL-321-1 Cat. # 321124256VQB354 21-PhSEL-121-G Phase Distance Relay W Ord. Overcurrent For POT Scheme 27CF- BEI-27-AJQ-EIJ-N080F Close into Fault UV Relay	94TT- AR, 5 UNIL W Target H Thresh, #714 BT1A12 Transferred Tripping Relay 94TDX- AR, 5 UNIL 2ND, 2ND #666 ED17A15 Transferred Tripping Relay 94OST- AR, 5 UNIL W Target H Thresh, #714 BT1A18 Transferred Tripping Relay 94DSTX- AR, 5 UNIL W Target H Thresh, #714 BT1A18 Transferred Tripping Relay	21A-SEL-321-1 Cat. # 321124256VQB354 21-A-SEL-121-G-5 Phase Distance Relay W Ord. Overcurrent For DC Blocking Scheme 27CF- BEI-27-AJQ-EIJ-N080F Close into Fault UV Relay	94GX- 12 HGA17 D52 (TDDQ) Trans Trip Released Relay 94TT- AR, 5 UNIL W Target H Thresh, #714 BT1A12 Transferred Tripping Relay 94TDX- AR, 5 UNIL 2ND, 2ND #666 ED17A15 Transferred Tripping Relay	32X- Agas170 12 PC Taps Reactors for Open 230 KV B 32X- Agas170 12 PC UNIL 32 Trip 6 Sec (15-9) 21B-SEL-311C Cat. # 9311C014242544X 115 KV Backup Distance 49T- H5A Auto Trans H Temp Trip 51R1- 12 VCS 1A80 1A 12 Z/R/ Reactor Overcurrent 51R2- 12 VCS 1A80 1A 12 Z/R/ Reactor Overcurrent	51T- 12 VCS 1B04A Auto Trans Overcurrent Relay 51NB- 12 VCS 3A0A Backup Dist. Overcurrent 59B- 12 H40 1A1A 230 KV Overcurrent Relay 62FK- Type J Four Pole Relay (In Transmitter) 87T1-APT, T-PRO-8700 Transmitter Overcurrent 86T1- H66 1C Lockout Relay	21A-SEL-311C Cat. # 9311C014242544X 3 Zone Distance Relay 21B-SEL-311C Cat. # 9311C014242544X 3 Zone Distance Relay 5082BF- 66F-1 #1523 P93A02 Overcurrent Relay (0.121, 5.125, 5.150) 86BF- L07B 10 D for Fail Lockout (0.121, 5.125, 5.150)	T = Trip TT = Transferred Trip X = Trip 294X P = Primary Trip S = Secondary Trip = Initiates Bkr Failure B = Blocks ALL Closing
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Revised 6/8/92 CMF
87T REPLACEMENT 4-2-03 PL

57-2156



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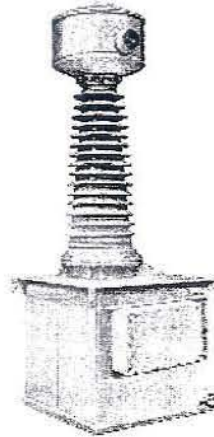
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PRODUCT CATEGORY

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SSVT Product Line

Station Service Voltage Transformers Reliable POWER Direct from Transmission Lines!



Bring your installation down to size and budget using Kuhlman Electric's Type SSVT Station Service Voltage Transformer

- Low cost alternative to distribution feeder construction.
- Low profile, compact design, power-rated transformer.
- Power ratings up to 100kVA, available with isolated metering winding option.
- Reliable transmission voltage access for substation power.
- Special designs easily accommodated for different low voltages and outputs.
- Isolated windings for flexibility in making various required secondary connections.
- High seismic withstand capability.
- Short lead-times.

SSVT Product Information

A Kuhlman station service voltage transformer (SSVT) combines the characteristics of a voltage transformer with convenient power capability. This provides a fully insulated transformer up to 230kV with power performance up to 100 kVA. The standard design can withstand 173% voltage for 1 minute (230kV designs are rated for 140% over voltage per C57.13 group3).

This combination allows **direct connection to the high voltage transmission line** in an economical, conveniently installed, pedestal mounted transformer. The transformation is directly from the high voltage primary down to the low voltage output that supplies 125/250 VAC power.

up to 600 VAC, if specified) to drive lighting loads, motor loads, and instrumentation.

Typical secondary ratings available: 115 vac, 120/240 vac, 277 vac, 240 vac, 600 VAC. Contact us at 800-274-6960 for other configurations.

APPLICATIONS

Switching Station Application The station service voltage transformer mounted onto a pedestal with primary tied to the transmission line. The secondary control wiring is connected to the station power panel. Self-contained power from transmission line, reliability assured.

- Can be used for metering or bus potential
- Eliminates reliance on outside power sources

Remote Cell Tower Site Application It is often required to site cell tower in remote locations for repeating the phone transmissions. A tap can be taken from the transmission line to the station service voltage transformer. This offers you substantial cost savings over installing a dedicated distribution feeder.

- User advantage of power purchases at transmission level
- Avoid costs of tower permits by using existing towers
- Avoids Outages

Reliable Power From Transmission Voltage Eliminates reliance on outage-susceptible distribution lines, or power transformer tertiary for control power by placing SSVTs within the substation. Power supplied within the substation, improving reliability.

- Returns power tertiary windings to control harmonics
- Dual function in one unit as a power source and metering

Transmission Line Lighting Application Used to power aircraft clearance lighting on transmission towers crossing a river for security and safety purposes. Our SSVT has been mounted on towers and used to provide lighting power up on the tower.

- Reduced total installed cost for application
- Limited installation to a compact space up near transmission line
- Less control wiring to reduce future problems

Transmission Switch Automation Application Service voltage transformer used with power rating and a metering winding, to get both control power and tap voltage indication for monitoring circuits for SCA for automatic switch use.

- Reduced space & installation timing on compact switch structure
- Self-contained power from transmission line, reliability assured

- Used for metering circuit if primary metering is needed

Product Ratings

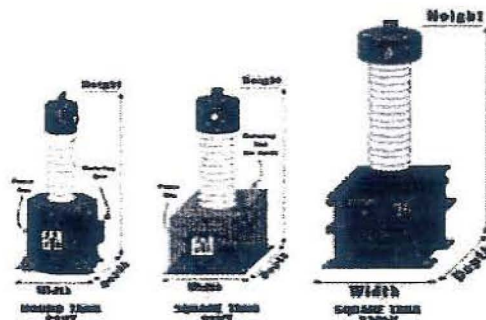
System	Oil	Style	10 kVA	25 kVA	60 kVA	100 kVA
48 kV	250 kV	Power Only + Metering	(0.3%)	(0.15%)	(0.15%)	(0.15%)
69 kV	300 kV	Power Only + Metering	(0.5%)	(0.15%)	(0.15%)	(0.15%)
115 kV	550 kV	Power Only + Metering		(0.15%)	(0.15%)	(0.15%)
138 kV	850 kV	Power Only + Metering			(0.15%)	(0.15%)
161 kV	600 kV	Power Only + Metering			(0.15%)	(0.15%)
230 kV	900 kV	Power Only + Metering			(0.3%)	(0.3%)

Mechanical Data

System/Oil	kVA	Tank Type	Ht (in)	Width (in)	Depth (in)	Wt (lbs)
48/250 kV	10	Round	60	21	28	676
	25	Square	64	30	32	1850
	50	Square	64	30	32	1950
	100	Square	64	30	32	2125
69/300 kV	10	Round	67	25	25	715
	25	Square	72	30	32	1875
	50	Square	72	30	32	1975
	100	Square	72	30	32	2150
115/550 kV	25	Square	88	30	32	2200
	50	Square	88	30	32	2300
	100	Square	88	30	32	2500
138/850 kV	50	Square	103	31	39	2776
	100	Square	103	31	39	3070
161/600 kV	50	Square	112	31	39	2875
	100	Square	112	31	39	3175
230/900 kV	50	Square	155	70	66	9550
	100	Square	155	70	66	9750

Electrical Distance

Bushing	48 kV	69 kV	115 kV	138 kV	161 kV	230 kV
Size	17.86"	23.6"	38.26"	49.0"	52.0"	70.0"
Creepage	46.25" (1862F)	54.7" (1792F)	141.0" (1822F)	160.0" (1822F)	197.0" (1822F)	178.0" (1822F)

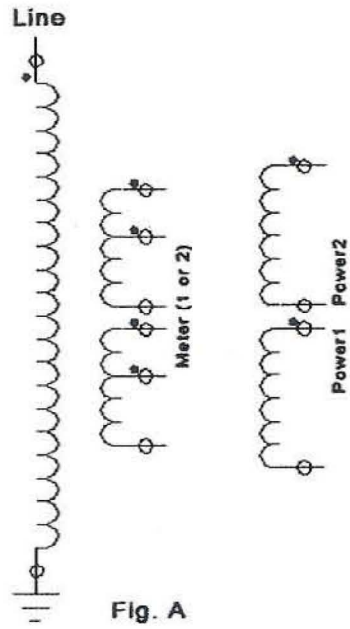


SSVT Winding Options

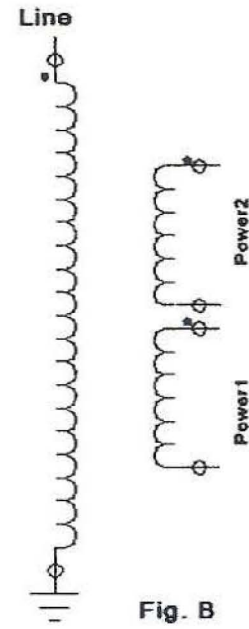
The standard station service (power only) voltage transformer has two isolated secondary windings that can be either series or parallel connection for different voltage output. These coils are series connected when shi but hardware is provided for parallel connection. Also, one or two addit tapped meterings winding, or an auxiliary control winding can be suppl with isolation from the power coils to minimize voltage fluctuations.

Winding variations shown below are: Fig. A (Power + Metering), Fig. B (Power Only), and Fig. C (Power + Control).

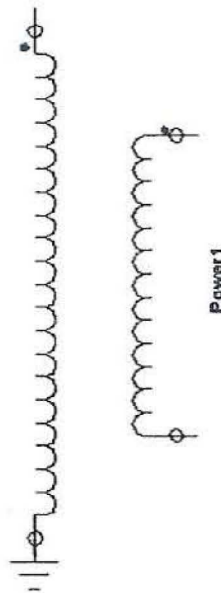
**Power + Metering
C57.13 Group 3**



**Power Only
C57.12 Distribution**



**Power Only
Single Secondary**



**Optional Isolated
Auxiliary Winding**

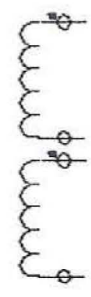


Fig. C

WELCOME TO KUHLMAN ELE

SUBSTATION SPECIFICATION
230kv Ring Bus Wind Farm Substation
MONTANA-DAKOTA UTILITIES CO.
A Division of MDU Resources Group, Inc.

The following substation shall be delivered to:

Supplier shall design a substation, provide structures of a low profile design, all insulators, bus work, connectors, switches, lightning arresters, and other materials required, which would function similar to that shown on the Purchaser's drawing(s).

General Requirements

The station shall be designed such that all indicated future bays will be available for Purchaser use. Future plans for this station include the potential expansion to operate as a breaker-and-a-half bus arrangement.

Purchaser's drawings are provided as a reference. Supplier designs which operate in accordance with the station one-line (Dwg 08312004-1) and results in modifications to Purchaser's drawings may be acceptable. The station design must fit within a reasonable area and provide safe clearance between equipment and fence for personnel and trucks to pass. Trucks must be able to drive completely around station structures to accommodate installation and removal of equipment. At a minimum, clearances must meet NESC-C2 requirements. The distance between any station structure and the fence shall not be less than 40 feet. Variance from bid drawings must be approved prior to acceptance of design and bid.

The design shall be low profile utilizing wide flange beam or square, round or octagon tube construction. Lattice type structures will not be acceptable. Structure materials shall be either galvanized steel.

Line towers and other structures, which will bear a heavy moment load, shall be designed such that foundations will be subjected mainly to uplift and compression loading.

All structures shall be designed to limit the relative movement of electrical equipment terminals or switch terminals to 1" maximum in any plane under equipment operation and/or bare wind loading.

General structures are to be designed to utilize drilled caisson type foundations of a maximum diameter of 36" with maximum bolt circle 28". The preferred drilled pier foundation diameter is 26" with a maximum bolt circle of 18".

Lightning protection shall be 45 degrees with the vertical.

The structures shall be designed to withstand a wind force of 25 lbs. per sq. ft.

Conductor loadings to be 1/2 inch ice with a wind force of 8 lbs. per sq. ft.

All structures must be designed to meet or exceed the latest version of ANSI C2 safety factors in conjunction with all loadings and other conditions specified.

Design Parameters

230KV Deadend Design Parameters

Deadend towers to withstand unbalanced tension due to any one outside conductor breaking.

Phase wire tension of 5,000 lbs. per conductor +/-15 degree from straight pull-off.

Static wire tension of 2,500 lbs. per wire +/-15 degree from straight pull-off, with 2 static wires per line deadend.

SUBSTATION SPECIFICATION (CONTINUED)

Insulation Level

230KV section shall have equipment and equipment spacing rated 900KV BIL.

Minimum Clearances

	Between Live Parts	Between Live Parts and Ground	Vertical Clearance From Foundation to Live Parts	Between Horn Gap Switches and Expulsion Power Fuses	Vertical Break Disconnect Switches and Bus Supports
230KV	89"	76"	15'-0"	192"	132"

Fault Duty

	Design Fault Duty	Actual Fault Duty
230KV	4,000 MVA	1830 MVA

Current Capacity Ratings (Minimum)

230KV SECTION	CONDUCTORS	CONNECTORS	SWITCHES
Main Ring Bus	1,200	1,200	1,200
Transformer Tap	1,200	1,200	1,200
Line Taps	1,200	1,200	1,200

Conductor and connector current ratings are to be based on a conductor temperature rise of 30 deg C over an ambient temperature of 40 deg C.

Switch current ratings are to be nominally rated based on a maximum temperature rise of 53 deg C increase over 40 deg C design.

All bus tubing minimum sizes are specified on Purchaser's drawings. Larger sizes may be used if span lengths or loadings required.

Material Specifications

Switch & Bus Support Insulators

Standard station post, light gray color as follows:

230KV: 900KV BIL, 5" Bolt Circle, T.R. 304

Single piece, or multicone type insulators will not be acceptable. Specify insulator types to be supplied (subject to Purchaser approval). Three spares of each type insulator shall be included.

Switches

The attached General Switch specification indicates the general requirements for any three-pole, group operated, disconnect switch. All switches are to meet ratings according to Current Capacity Table included, in these specifications.

Switches to have continuous current ratings of 600, 1200, 1600, or 2000 amperes as previously specified. All group operated switches shall be equipped with arcing horns. The live parts may be either copper or aluminum. Switches to be equipped with operating mechanism as follows:

230KV – gear operator

SUBSTATION SPECIFICATION (CONTINUED)

The following table indicates switches which may be used, providing the switches meet the general switch specification for group operated switches referenced above. It should be noted that unacceptable switches are also indicated.

Manufacturer	Vertical Break Group Operated	Double Break	Center Break "V" Group Operated	Side Break Group Operated	Hookstick	Center Break
ABB T&D Power Co.	TTR-6	TTT	DRV	A7A	HPL	DR
Cleaveland/Price	V2-CA V2-C V2-HC	DB-C		RL-C	LCO-C RBI RBO-C	
Southern States	AVB, CVB TA (to 72kV) EV, EV1	DEB DBL RDA-1	CBL-T *** CBL-2 ACB-2 ***	SSB ** (to 72kV) 57L	HS HA PBO	CCB ACB ACB-2 WT**
G.W. Electric	MK-40A ** MK-40 **	80	LPV	PMB-40A PMB-40	B2MV	LPC
USCO	AVR **	---	GCH-V ** AGCH-V **	ASB ** GSH	HH-6 HH-6V	GCH AGCH
Royal	AVB		V	SB (to 46kV)	BT	CB
Pascor	VBP, VBS					
Johnson *	VIP, VIP-A	DSB			HPT	

* Indicates approval for gaining experience.

** Indicates that manufacturer's standard switch does not meet Montana-Dakota switch specs.

*** Not Approved

Specific requirements:

11 - 230KV vertical break switches. (Reflects switches shown on 08312004-1)

Bell Insulators

Bell insulators shall be 10" diameter, standard ball and socket construction, light gray color as follows:

230KV: 16 units per horizontal string, 14 units per vertical string

Anchor Bolts

All necessary anchor bolts shall be provided by supplier. All anchor bolts shall be supplied with two (2) nuts and two (2) flat washers each for leveling of structures. No grout will be used under structure base plates.

Arresters

Arresters shall be metal oxide, porcelain or polymer construction. Arresters to be light gray in color.

230KV SECTION	LINE VOLTAGE (nominal)	MCOV RATING
Transformer	230kV L-L	144 kV MCOV Station Class
230KV Lines	230kV L-L	153 kV MCOV Station Class

Acceptable Arrester Suppliers:

- ABB - Siemens - Cooper - Hubbell / O.B. - Joslyn - General Electric

Supplier shall provide mounting bolts with each arrester. Mounting plates are approximately 3/4" thick.

SUBSTATION SPECIFICATION (CONTINUED)

Connectors

Deadends of strain buses internal to the station utilizing either aluminum or ACSR cable shall be Alcoa compression deadends. Line terminations shall be Alcoa compression deadends.

Conductor terminals shall be Alcoa compression fittings for all ACSR and aluminum cable, except tee connectors are to be bolted main to 2 or 4 hole NEMA pad tap.

Tubing to tubing connectors shall be bolted type.

Expansion fittings are required on bus connectors to equipment bushings, arresters, switches and any other points of expansion as required. Expansion connectors to be of the type using flexible laminated straps. Flexible braided type straps are not acceptable. Expansion fittings shall only be installed in buswork at a point of support. Bus support slip fittings are allowable on bus work runs to provide for expansion. Slip fittings are to be mounted only on bus supports.

Supplier shall furnish a minimum of 3 spare compression connectors for any compression type connectors having necessary quantities of 12 or more.

Bolted connections shall be made up as follows:

Aluminum pad to Aluminum pad - Stainless steel bolts, flat washer, Belleville washer & nut.

Aluminum pad to Bronze pad - Transition pad, stainless steel bolt, flatwasher, Belleville washer and nut

Bronze pad to Bronze pad - Silicone bronze bolts, lockwasher and nut

Copper cable shall use bolted connectors.

Static wire shall have strain clamp deadends and bolted connectors for connection to 4/0- 19 strand copper ground wire.

Tubing to wire connections shall be tee connectors, bolted tubing main to 2 or 4 hole NEMA pad tap.

End bells or plugs to be used on all tube conductors.

Supplier to furnish Alcoa joint and filler compounds as required. Filler compound to be used in compression terminals. Joint compound to be used on all aluminum to aluminum and aluminum to bronze bolted connections.

Bus Damper

Aluminum tube bus to contain ACSR cable for vibration damping when runs are longer than those listed in center column. Lengths apply to both Schedule 40 and Schedule 80 tubular bus.

NOMINAL PIPE SIZE	Maximum Safe Span Length without Damper Cable	Minimum Size ACSR to be used for Damper Cable
1"	5'-0"	4/0 ACSR
1 1/4"	6'-0"	4/0 ACSR
1 1/2"	7'-0"	4/0 ACSR
2"	9'-0"	266.8 ACSR
2 1/2"	11'-0"	266.8 ACSR
3"	13'-0"	266.8 ACSR
3 1/2"	15'-0"	397.5 ACSR
4"	17'-0"	795.0 ACSR
4 1/4"	19'-0"	1,113.0 ACSR
5"	21'-0"	1,431.0 ACSR
6"	25'-0"	1,590.0 ACSR

Aluminum tube bus loaded deflection between supports shall be limited to the diameter of the tube. Each ACSR wire size used shall have a minimum 100 feet spare furnished.

SUBSTATION SPECIFICATION (CONTINUED)

Line Deadends

Transmission line conductors will be of the following sizes:

Design Section	Conductor	Static
230KV Lines	795 ACSR 45/7 (Tem)	3/8" EHSS

Supplier to furnish transmission line deadend provisions in structures suitable for ball clevis attachment. Transmission line deadends will be Alcoa compression deadends (provided by Purchaser) for the sizes listed above. These deadends are single tongue and have NEMA pads standard for the conductor size. Supplier to furnish conductor for jumpers of a minimum size equal to the line conductor, and all jumper terminals.

Jumper terminals that will be attached to deadends must have pads compatible with pads on deadends.

Supplier to furnish strain clamp deadends for all static wires and bolted connectors for connection to 4/0 - 19 strand copper ground wire.

Grounding

Each structure leg to have drilling for standard 2-hole NEMA grounding pads.

Supplier to provide single switch operating platforms for all switch structures as per attached Galvanized Steel Switch Mat detail drawing.

Supplier to provide bolted structure terminators and connectors as required for 4/0 - 19 strand copper ground conductor. A continuous length of ground conductor will be attached to a structure leg, extend up the structure, and be connected to any static wires, lightning arresters, PT's, CCVT's, CT's, or other equipment requiring grounding which is mounted on the structure. Supplier to furnish all drilling and connectors for these ground conductors at approximately 4 foot intervals.

Supplier to provide all 4/0 - 19 strand soft drawn copper ground conductor, 1/0 - 7 strand soft drawn copper ground conductor, ground rods, 2-Hole NEMA ground terminals, fence ground clamps and below grade exothermic connections to complete station ground grid.

4/0 copper shall be used within the substation fenced area. 1/0 copper shall be used to form a ground perimeter approximately 3 feet outside the fenced area. 1/0 copper shall be used to connect switchboard ground bus, with 1- 1/0 copper conductor to each switchboard cabinet. A 4/0 copper conductor shall form a "loop" within the control house for grounding all equipment inside the control house. 1/0 or 4/0 copper jumpers, with exothermic connections to the 4/0 copper loop, shall connect individual pieces of equipment as required. Jumpers will be connected to equipment using bolted connections.

Bus Supports

Bus supports used at tap locations of ring bus shall be designed so that the bus can be tapped in any manner.

Bus supports used at future switch locations shall be designed such that the stands will accommodate installation of future switches on the bus support structure itself or on the bus support foundations.

Lighting

Supplier to furnish yard floodlights to provide adequate lighting for night construction or inspection activities. Lighting standards are to be constructed as per standard drawing. Lighting standards are to be placed in the substation yard to provide lighting over all buswork and equipment. Lamp ballasts shall be 240 VAC, 400 watt Metal-Halide bulbs, with varying NEMA beam sizes, with knuckle type slipfitter mount onto 2 1/2" galvanized steel pipe (similar to GE Type P-400C Power-flood).

Conduit – Above Grade

Supplier to furnish ALL above grade conduit. ALL above grade conduit shall be hot-dip galvanized threaded conduit with appropriate fittings. Above grade conduit sizes shall range from maximum 4" to breakers with

SUBSTATION SPECIFICATION (CONTINUED)

multiple control cables down to minimum 1 ¼" conduit to devices with only 1 single 4 conductor 10 control cable. Actual conduit sizes are a design decision based on number of control cables and the ability to easily pull cables through conduits.

All PT's, CCVT's, freestanding CT's are to have aluminum or stainless steel NEMA type 12, continuous hinge junction box mounted on each respective equipment stand, about 4 feet above the stand base. Provisions are to be included on the equipment stands to mount the junction boxes. Junction box to include interior sub-panel. Box to have no knockouts. Junction box is to be adequately sized to contain secondary fuses and terminal boards for potential devices, and short-circuiting type terminal boards for current devices. Junction box and terminal boards are used for terminating control cable between control building and equipment.

Conduit – Below Grade

Supplier to furnish ALL below grade conduit. ALL below grade conduit shall be Carlon Type DB, Schedule 40 or Schedule 80 depending on surface loading conditions with appropriate Carlon fittings. Underground conduit sizes shall range from maximum 4" to breakers with multiple control cables down to minimum 1 ¼" conduit to devices with only 1 single 4 conductor 10 control cable. Actual conduit sizes are a design decision based on number of control cables and the ability to easily pull cables through conduits.

Wave Traps and Coupling Capacitors

Deadend towers must be designed to be field adaptable to accommodate a wave trap/coupling capacitor combination installation on any phase.

Deadend towers to have drilling at approximately 4 foot intervals for 15KV line post insulators used to insulate 5KV cable routed between line tuner and CCVT.

Deadend towers shall include provisions for mounting a line tuner cabinet on both outside facing legs.

Provisions for mounting a cable pull-box on PT or CCVT stands approximately 3 feet above ground .

Station Service

Provide mounting stand, high voltage connections, conduit, and secondary connections for: 1 - single phase, 230kV to 120/240 volt, 100 kVA, Station Service Voltage Transformer. "Power Only" secondary windings required.

Lightning Mast

Due to vibration problems with lightning masts, a covered damper cable will be suspended from top of the mast 2/3 to 3/4 of total length. Purchaser will provide and install the cable. However, the top of the mast must be removable and a U-bolt with a 2" minimum diameter open area provided for installation of the cable as indicated on the drawings.

Standard Conductor Sizes

The following is a listing of the standard conductor sizes used by Purchaser. Please select wire conductors from following table:

Copper	Aluminum	ACSR	Aluminum Tube
#6 Solid	3/0-7 strand	1/0-6/1 strand	1"
#4 Solid	336.4-19 strand	2/0-6/1 strand	1 1/2"
1/0-7 or 19 strand		4/0-6/1 strand	2"
2/0-7 strand		336.4-26/7 strand	3"
4/0-19 strand		397.5-26/7 strand	4"

SUBSTATION SPECIFICATION (CONTINUED)

350-37 strand		477-26/7 strand	
500-37 strand		795-45/7 strand	
750-61 strand		954-45/7 strand	
1000-61 strand		1113-45/7 strand	
		1431-45/7 strand	
		1590-45/7 strand	

DRAWINGS & INSTRUCTIONS

Supplier to furnish three (3) sets of the following drawings with the quotation:

- Station Arrangement - to include plan view and elevations
- Material List (Material list shall include itemized price & delivery)
- Overall Package Price & Delivery

Supplier to furnish three (3) sets of the following drawings for approval upon bid award:

- Station Arrangement - to include plan view and elevations
- Structure Loadings - to assist with foundation design
- Anchor Bolt Plan & List
- Material List

Supplier to furnish *five (5) sets of the following drawings as FINAL drawings:

**In lieu of Five printed sets, final drawings may be supplied in AutoCAD format & Two printed sets.*

- Station Arrangement
- Instructions and Outline Drawings for all equipment supplied
- Detailed Steel Erection Drawings
- Detailed Steel Fabrication Drawings
- Anchor Bolt Plan & List
- Material List

CONSIDERATION OF BIDS

Until final award of the contract is made, the purchaser reserves the right to reject any and all bids, waive any informalities or accept any bid or bids which, in the opinion of the purchaser's engineers, will serve the best interest of the purchaser. The purchaser also reserves the right to accept or reject any alternatives that may serve his best interest.

Any exception to any part of these specifications must be noted in the bid.

SUBSTATION SPECIFICATION (CONTINUED)

Separate Material Specification

The following material is required by the Purchaser. Negotiations between Purchaser and Substation Packager will determine the provider of following items. However, in all cases, the Substation Packager is required to provide appropriate mounting accommodations of equipment.

ALL transmission line deadend materials, including ball clevis, bell insulators, socket clevis and/or socket eyes and single tongue compression deadends.

ALL static wire and connectors furnished with termination of line static into station deadend structures.

Fence Materials & Installation

Control Building & Accessories

Concrete, reinforcing steel and foundation construction per foundation designs.

ALL Control Cable

1 – 24' x 48' Control house containing all interior materials.

Switchboard, containing all panels, relays, alarming & control devices and associated wiring

9- 230KV CCVT's

3 - 1200 amp wave trap (pedestal mount)

3- 242KV dead tank SF6 circuit breakers

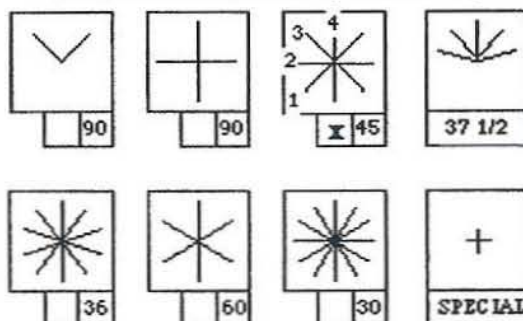
1- 100 kva station service transformer, Similar to Kuhlman SSVT 230kV-120/240 VAC

_____ SUBSTATION
SWITCHGEAR SUMMARY

MARK NO.	QTY.	DESCRIPTION	DEVICE NO.
5AK	1	Recloser Selector Switch, G.E. Type SB-1	43R/324

ON SB-10 SWITCHES MARK LAT. STAGES WITH A DOT. (.)		CONTACT ARRANGEMENT MARK "X" FOR CLOSED CONTACT		HANDLE POSITIONS (BACK VIEW)														
				4	3	2	1											
		1	X															
		2	X															
		3	X	X	X													
		4	X	X	X													
		5	X	X	X													
		6	X	X	X													
		7	X	X	X													
		8	X	X	X													
		9	X	X	X													
		10	X	X	X													
		11	X	X	X													
		12	X	X	X													
		13	X	X	X													
		14	X	X	X													
		15	X	X	X													
		16	X	X	X													
		17			X													
		18				X												
		19					X											
		20						X										
		21							X									
		22								X								
		23									X							
		24										X						
		25											X					
		26												X				

MARK HANDLE POSITIONS (FRONT VIEW)



RECIOSER SELECTOR	
1	BREAKER MAINTENANCE
2	
3	NON-RECLOSING
4	RECLOSING

ROTATING ACTION MAINTAINED ALL POSITIONS:

SPRING RETURN ACTION

S.P. FROM CCW POS. S.P. FROM CW POS.

FROM POS. TO FROM POS. TO

MAINT. POS.

PULL TO LOCK IN POS.

HANDLES

KNURLED

OVAL

PISTOL GRIP

LEVER

ROUND

RADIAL

L. PISTOL GRIP

NONE

ESCUTCHEON

STANDARD

OR ROUND

TARGET

KEYED FOR

REMOV. HANDLE

REMOV. IN POS.

NONE

SPECIAL _____

COVER (NEMA D)

*WATERTIGHT (NEMA III IV)

*DUSTTIGHT (NEMA V)

*OIL FILLED (NEMA VIII)

EXPLOSION PROOF (NEMA VII CLASS 1 GRD)

*FAB. METAL (NEMA D)

*SURFACE MTG.

PANEL THICKNESS 1 INCH

FILL OUT BELOW FOR SB-10

LATERAL ACTION

NO ROTATING WHEN	IN	OUT
MAINTAINING (IN & OUT)		
SPRING RETURN TO	IN	OUT
PUSH PULL	IN POS. _____	
TO CLOSE CONTACTS		
TO OPEN CONTACTS		

SPECIAL REMARKS _____

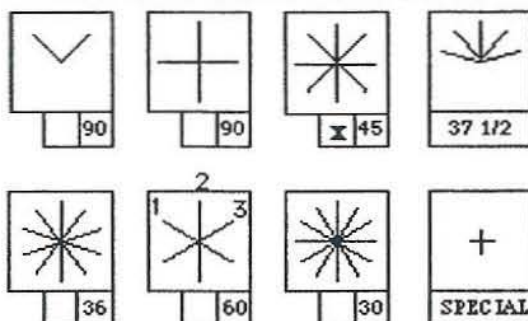
There should be no escutcheon engraving for position #2.

_____ SUBSTATION
SWITCHGEAR SUMMARY

MARK NO.	QTY.	DESCRIPTION	DEVICE NO.
7AL	1	Breaker Control Switch GE type SB-1	52CS

ON SB-10 SWITCHES MARK LAT. STAGES WITH A DOT (.)		CONTACT ARRANGEMENT MARK "X" FOR CLOSED CONTACT									
		HANDLE POSITIONS (BACK VIEW)									
CONTACTS HANDLE END ODD EVEN	↓	3	2	1							
		1	X								
2	X										
3				X							
4				X							
5	X										
6	X										
7				X							
8				X							
9											
10											
11											
12											
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23											
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25											
26											

MARK HANDLE POSITIONS (FRONT VIEW)



CIRCUIT BREAKER E-63005-6		Breaker Control
N.S.	SPECIFIER = E-63005-6	
1	Trip	
2	(blank)	
3	Close	

SEE - 2 2 2 2 -
FOR LAL IN CASE

ROTATING ACTION
MAINTAINED ALL POSITIONS:

SPRING RETURN ACTION
S.P. FROM CCW POS. S.P. FROM CW POS.
FROM POS. 1 TO 2 FROM POS. 3 TO 2
MAINT. POS. 2 1 1

PULL TO LOCK IN POS.

HANDLES
KNURLED
OVAL
PISTOL GRIP
LEVER
ROUND
RADIAL
L. PISTOL GRIP
NONE

ESCUTCHEON
STANDARD
~~OR ROUND~~
TARGET
KEYED FOR
REMOV. HANDLE
REMOV. IN POS.
NONE
SPECIAL _____

COVER (NEMA I)

*WATERTIGHT (NEMA III IV)
*DUSTTIGHT (NEMA V)
*OIL FILLED (NEMA VIII)
EXPLOSION PROOF
(NEMA VII CLASS 1 GRD)
*FAB. METAL (NEMA I)
*SURFACE MTG.

FILL OUT BELOW FOR SB-10

LATERAL ACTION

NO ROTATING WHEN	IN	OUT
MAINTAINING (IN & OUT)		
SPRING RETURN TO	IN	OUT
PUSH	PULL	IN POS. _____
TO CLOSE CONTACTS		
TO OPEN CONTACTS		

(CROSS OUT THE ACTION WHICH DOES NOT APPLY)

SPECIAL REMARKS _____

SINGLE PHASE A.C. DISTRIBUTION PANEL SPECIFICATIONS

Following AC Distribution Panel shall be delivered to:
230kv Wind Farm Substation

GENERAL SPECIFICATIONS

Single Phase 120/240 VAC Service – Solid Neutral

Panel to be Main Lugs only for #6-250 MCM Copper conductor. Main Lugs to be a 2 conductor style to provide sub-feed capability for two (2) #6-250 MCM Copper conductors.

Panel to be bottom feed with sub-feed lugs.

Panel Bus to be 400 Ampere rated Mains and Main lugs

(Sub-feed lugs to be rated same as Main lugs.)

Branch Breakers to be of Bolt-on style. Single pole breakers to be rated 120 VAC, 10,000 amp interrupting. Two pole breakers to be rated 120/240 VAC, 10,000 amp interrupting. All branch breakers rated 300 amps and above to have UL rating as HACR type for use with air conditioning, heating and refrigeration equipment having motor group combinations.

Branch Breakers to be provided and factory assembled into Distribution Panel with the bus to be tapped exactly as specified on Purchaser's drawing.

Galvanized steel box to have NO Knockouts

Minimum Box Dimensions: 20" wide x 7 1/4" deep, with gutters of 6" on sides and 15" on ends.

Panelboard is to be surface mounted NEMA #1 enclosure with surface trim.

Distribution Panel to be complete with box, internal copper bus, copper ground, copper neutral, all branch breakers, trim & cover panels, wire trough and swinging cover door with metal directory card holder. Distribution Panel to be factory assembled.

Non-UL listed Panelboards will be considered.

CONSIDERATION OF BIDS

It will be assumed that the manufacturer is quoting and will provide equipment in strict conformance with these specifications, unless the quotation includes a statement and description of proposed exceptions. Any exception to any part of these specifications must be noted in the bid. All bidders shall supply Panel Type & Branch Breaker Type information at time of bid.

Until final award of the contract is made, the purchaser reserves the right to reject any and all bids, waive any informalities or accept any bid or bids which, in the opinion of the purchaser's engineers, will serve the best interest of the purchaser. The purchaser also reserves the right to accept or reject any alternatives that may serve his best interest.

ANNUNCIATOR SPECIFICATIONS
 Ref. #080403-JPH2
MONTANA-DAKOTA UTILITIES CO.
 A Division of MDU Resources Group, Inc.

Following Annunciator shall be delivered to:
 Montana-Dakota Utilities Co.

ANNUNCIATOR OPERATING SEQUENCE

This annunciator will be used in an unattended substation and shall have the following alarm sequence:

ALARM SEQUENCE CHART

	CONDITION	FIELD CONTACT	ALARM LIGHTS	AUX CONTACTS
Step 1	Normal	Open	Off	Open
Step 2	Alarm	Closed	On	Closed
Step 3	Reset	Closed	On	Closed
Step 4	Return to Normal	Open	On	Open
Step 5	Reset	Open	Off	Open
Step 6	Lamp Test	Open	On	Open

1. The alarm lights are to remain steady and locked-in subject to a manual reset.
No flasher or sound alarm required.
2. The auxiliary contacts are to reflect the status of the field contact, relay logic is used.

ANNUNCIATOR RATINGS

Operating Voltage: 125 volts D.C.

Alarm Inputs: Dry field Contact

Auxiliary Output Contact Ratings: 30 milliamp, 125 VDC continuous rating.

30 milliamp, 125 VDC interrupting rating.

MOUNTING

The annunciator shall be constructed for semi-flush switchboard mounting.

SPECIFIC REQUIREMENTS

Number of Alarm Points	28
Number of Spare Blank Nameplates	12
Number of Spare Alarm Lights	24

Annunciator window engraving list will be supplied by Purchaser. after award of purchase order.

CONSIDERATION OF BIDS

Until final award of the requisition is made, the Purchaser reserves the right to reject any and all quotations, waive any informalities, or except any bid or bids which, in the opinion of the Purchaser's engineers, will serve the best interest of the Purchaser. The Purchaser also reserves the right to accept or reject any alternatives that may serve his best interest.

Any exception taken to any part of these specifications must be noted in the quotation, or it will be assumed that the supplier is quoting in strict conformance to these specifications.

LEAD ACID SPECIFICATIONS
MONTANA-DAKOTA UTILITIES CO.
A Division of MDU Resources Group, Inc.

Following Battery shall be delivered to:
_____ Substation

INTENT

This specification describes the technical requirements of a 60 cell lead-acid storage battery to supply control and emergency circuits. The battery will be connected across a suitable voltage regulated charger and the continuous and emergency loads for floating operation.

This battery shall comply with all the applicable published standards of ANSI & NEMA and any additional requirements prescribed in this specification.

The battery shall be of the lead-calcium or lead selenium type having a fully charged specific gravity of 1.210-1.220 at a normal battery temperature of 77 F., with 200-250 ampere hour capacity for an 8 hour rate of discharge.

Also to be supplied with battery are all **battery connectors & hardware, one pilot cell thermometer, one hydrometer syringe with wall type holder & drip cup, one cell lifter, and one steel battery rack**, as described below.

SERVICE REQUIREMENTS

The battery will be installed in a suitable ventilated room. The ambient temperature will range from 60 deg F to 80 deg F.

BATTERY RACK

The battery rack supplied shall be constructed as a 2 step, continuous length, acid-proof steel rack. Height and width dimensions shall be held to a minimum. Steel channel rails shall be suitably insulated from the bottoms of the cells. All metal rack members shall be painted with two coats of acid resistant paint.

The rack parts shall be suitably identified for quick assembly. Assembled height shall be such that the lower step of battery terminals is no lower than 30 inches and the upper step of battery terminals is no higher than 42 inches.

CELL CONSTRUCTION

- Containers - Shall be clear plastic with high and low level lines clearly indicated and may have one, two or three cells per container. On multi-cell containers, each cell must have individual posts for testing and charging. Individual containers may not weigh more than 120 lbs per container
- Plates - The positive and negative plates shall be suitably matched in construction to deliver the required capacities.
- Cell Covers - Shall be of suitable material to effectively seal the cell with a permanent type bond to the containers.

- Vent Plugs - Shall be constructed to allow the escape of gases, but not of acid spray. Shall be explosive proof design with permanent type snap-on covers for filling holes to prevent dust entering the cell. One vent plug shall be suitable for mounting a thermometer. One vent plug shall be suitable for mounting a hydrometer syringe for pilot cell readings
- Cell Posts - These shall be of sufficient number and size to safely deliver the specified current. Copper inserts shall be used when necessary to hold the voltage drop to a minimum value. On multi-cell containers the cell posts must be such that a single cell may be bypassed in the event of the failure of a single cell.
- Sediment Space - Ample sediment space shall be provided beneath the plates to eliminate the necessity for sediment removal during the life of the battery.
- Connectors - These shall be lead plated copper strips of adequate current carrying capacity to connect the units in series. The inter-unit and terminal connectors shall be bolted to the cell terminal posts with lead protected brass nuts and brass studs. Cells 1, 30, 31 and 60 must have connectors that will accept One 250 MCM stranded copper conductor each.

BATTERY CHARGER SPECIFICATIONS
MONTANA-DAKOTA UTILITIES CO.
 A Division of MDU Resources Group, Inc.

Following Battery Charger shall be delivered to:
 _____ Substation.

BATTERY CHARGER

The charger shall be of constant voltage design. Rectification shall be by semiconductors of the silicon type. The charger shall be enclosed in a suitable metallic case, well ventilated, and equipped with adequate provisions for conduit entrance from any side of the enclosure. The various parts of the charger shall be readily accessible from the front for maintenance work and cleaning. All steel work shall be carefully finished to remove all sharp edges and burrs, thoroughly cleaned, rust proofed and painted with one coat of rust inhibiting primer and the necessary coats of finishing paint. The exterior surface finishing paint shall be ANSI #70 standard light gray.

The charger shall maintain a fixed voltage from no-load to full-load, with an allowable D.C. voltage variance of + or - 1% with an A.C. input voltage fluctuation of + or - 10%. For D.C. current demands in excess of the chargers rated full load current, the charger voltage will drop allowing the battery to supply the balance of the current above the chargers rating.

The charger shall be of such design that it can supply the rated current continuously, cannot be overloaded and will withstand short circuit without damage, the blowing of fuses or tripping of the chargers circuit breakers.

Ripple voltage (rms) shall not exceed 100 millivolts with the charger connected to a battery with a minimum ampere hour rating of four times the rated output current of the charger.

The charger shall provide a field adjustable (continuously, without taps) float and equalize voltages which include the following ranges:

<u>Nominal Charger Voltage</u>	<u>Min. Float Voltage Range</u>	<u>Min. Equalize Voltage Range</u>
130 Volts D.C.	120.0 - 135.0 Volts D.C.	130.0 - 145.0 Volts D.C.

Charger nominal rating: 130 Volts D.C., 25 Amps D.C

Input voltage: 240 Volts A.C., Single phase, 60 Hertz

Standard Equipment: (Mounted on the front of the charger panel)

- Meters (output) voltmeter and ammeter of + or - 2% accuracy to be provided.
- A.C. and 2 pole D.C. circuit breakers shall be furnished.
- Locations for connecting A.C. and D.C. supply shall be clearly marked.
- A.C. power "ON" indicator light.
- Ground detection lamp system, connected as continuous unswitched indicators. Indicating lights used are to be supplied with one dozen spare bulbs for each type of indicating light supplied.
- Float - Equalize switch.

Alarm Package: Loss of AC Power & Low DC Voltage Alarming shall be provided individually or as part of a complete alarm system with alarm contacts wired to terminal strips for customer access.

Drawings: Five sets of drawings and instruction books for the battery charger shall be provided.

CONCRETE SPECIFICATIONS MONTANA-DAKOTA UTILITIES CO.

A Division of MDU Resources Group, Inc.

SCOPE:

1. This specification covers the mixing and placing of Class B concrete. It includes requirements not only for the cement, but also for the aggregate, admixtures and forms. Methods of placing concrete in cold weather are also covered.

GENERAL:

- 2.0 For the construction of acceptable and durable concrete, it is essential that the five basic principles stated below be adhered to.
- 2.1 Provide sound cement and aggregates, with clean fresh water, and maintain the character of these ingredients throughout their storage and carriage to the concrete mixer.
- 2.2 Secure accurate proportioning and very thorough mechanical mixing of these ingredients.
- 2.3 Regulate the water content for suitable plasticity of the concrete, while restricting to a minimum the employment of water as a vehicle for transporting and placing concrete.
- 2.4 Maintain the integrity and coherence of the plastic mass all the way from the mixer to its final position in the structure. There, the concrete shall be deposited and compacted systematically in layers or courses of masonry effectively interbonded.
- 2.5 Complete all concrete by wet curing and positive prevention of drying, freezing and other harmful influences for ten days after placing.

DEFINITION OF TERMS:

- 3.0 Cement means any commercial brand of Portland cement.
- 3.1 Cement: The unit of measure shall be the bag package containing 94 pounds of usable cement and will be used as a volume of one cubic foot in proportioning ratios.
- 3.2 Cement content is expressed by the amount required in a cubic yard of concrete in place.
- 3.3 Sizes of aggregates, herein specified, shall be determined by passing them through a ring or screening through plate metal perforations of the stated diameters.
- 3.4 Sand is that portion of the aggregate passing through the 1/4" square mesh or the 5/16" diameter round openings and being 95 percent retained on a 100-mesh sieve.
- 3.5 Coarse aggregate is that portion of the aggregate passing through the 1 1/4" diameter round openings and being retained on the 5/16" diameter round opening or 1/4" square mesh.
- 3.6 Fineness modulus is a simple index number which has been developed to indicate the size and grading of aggregates.

To determine the fineness modulus of an aggregate, it is necessary to make a simple sieve analysis. A set of U.S. Standard square mesh sieves is used, each sieve having a clear opening double the width of the next smaller size. These sizes are 100, 50, 30, 16, 8 and 4 meshes per linear inch, and 3/8", 3/4" and 1 1/2". The percentage of the aggregate, either by weight or by volume, coarser than each sieve is measured. The sum of these percentages divided by 100 is called the fineness modulus.

The fineness modulus of any mixture of two or more aggregates, such as fine and coarse, is merely the weighted average of the fineness moduli of the separate materials. For example, if 32% of sand (F.M.=3.15) is mixed with 68% coarse aggregate (F.M.=7.00), the fineness modulus of the mixture is:

$$\text{Fineness Modulus (F.M.)} = \frac{32 \times 3.15 + 68 \times 7.00}{100} = 5.77$$

- 3.7 Proportioning ratios, such as 1:2:4, refer to volumes respectively of cement, sand and coarse aggregate. Proportions specified are approximate and are subject to adjustment for economic use of available aggregates in producing dense and durable concrete, which shall have stated cement content and compressive strength.
- 3.8 Compressive strength shall be measured by the breaking stress per square inch of end area of 6 inch x 12 inch cylinders properly made, cured and tested in accordance with American Society for Testing Materials Standards, hereinafter abbreviated ASTM.
- 3.9 Slump test is a test of plasticity of the concrete. To perform a slump test, a standard slump cone (a hollow 16 gauge metal frustum of a cone 12" high with a base diameter of 8" and a top diameter of 4") is placed on a smooth level surface and filled in three equal layers with a representative sample of a batch of concrete, each layer being rodded 25 times with a 5/8" diameter rod. The metal cone is then raised vertically and the contained cone of concrete allowed to slump. The height of the slumped pile is measured, and the difference between this measurement and the original 12" height is referred to as the inches of slump.
- 3.10 Additives are chemical products added to the mix to alter the hardening rate, the plasticity, the resistance to frost action or the resistance to wetting and drying of salt solutions. Calcium chloride is an example of an additive used in cold weather to accelerate the hardening, thus preventing frost damage in concrete.

CEMENT:

- 4.0 Portland cement and all modified cements shall conform to the requirements of the current standard specifications of ASTM and, in general, shall be Type 2, to resist soil alkalinity.
- 4.1 Cement shall not be accepted hot from the mills. It shall have at least two weeks seasoning in bins at the mill before packing for shipment.
- 4.2 All cement shall be adequately protected from the weather, in transit, in storage at the works, and until it enters the concrete mixer as a dry flour free from lumps.

WATER:

5. Fresh water for mixing, cleaning and curing concrete shall be clean and free from any injurious amounts of organic matter, oil, acid or alkaline salt.

SAND:

- 6.0 Sand of natural origin is preferred, but machine-made sand will be acceptable, provided that in all sand, the constituent rock composition shall be sound, hard, inorganic and durable against weathering.
- 6.1 Sand shall be prepared for use by such screening, washing, or both, as will remove all vegetable or other perishable substance and objectionable amounts of other foreign matter, while sizing the sand grains to the required gradation.
- 6.2 The prepared sand shall be clean and practically free from mica, shale, loose scale or adhesive clay. Not more than 5 percent of the sand volume may consist of sound mineral flour, such as clay, silt or crusher dust, provided such be well distributed and prevented from segregation in handling.
- 6.3 Sand shall be sized by screening through 1/4" square mesh or 5/16" round perforations. The granular gradation shall be limited to not over 5% passing the standard 100 mesh sieve in addition to the permitted clay or dust content. Acceptable grading of sand (ASTM Designation C33) is shown in the following table:

SIEVE ANALYSIS										
Per cent Coarser than Each Sieve										Fineness
Sieve No.	100	50	30	16	8	4	3/8	3/4	1-1/2	Modulus
% Retain	90-97	70-90	45-73	20-55	10-30	0-5	0	0	0	2.35-3.50

- 6.4 Sand Screens shall be maintained to size and the plant kept in full repair for effectual separation of aggregate sizes.
- 6.5 Samples of the prepared sand, dried and compacted, shall have voids in the mass not exceeding 33%, with fineness modulus between 2.35 and 3.5.
- 6.6 Sand failing in the standard colorimetric test shall not be used.
- 6.7 Sand having a specific gravity below 2.60 shall not be used without special permission of the Montana-Dakota Utilities Engineer.

COARSE AGGREGATE:

- 7.0 Crushed stones or gravel stones for concrete shall be clean, sound, hard and weatherproof in all climates.
- 7.1 Such stones shall be prepared by screening, washing or both, for removal of all vegetable and perishable matter, together with loose scale or adhesive earth and all objectionable amounts of structurally weak elements. No coarse aggregate of less than 2.50 specific gravity shall be used without special investigation and permission of the Montana-Dakota Utilities Engineer.
- 7.2 Coarse aggregate shall be sized up to 1 1/2". Acceptable grading of the coarse aggregate (ASTM Designation C33) is shown in the following table:

SIEVE ANALYSIS										
Per cent Coarser than Each Sieve										Fineness
Sieve No.	100	50	30	16	8	4	3/8	3/4	1-1/2	Modulus
% Retain	100	100	100	100	100	95-100	70-90	30-65	0-5	6.95-7.60

ADDITIVES:

- 8. Calcium chloride, flaked and liquefied, added to the mixing water in amounts not over 2% of the cement weight in each batch of concrete, has been found useful in cold weather work for retarding the temperature drop and accelerating the set of cement, while improving plasticity.

CLASS OF CONCRETE:

- 9.0 Class B concrete shall be designated on approved drawings and used in given structures.
- 9.1 Class B concrete shall have a compressive strength of 3000 pounds per square inch when properly cured for 28 days.
- 9.2 For small jobs under 25 cubic yards, Class B concrete may be proportioned, with the approval of Montana-Dakota Utilities Engineer, as follows: 1:2:4 using 1 1/2" or smaller coarse aggregate, requiring 6 sacks of cement per cubic yard and acquiring tested compressive strength of 3000 pounds per square inch in 28 days.
- 9.3 On jobs exceeding 25 cubic yards, or at the direction of the Montana-Dakota Utilities Engineer, the mix shall be designed to give the required strength, taking into consideration the sieve analysis of the aggregates available.

ASSEMBLING:

- 10.0 All materials for concrete shall be assembled at the mixing plant in a manner that will preserve their specified qualities until each is measured out to the mixer.
- 10.1 Washed sand shall be drained of its free water before going to the stock bin at the mixer. If the washing plant is situated within a mile of the concrete mixer, there shall be provided two or more stock piles for draining sand to a reasonably uniform water content by standing for at least 12 hours after washing. Wash water shall not be allowed to drip into conveyors of aggregates.
- 10.2 On jobs where ready-mix or transit-mix concrete is available from reliable plants, it may be permissible to contract for such service under provisions for regulation and inspection which will insure delivery of concrete that will meet all the requirements of this SPECIFICATION.
- 10.3 Apportionment of mixing water shall be accurately measured and controlled by an approved measuring tank equipped with suitable fixtures for filling and discharging satisfactorily into the concrete mixer.
- 10.4 Water control in ready-mix and transit-mix concrete shall be regulated to give the required plasticity, without over watering, with not less than five minutes of fully active operation of the mixer, and suitably retarded activity during delays. For delivery delays of substantial duration, the Montana-Dakota Utilities Engineer shall decide if the batch shall be accepted or rejected.

MIXING:

- 11.0 The carefully measured proportions of cement, water and aggregates shall be thoroughly incorporated in suitable batch mixing machines of approved type and capacity. Such concrete mixers shall be continuously maintained at full efficiency by timely and sufficient repairs.
- 11.1 All mixers shall be equipped with a timing device for regulating the duration of the mixing period. This period shall be a minimum of 2 minutes for mixers of 1 cu. yd. or larger batch capacity and 1 1/2 minutes for smaller mixers, each to be operated at its most effective rate of rotation after all ingredients have entered and before starting to dump.
- 11.2 The water-cement ratio, allowing for the moisture in the aggregates, shall be adjusted to produce in each batch a consistence of concrete which will be plastic for the given structural purposes. Slumps of 2 to 5 inches shall be used as directed by the Montana-Dakota Utilities Engineer in proportioning the mix. The suitable plasticity for mass concrete will be evidenced by coherence of the stream of concrete flowing or sliding down a steel lined chute fixed on a slope not flatter than 1 2/3 horizontal to 1 vertical. This shall be the limiting slope permitted for transferring this class of concrete. A practical slump test for the same plasticity is applied when each batch delivered vertically into a bucket or hopper is found to assume a rounded or conical shape, which will not flatten to horizontal until shaken in transit and then without flooding the top surface with water or grout.
- 11.3 In no case shall the consistency be such as will promote separation of stones from mortar, nor such as will induce the formation of laitance or the accumulation of water within the forms.

PLACING:

- 12.0 All concrete shall be conveyed from the mixer in complete batches to the structure in suitable buckets, containers or conveyors which shall be mortar-tight. No chuting of concrete directly into the structures will be permitted. However, transfer chutes between mixers, containers and hoppers may be used subject to the Montana-Dakota Utilities Engineer's approval for slopes, baffles, gates and vertical terminals. All means of conveyance shall be adapted to delivering concrete of the required consistency and plasticity without separating its constituents.
- 12.1 All concrete shall be placed in the structure within one hour after mixing.
- 12.2 Every placing gang shall employ one or more men charged with the duty and responsibility of insuring homogeneous concrete against the face forms and in contact with all embedded metal.

- 12.3 Forking and spading shall be done by these men immediately after dumping the bucket and before compacting the concrete against the form. The leveling and spading work may be much reduced by skillful use of a high-speed vibrator, either pneumatic or electric, of the plunging type. However, the vibrator should not be relied upon for lateral transfer of concrete nor to cure all its imperfections. Some head work and manual labor will still be needed, and the vibrator should not be overworked to induce formation of laitance, nor in contact with forms, nor at such depth as will disturb the set of proper curing of concrete previously placed.

COLD WEATHER:

- 13.0 All concrete shall be mixed and placed with adequate precautions against freezing.
- 13.1 No frosted materials shall be used.
- 13.2 Mixing water shall be heated, preferably by live steam, in a tank regulated to such temperatures between 100 Degree F and 200 Degree F as the Montana-Dakota Utilities Engineer may direct, in view of the weather and working conditions.
- 13.3 The sand shall be heated when necessary, in conjunction with the hot water, to take the frost out of the coarse aggregate and to bring the temperature of the mix up to 70 Degree F. No open flame or other scorching heat shall be applied to concrete materials or concrete in place.
- 13.4 Fresh mixed concrete at all seasons shall have a temperature not under 50 Degree F. No concrete shall be placed in freezing weather, nor against frozen surfaces, until such surfaces have been thawed out and satisfactory provisions made to maintain the ambient temperature at or above 40 Degree F for ten days after placing.
- 13.5 Calcium chloride may be used on approval of the Montana-Dakota Utilities Engineer and as specified in Section 8.

PROTECTING:

- 14.0 Fresh concrete in place shall be protected by retention of the forms for an ample period, by prevention of disturbing shocks and vibrations, and by avoidance of the premature stressing of heavy or eccentric loading.
- 14.1 Workmen shall be warned and prevented from disturbing green concrete during the cement setting period.
- 14.2 Every precaution shall be taken to preserve finished surfaces from stains or abrasions. Exposed edges shall be protected during construction by retention of forms or provisions of covers. No fires shall be kindled on or against concrete.

CURING:

- 15.0 The prime essential for curing concrete is abundant water continuously applied or prevented from evaporating on all exposed surfaces, particularly on the sunny side salient corners, moldings and projections, until the concrete is ten days old, or as much older as local conditions may require.
- 15.1 Whenever in the judgment of the Montana-Dakota Utilities Engineer it may be necessary, there shall be provided and used as many tarpaulins, burlap, plastic blankets or other coverings, or as much sand, earth, sawdust or other approved mulching as will prevent drying, freezing, staining, disfiguring or other damage to the concrete during and after the curing period.
- 15.2 Curing compounds, paints and coatings for retention of moisture shall be used only by special permission and under the direction of the Montana-Dakota Utilities Engineer.

FINISHING:

- 16.0 Unless specifically required by the drawings, the finish of exposed faces of concrete will consist only in removal of excrescencies remaining after stripping forms, with a general cleanup of any adhesive debris of construction, the pointing up of all anchor bolts and the repair of small cavities with 1:2 cement-sand putty tamped in and rubbed off flush. Any large cavities or imperfections in concrete shall be cut out and repaired immediately after stripping forms.
- 16.1 The top surfacing of dams, walls, floors, or other cement finishing outside of forms, shall be placed integrally with the body of the work and completed with due observance of the above basic requirements.
- 16.2 Top surfaces of concrete to be molded without forms will be shaped and finished by straight edging, screening and floating with suitable wood or metal tools in the manner and at the times directed by the Montana-Dakota Utilities Engineer.

FORMS:

- 17.0 Forms, molds, and centering shall be made, and maintained during use, true to the shapes and dimensions prescribed on the approved drawings.
- 17.1 Wooden forms shall be built of lumber, sized and surfaced to present smooth and tight faces for molding concrete. Wooden forms shall be of ample strength and rigidity to withstand all stresses of fluid concrete without yielding during placement of concrete.
- 17.2 Forms in place with ties and braces shall be subject to inspection and approval of the Montana-Dakota Utilities Engineer or authorized Inspector. This provision shall not relieve the Contractor of his obligation to repair or rebuild all concrete having imperfections due to failure of forms.
- 17.3 Special forms of metal, plywood or water absorbent material, for giving desired face finishing will be shown or specified on approved plans, when required.
- 17.4 Tie rods, in or through walls designed for water tightness, shall have a removable section in each face of the wall with a sleeve or other type of nut acting as a water stop. The hole shall be caulked with cement-sand putty after removal of the rod. Wire ties, if permitted, shall be unyielding and shall be cut off flush with the face of concrete, or countersunk and coated over with cement-sand putty to prevent rust streaks on face of wall.
- 17.5 Corners and angles shall be mitered by using 45 Degree moldings of appropriate dimensions during forming.
- 17.6 Joints in forms or between panel forms shall be made smooth, tight and unyielding.
- 17.7 Face forms shall be cleaned, oiled and maintained in the specified efficiency and smooth appearance.
- 17.8 Forms shall not be released or removed from concrete structures, except by specific approval of the Montana-Dakota Utilities Engineer. Except by special consent of the Montana-Dakota Utilities Engineer, the unfastening and stripping of forms shall not be done less than 36 hours from the time of placing concrete in dams or ordinary walls nor within a longer period, as conditions may determine, in important arches or other structures requiring special support.
- 17.9 All removal of forms shall be done, without danger of injury to personnel or injury to recent concrete pours, in a manner approved by the Montana-Dakota Utilities Engineer

Specification Summary

SCOPE: Placement of Class B Concrete

GENERAL: Construction of acceptable & durable concrete

1. Provide acceptable mixing materials
2. Accurate proportioning
3. Control water content
4. Proper care of mixture
5. Cure for 10 days

TERMS: Concrete Construction terms

CEMENT: Portland cement Type 2

1. Seasoned for minimum of 2 weeks, "Hot" from mills unacceptable
2. Protection of cement

WATER: Water to be clean & fresh

SAND: Natural origin preferred, machine-made may be acceptable

1. Prepared by screening and/or washing
2. Clean & free from foreign material
3. Sized by screening
4. Screens to be properly maintained
5. Specified voids & fineness modulus
6. Colorimetric test testing
7. Specific gravity testing

COARSE AGGREGATE: Crushed stones or gravel stones

1. Prepared by screening and/or washing to remove foreign material
2. Sized by screening

ADDITIVES: Calcium chloride not to exceed 2% to extend plasticity

CLASS OF CONCRETE: Class B concrete

1. Compressive strength of 3000 #/sq.in. at 28 days
2. Proportions for small jobs - 6 sacks @ 1:2:4
3. Proportions for large jobs - Design furnished to Montana-Dakota Utilities Co.

ASSEMBLING: Assembled at mixing plant in proper manner

1. Control water from washed sand
2. Ready-mix or Transit-mix concrete
3. Apportionment & Control of mixing water
4. Control of mixing water of Ready-mix or Transit-mix

MIXING: Ingredients to be properly incorporated in suitable batch machines.

1. Mixing time control
2. Water-Cement ratio & Slump requirements
3. Consistency requirements

PLACING: Conveyance shall be such that constituents will not separate.

1. Concrete to be placed within one hour after mixing
2. Concrete shall be placed against forms & in contact with reinforcing steel
3. Vibrator use to insure proper homogeneous concrete

COLD WEATHER: Placement to prevent concrete freezing

1. No use of Frozen materials
2. Heating of mixing water
3. Heating of Fine aggregate (sand) & Coarse aggregate
4. Temperature of concrete at placement (50 F)
5. Use of Calcium Chloride to prevent freezing

PROTECTING: Protection of fresh concrete by forms in place

1. Workmen to be warned about disturbing fresh concrete
2. Finished surfaces shall be protected from damage

CURING: Prevent evaporation or add curing water to surfaces

1. Addition of coverings may be required as per Engineer
2. Curing additives to be only used by Engineer permission

FINISHING: Repair imperfections & general cleanup

1. Top surfacing of concrete outside of forms
2. Top surfaces to be floated with suitable tools

FORMS: Forms to be true to dimensions on approved drawings

1. Wooden forms to withstand fluid concrete stresses
2. Tie/Brace forms are subject to repair or rebuild
3. Special forms shall be specified on approved drawings
4. Tie rod holes to be grouted with cement/sand mixture
5. Corners/Angles shall be mitered by 45 degree moldings
6. Joints in forms to be smooth, tight & unyielding
7. Face forms to be cleaned & oiled to maintain smooth surface
8. Removal of forms shall be 36 hrs from placement, or as per Montana-Dakota Utilities Engineer
9. Removal of forms shall not damage concrete face

CONTROL BUILDING SPECIFICATIONS
MONTANA-DAKOTA UTILITIES CO.
A Division of MDU Resources Group, Inc.

SCOPE

Bidder shall furnish and erect one (1) pre-fabricated metal building complete; including door(s), hardware, anchor bolts, metal ceiling and wall panels, flooring, insulation, interior walls, ventilation equipment, heating and air-conditioning equipment, caulking, fasteners, eaves, down spouts, and all flashing and trim required for weather tight construction as shown on the attached Purchaser's drawings (See typical Control House Layout Drawing # 111504-H) and as herein specified. Bidder shall also furnish accessories listed to comprise one complete substation control building.

APPLICABLE STANDARDS

The house covered by these specifications is to be designed, tested and assembled in accordance with all applicable standards of ANSI, IEEE and NEMA, including, but not limited to the all applicable ANSI C37 standards. Also, all applicable NEC and OSHA requirements must be followed.

GENERAL REQUIREMENTS

Building may be either self-framing with inside walls free of support members and protruding reinforcements, or rigid frame type requiring supporting members along the walls and at each end of the building. Please identify in quotation as to type of building being supplied.

Building must be designed to meet local building codes and/or must be capable of withstanding a combined minimum of 30 psf live load on the roof and 20 psf wind load on the walls, whichever requirement is greater. A certificate stating that the building meets the above loadings will be required from the successful bidder upon receipt of an order.

Walls and ceiling are to have a vapor barrier. The walls shall be insulated to a value of R-19, equivalent to 6" of fiberglass insulation. The ceiling shall be insulated to a value of R-38, equivalent to 12" of fiberglass insulation.

Ceiling must be capable of supporting lighting fixtures.

Interior walls must be capable of supporting surface mounted wiring duct, outlets, and light switches.

Interior walls and ceiling to be flat-formed and painted metal. Interior paint shall be default white.

Exterior walls to be formed and painted steel. Roof to be aluminum coated steel (aluminized steel) or painted steel. Exterior paint color shall be selected from standard colors by Purchaser at time of order. Bidder to provide color chart with bid.

Building is to include the following accessories:

DOORS

Exit & Interior doors as listed:

- 1 - 6'-0" x 9' -0" insulated steel walk-in double door. Doors to open to the outside. Left door to be inactive, right door to be active (see drawing). Inactive door to have head and foot bolts. Active door to have cylindrical door lock with guarded latch bolt and an automatic door closer with manually controlled hold open feature. Active door must have "Panic", release exit bolts modified with thumb piece and pull-on exterior side. Both active and inactive doors to have window with reinforced glass. Doors to have insulating weather-strip on all edges.
- 1 - 3'-0" x 7' -0" insulated steel walk-in door. Door to open to the outside with "Panic" release exit bolts modified with thumb piece and pull-on exterior side. Door to have cylindrical door lock with guarded latch bolt and an automatic door closer with manually controlled hold open feature. Door to have window with reinforced glass. Door lock to be keyed identical to the active door of the 6'-0" x 9' -0" insulated steel walk-in double door. Door to have insulating weather-strip on all edges.

- 1 - 3'-0" x 7'-0" interior steel door to the battery room to be located and open as indicated on attached drawing. Door to have "Panic" release exit bolts modified with thumb piece and pull-on exterior side.
- 2 - 2'-4"x7'-0" steel doors to be located and open as indicated on the drawing. Doors to have passage latch sets.

LIGHTS

Normal AC Aisle Lighting

Fluorescent type, 120 or 240 VAC single phase supplied from AC Panel, with switches located near each entry providing control from either entry. Fluorescent fixtures shall be 48", 2 bulb channels.

Entrance Lighting

120 VAC, 100 watt, Mercury Vapor Wall lamp shall be mounted above each entrance with control switch near each entry providing control from either entry.

Emergency DC Lighting

Incandescent type 125 VDC supplied from DC Panel, with switches located near each entry providing control from either entry.

HEATERS

Electric Baseboard type heaters, 240 VAC single phase, 8 foot long, controlled by single thermostat and contactor. Heater configuration must be capable of maintaining 70 Deg F inside building with ambient air temperatures ranging down to -50 Deg F.

Heaters inside the battery room are to be placed on opposite wall from the batteries to prevent overheating of batteries.

AIR CONDITIONING

Ductless air-conditioning, 240 VAC, controlled by single thermostat and contactor. Air conditioning configuration must be capable of maintaining 75 Deg F inside building with ambient air temperatures ranging up to +110 Deg F. Ductless air-conditioning system to be approved by Purchaser.

FANS

2 - Wall mounted vent fans, to exhaust to outside, approximately 90 CFM for 120 VAC. Fans are to have automatic weather tight louver. Fans to be located as indicated on Purchaser's drawing, as close to ceiling as possible. Battery room fans must be time clock controlled operation to circulate battery room air on regular intervals. Intake and exhaust vents must be screened and filtered with either washable or disposable filters.

Operable wall louver, manually adjustable from a closed to an open position. Dimensions shall be approximately 12" x 12".

OUTLETS

Minimum of 5 - 115 VAC, 20 amp rated convenience outlets shall be equally spaced along each section of main control area wall at distances no greater than 6 feet. No outlets allowed within battery room. Breakers supplying the outlets shall be GFI type - Outlet power shall be divided into two equal 20 amp rated circuits.

AC POWER

1 - 400 amp heavy duty fusible disconnect switch for incoming 240 VAC single phase auxiliary power with neutral connection NEMA #1 enclosure.

____ - 400 amp circuit breaker equipped distribution panel(s), Single Phase 120/240 VAC Service - Solid Neutral for all AC auxiliary circuits, including as a minimum the breakers indicated on the attached Purchaser's AC Panel drawing(s) _____ and as per attached AC Distribution Panel specification. **Breakers supplying convenience outlets to be GFI type.**

DC POWER

1 - 200 amp heavy duty fusible disconnect switch, NEMA #1 enclosure, 2-pole 250 VDC for isolation from battery.

____ - 225 amp circuit breaker equipped distribution panel(s) for use on 125 VDC circuits. All breakers should be 2-pole type. Bidder to furnish as a minimum the breakers indicated on the attached Purchaser's DC Panel drawing(s), _____ and as per attached DC Distribution Panel specification.

FLOOR Floor shall be covered with 3/32" thick, 12" X 12" tile flooring.

SIGNAGE Signs shall be placed throughout the building as per the Substation Sign Specification.

TELEPHONE PROTECTIVE EQUIPMENT

A wall mounted "shelf" is required for mounting telephone protective equipment if such equipment is required by the telephone service provider. Shelf space/mounting dimensions are 31"W x 14"H x 10"D.

CONDUIT Conduit and/or Cable way shall be provided between AC Disconnect, AC Distribution Panel, DC Disconnect, DC Distribution Panel, Lights, Heaters, Fans, Switches and above the Switchboard area. Conduit between 125V DC Battery, Charger & DC Distribution Panel shall be installed upon delivery of Purchaser supplied battery and charger.

Lot - Ridge vent with manually controlled damper, 50% length of the building, centered on roof.

Lot - Full length eaves with 4 down spouts, one at each corner.

1 - Base Z-channel flashing, around perimeter of foundation, or equivalent.

Lot - Mop Boards on all interior walls.

Lot - Interior room dividing walls located approximately as indicated on the Purchaser's drawings.

Lot - Aluminum Diamond Tread plate, 1/4" thick and cut to lengths no greater than 72" long, to cover trenches as indicated on the Purchaser's drawings.

1 - Incinolet Model 'TR', 240`VAC, 3600 Watts, 15 Amp Electric Toilet, with 1 case of Bowl Liners.

1 - Fendal Model 100 Portastream #1, 6 gallon eyewash station, with 6 - 70 oz bottles of Fendal No. 509 Eye saline concentrate. (Equivalent may be acceptable.)

ERECTION

Building to be installed at an electrical substation at a location to be indicated by Purchaser.

The building shall be erected on a concrete foundation provided by Purchaser. The building shall be anchored to the concrete by means of either cast in concrete or drilled in anchor bolts which are to be supplied and installed by the bidder.

Bidder to completely assemble and install building and all accessories as listed in these specifications and as indicated on the attached drawing.

The bidder shall clean building surfaces and touch up any scratches or other damage to the factory applied finish as required upon assembly.

Erection should be completed at dates set by the Purchaser, currently estimated to be _____. However, since the bidder has no control over the foundation installation, approximately one month will be allowed for erection of the building after completion of the foundation, whichever date is later. Additional time will be allowed for inclement weather or other circumstances beyond the control of bidder.

SPECIFIC REQUIREMENTS

Building is to have minimum completed interior dimensions as follows:

46'-0" long X 22'-0" wide- 9'-2" floor to ceiling height

Interior dimensions may of course be larger than those stated above.

Slight variations in length and width are acceptable.

Approximate outside dimensions as follows:

48'-0" long X 24'-0" wide - 10'-0" or 12'-0" wall height

Successful bidder to provide Purchaser with exact foundation dimension requirements as around the outside edge of the foundation. Also required are the exact interior dimensions and exact locations of and dimensions of room divider walls and doors, so that electrical conduits may be cast in the concrete foundation for wall mounted electrical equipment.

DRAWINGS

Bid prints of the following shall be furnished with the quotation:

Plan View
Elevation Views
Foundation Requirements

The Successful bidder shall supply approval drawings of the above for approval prior to construction of building. One set of reproducible "As Built" AutoCAD drawings shall be required for digital archiving.

INSURANCE REQUIREMENTS

Without limiting any of the other obligations or liabilities of the contractor, the contractor shall provide and maintain, until the work is completed and accepted by the Owner, minimum insurance coverages in accordance with requirements established in Montana-Dakota Form Acord 25, which is attached hereto and made a part hereof.

Please include a completed copy of the insurance certificate with bid, along with a copy of your North Dakota Workmen's Compensation Certificate.

CONSIDERATION OF BIDS

Until final award of the contract is made, the Purchaser reserves the right to reject any and all bids, waive any informalities, or accept any bid or bids which in the opinion of the Purchaser's engineers will serve the best interest of the Purchaser. The Purchaser also reserves the right to accept or reject any alternates that may serve his best interest.

Any exception taken to any part of these specifications must be noted in the bid, or it will be assumed that the bidder is bidding in strict conformance to these specifications

ALTERNATE #1

Building to be supplied as specified above, except with the following alternate:

1 - 6'-0" x 7'-0" insulated steel walk-in double door with removable 2'-0" transom to allow an opening height of 9'-0". This item would be the alternate to the 6'-0" x 9'-0" double door specified.

ALTERNATE #2

Building to be supplied as specified above, except as pre-fabricated modular construction subject to engineering review

BUILDING FURNISHINGS TO COMPLETE BUILDING

1 – 36" X 60" Steel Desk, complete with shelving and drawers

1 – Chair for desk

1 – 36" X 72" Work Bench, non-conductive surface

1 – Adjustable Stool for Work Bench, adjusts 24"-30", gray

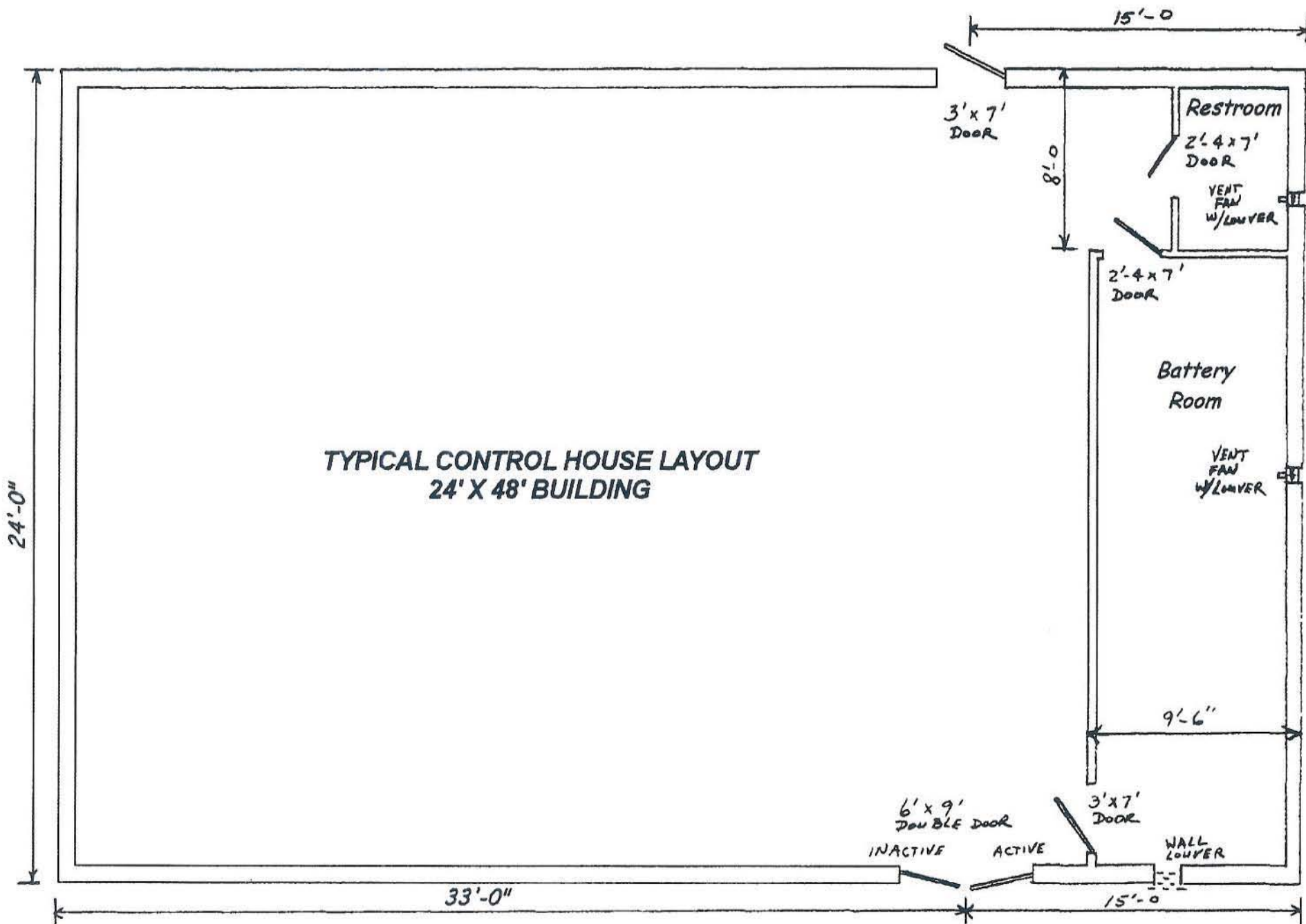
2 – Double-door storage cabinet, 36W X 18D X 72H

1 – 115 VAC Electric Clock

1 – Fire Extinguisher

1 – First Aid Kit

1 – Telephone with external ringer



**TYPICAL CONTROL HOUSE LAYOUT
DRAWING # 111504-H (NTS)**

CONTROL CABLE SPECIFICATIONS
MONTANA-DAKOTA UTILITIES CO.
 A Division of MDU Resources Group, Inc.

12 conductor #12:

(7 strand uncoated copper) 600 volt control cable for direct burial, 20 mil high molecular weight polyethylene insulation and 10 mil polyvinyl chloride (or equivalent) jacket color coded as per IPCEA Table 5-1 Method 1 for non-NEC applications over each conductor, fillers as required, binder tape and overall 60 mil polyvinyl chloride jacket. Running footage to be marked on jacket at intervals not exceeding 10 feet. Cable shielding if specified must be as specified below. 3000' min. reel length, 5500' max. reel length

4 conductor #10:

(7 strand uncoated copper) 600 volt control cable for direct burial, 20 mil high molecular weight polyethylene insulation and 10 mil polyvinyl chloride (or equivalent) jacket color coded as per IPCEA Table 5-1 Method 1 for non-NEC applications over each conductor, fillers as required, binder tape and overall 60 mil polyvinyl chloride jacket. Running footage to be marked on jacket at intervals not exceeding 10 feet. Cable shielding if specified must be as specified below. 3000' min. reel length, 5500' max. reel length

Color Coding of Conductors:

Color Sequence* for Control Cables

Conductor Number	Background or Base Color	Tracer Color
1	Black	----
2	White	----
3	Red	----
4	Green	----
5	Orange	----
6	Blue	----
7	White	Black
8	Red	Black
9	Green	Black
10	Orange	Black
11	Blue	Black
12	Black	White

*Color coding required by Purchaser is recognized as Non-standard.

Shielding:

A copper braid, basket weave, consisting of soft-annealed, uncoated copper shall be applied over the mylar taped assembly. The braid shall be constructed with 24 groups of 6 strands, #30 AWG copper to provide the equivalent to #9 AWG in total transverse cross-section of all strands, with a #12 (7 strand uncoated copper) drain wire in contact with braided shield. The minimum coverage shall be 85%. Separation tape between shield and PVC overall jacket.

Alternate Shielding:

Spirally wrapped tape shield with a thickness of at least 5 mils and minimum lap of 10%, to be applied over the mylar taped assembly, with a #12 (7 strand uncoated copper) drain wire in contact with tape shield, separation tape between shield and PVC overall jacket.

**230KV COUPLING CAPACITOR VOLTAGE TRANSFORMER
GENERAL SPECIFICATIONS**

MONTANA-DAKOTA UTILITIES CO.
A Division of MDU Resources Group, Inc.

Devices specified shall be delivered to:

230kV WIND FARM SUBSTATION

<u>QTY</u>	<u>DESCRIPTION</u>
—	Coupling Capacitor Voltage Transformer with carrier accessories as follows: Coupling capacitor voltage transformer to be used on 230KV line-to-line primary voltage. 1050KV BIL with standard leakage distance porcelain. Dual secondaries with marked ratios per ANSI Standard C93.2, 1200/2000:1. Operation on 60 Hz system.. Color to be ANSI #70 gray porcelain and paint. Accuracy class rating shall be 0.3 (Metering class) for burdens M, W, X, Y, Z, and ZZ for each secondary winding to tapped portion of the secondary winding up to a total simultaneous loading equivalent to ZZ burden (400 VA, 0.85 pf lagging) as defined by ANSI C57.13. 1000 VA thermal rating, internal ferroresonance damping. Top cap to have ANSI 4-hole pad terminal.

<u>QTY</u>	<u>DESCRIPTION</u>
—	Coupling Capacitor Voltage Transformer without carrier accessories as follows: Coupling capacitor voltage transformer to be used on 230KV line-to-line primary voltage. 1050KV BIL with standard leakage distance porcelain. Dual secondaries with marked ratios per ANSI Standard C93.2, 1200/2000:1. Operation on 60 Hz system.. Color to be ANSI #70 gray porcelain and paint. Accuracy class rating shall be 0.3 (Metering class) for burdens M, W, X, Y, Z, and ZZ for each secondary winding to tapped portion of the secondary winding up to a total simultaneous loading equivalent to ZZ burden (400 VA, 0.85 pf lagging) as defined by ANSI C57.13. 1000 VA thermal rating, internal ferroresonance damping. Top cap to have ANSI 4-hole pad terminal.

Required Documentation for each type Coupling Capacitor specified:

Five sets of the following documents are required to be included with a complete instruction book.

Documentation: Outline Diagrams
Nameplate Diagrams
Elementary Diagrams
Wiring Diagrams
Renewal Parts Lists
Certified Test Reports for 0.3 accuracy class at all burdens M thru ZZ

Consideration of Bids:

Until final award of contract is made, the purchaser reserves the right to reject any and all bids, waiver any informalities or accept any bid or bids which, in the opinion of the purchaser's engineers, will serve the best interest of the purchaser. The purchaser also reserves the right to accept or reject any alternates that may serve his best interest.

D.C. DISTRIBUTION PANEL SPECIFICATIONS

Following DC Distribution Panel shall be delivered to:
230kv Wind Farm Substation

GENERAL SPECIFICATIONS

Single Phase 2 Wire – 125 VDC Service

Distribution Panel to be **Main Lugs Only** style & bottom feed. Main Lugs to be a 2 conductor style to provide sub-feed capability for two (2) #6-250 MCM Copper conductors. Sub-feed lugs to be rated the same as Main lugs.

Panel to be bottom feed with sub-feed lugs.

Panel Bus to be 2-pole rated 250 VDC and 225 Ampere.

Branch Breakers to be of Bolt-on style, rated 125/250 VDC with a 2-pole interrupting rating of 10,000 amps asymmetrical.

Branch Breakers to be provided and factory assembled into Distribution Panel with the bus to be tapped exactly as specified on Purchaser's drawing.

Galvanized steel box to have **NO Knockouts** .

Minimum Box Dimensions: 20" wide x 7 1/4" deep, with gutters of 5 1/2" on sides and 10 1/2" on ends.

Panelboard is to be surface mounted NEMA #1 enclosure with surface trim.

Distribution Panel to be complete with box, internal copper bus, all branch breakers, trim & cover panels, wire trough and swinging cover door with metal directory holder. Distribution Panel to be factory assembled.

Non-UL listed Panelboards will be considered.

CONSIDERATION OF BIDS

It will be assumed that the manufacturer is quoting and will provide equipment in strict conformance with these specifications, unless the quotation includes a statement and description of proposed exceptions. Any exception to any part of these specifications must be noted in the bid. All bidders shall supply Panel Type & Branch Breaker Type information at time of bid.

Until final award of the contract is made, the purchaser reserves the right to reject any and all bids, waive any informalities or accept any bid or bids which, in the opinion of the purchaser's engineers, will serve the best interest of the purchaser. The purchaser also reserves the right to accept or reject any alternatives that may serve his best interest.

Ref. #111204-1-DLA

INDUSTRIAL CHAIN LINK FENCE SPECIFICATION
MONTANA-DAKOTA UTILITIES CO.
A Division of MDU Resources Group, Inc.

NOTE:

FENCES QUOTED MUST MEET THE FOLLOWING STANDARD. Reference used in the development of this standard is "1989 ANNUAL BOOK OF ASTM STANDARDS VOLUME 01.06 COATED STEEL PRODUCTS."

GENERAL SPECIFICATION:

The chain link fence shall stand 8'4" above grade, including 3 strands of barbed wire on the outward extension brackets with the dimensions and gate(s) located per the attached Purchaser drawing _____.

This fence is to be quoted as:

- Materials only for erection by others
- Installed in place including materials and labor
- Materials only with installed in place as an alternate

The materials supplied for this fence and the installation (where applicable) shall be in accordance with the following:

CHAIN LINK FABRIC:

The chain link fabric shall be 84" high 9 gauge and have a 2" mesh, knuckled at one selvage and twisted at the other and have class 2 zinc coating of not less than 2 ounces per square foot of uncoated wire surface all in accordance with ASTM A-392.

BARBED WIRE:

The zinc-coated steel barbed wire shall be Chain Link Fence Grade consisting of two 12 1/2 gauge stranded line wires and 14 gauge barbs in a 4 point pattern on 5" centers with a Class 3 coating all in accordance with ASTM A-121.

FENCE FITTINGS:

All fence fittings including but not limited to post and line caps, rail and brace ends, top rail sleeves, tie wires and clips, tension and brace bands, tension bars, truss rods and barb arms shall be in accordance with ASTM F-626.

TOP RAIL:

The top rail shall be 1 1/4" NPS (Nominal Pipe Size) schedule 40 (2.27 lbs/ft.) with a zinc coating of not less than 1.8 ounces per square foot in accordance with ASTM F-1083 and shall be supplied in lengths of not less than 18 feet. The top rail shall pass through and be supported at each post so that a continuous brace from end to end of each stretch of fence is formed and shall be securely fastened to the terminal posts. Also, the top rail shall be joined with sleeves or couplings to allow for expansion and contraction.

LINE POSTS:

Line posts shall be 2" NPS schedule 40 (3.65 lbs/ft) with a zinc coating of not less than 1.8 ounces per square foot in accordance with ASTM F-1083 and shall be spaced not more than 10 ft apart. Post length shall allow for the following:

- 48" deep x 10" diameter full length embedment in concrete in dry, well drained locations
- 72" deep x 10" diameter full length embedment in damp or poorly drained locations

END AND PULL POSTS:

End and pull posts shall be 2 1/2" NPS schedule 40 (5.79 lbs/ft) with a zinc coating of not less than 1.8 ounces per square foot in accordance with ASTM F-1083. Post length shall allow for the following:

- 48" deep x 16" diameter full length embedment in concrete in dry, well drained locations
- 72" deep x 16" diameter full length embedment in damp or poorly drained locations

Ref. #111204-1-DLA

CORNER POSTS:

Corner posts shall be 2 1/2" NPS schedule 40 (5.79 lbs/ft) with a zinc coating of not less than 1.8 ounces per square foot, in accordance with ASTM F-1083. Post length shall allow for the following:

- [] 48" deep x 12" diameter full length embedment in concrete in dry, well drained locations
- [] 72" deep x 12" diameter full length embedment in damp or poorly drained locations

GATE POSTS:

Posts for swing gates shall be sized per the following table and shall be NPS schedule 40 with a zinc coating of not less than 1.8 ounces per square foot in accordance with ASTM F-1083. Post length shall allow for a minimum of 72" deep x 16" diameter full length embedment all locations.

INDIVIDUAL GATE LEAF WIDTH	NPS	OUTSIDE DIAMETER	LBS PER LINEAL FOOT
Up to 6'	2 1/2	2.875"	5.79 #/Ft
Over 6' to 13'	3 1/2	4.000"	9.11 #/Ft

GATES:

Gates shall be provided in quantities and at locations indicated on attached Purchaser's drawing _____.

Fence shall have the following quantity of gates:

- _____ - 3 foot walk-through (Minimum 1 per enclosed area)
- _____ - 20 foot double-leaf drive-through (Minimum 1 per enclosed area)

Gates shall be swing type complete with latches, keepers and hinges. Gate frames shall be constructed of round tubular members, welded at all corners. Welds shall be painted with zinc based paint. Gates shall have truss rods of 5/16" or greater nominal diameter to prevent sag and twist. Gate leaves shall have vertical intermediate bracing as required, spaced so that no members are more than 8 feet apart. Gate frame members shall be round tubular steel 1.90 inches O.D., 2.28 lbs/ft. with a zinc coating of 1.8 ounces per square foot. The end members of the gate frame shall be extended in height to accommodate three strands of barbed wire uniformly spaced and positioned so that the top strand is approximately 1 foot above the top horizontal member of the gate frame. Barbed wire shall be attached by suitable means to prevent wire from moving out of position and shall be supported by a gate frame member at maximum intervals of 8 feet.

Gate filler shall be the same fabric as specified for fence and shall be securely fastened at intervals of no more than 15".

Leaf gate latches shall be capable of retaining the gate in a closed position and shall have provision for a padlock.

Keepers shall be provided for each gate leaf over 5 feet wide. Gate keepers shall consist of a mechanical device for securing the free end of the gate when in full open position and shall be suitable for setting in concrete.

Hinges shall be structurally capable of supporting the gate leaf and allow the gate to open and close without binding. The gates shall be capable of being opened and closed easily by one person.

CONSIDERATION OF BIDS:

Until final award of the contract is made, Purchaser reserves the right to reject any and all bids, waive any informalities or accept any bid or bids which, in the opinion of Purchaser's engineers, will serve the best interest of Purchaser. Purchaser also reserves the right to accept or reject any alternatives that may serve its best interest.

Any exception to any part of these specifications must be noted in the bid.

Any material supplied, which is not in compliance with this specification, shall be replaced with material in compliance with this specification F.O.B. destination by the bidder, with no additional charge to Purchaser.

Ref. #111204-1-DLA

CHAIN LINK FENCE INSTALLATION SPECIFICATION

MONTANA-DAKOTA UTILITIES CO.

A Division of MDU Resources Group, Inc.

Installation of chain link fence under this specification shall be performed such that the workmanship shall be of first class in every respect and shall be done in a neat and workmanlike manner. Materials for installation shall be furnished under the attached attached "Industrial Chain Link Fence Specification". Chain link fence to be installed as per the arrangement shown on attached Purchaser's drawing _____.

POST SPACING:

Line posts shall be spaced equidistant at intervals not exceeding 10 feet from center to center of the posts along continuous fence sections.

POST SETTING:

All posts shall be set in 2500 PSI concrete at a depth determined by the soil conditions indicated in attached "Industrial Chain Link Fence Specification". Concrete fill shall be installed with straight sides up to a height of 6" below the surface to prevent "mushrooming" at or near groundline. Remaining backfill will be excavated material.

GATE KEEPER & STOP SETTING:

Gate stops shall not be installed. Gate shall be secured with ¼" thick galvanized steel chain for padlocking. Gate keeper shall be installed in 10" minimum diameter holes of 18" depth backfilled with 2500 PSI concrete up to a depth of 6" below grade to prevent "mushrooming" at or near groundline. Remaining backfill will be excavated material.

CHAIN LINK FABRIC:

The chain link fabric shall be placed on the outside of the line posts with the twisted end placed down. The fabric shall be stretched taut approximately 4" above the ground and securely fastened. The fabric shall be cut and each span shall be attached independently at all terminal posts. Fastening to terminal posts shall be with stretcher bars and tension bands spaced at maximum 15" intervals. Fastening to line posts shall be with tie wire at intervals not exceeding 15". The top of the fabric shall be fastened to the top rail with tie wires at intervals not exceeding 24". Rolls of wire fabric shall be joined by weaving a single picket into the ends of the rolls to form a continuous mesh.

PROTECTION TO PERSONS AND PROPERTY:

The fence contractor shall at all times exercise reasonable precautions for the safety of employees on the work and of the public and shall comply with all applicable provisions of Federal (included but not limited to the Safety Standards established and promulgated under the Federal Occupational Safety and Health Law, Public Law 91-956 and the regulations thereunder), state and local statutes, ordinances, rules and regulations which may pertain to the work.

INSURANCE:

The fence contractor shall provide and maintain, until the work is completed, minimum insurance coverages in accordance with requirements established in Montana-Dakota Form Acord 25, which is attached hereto and made a part hereof. The contractor shall furnish to the Company a certificate evidencing compliance with the requirements, signed by an authorized representative of the insurance company carrying the risk prior to any work being started.

CONSIDERATION OF BIDS:

Until final award of the contract is made, Purchaser reserves the right to reject any and all bids, waive any informalities or accept any bid or bids which, in the opinion of Purchaser's engineers, will serve the best interest of Purchaser. Purchaser also reserves the right to accept or reject any alternatives that may serve its best interest.

Any exception to any part of these specifications must be noted in the bid.

Any material or installation workmanship supplied under this specification, which does not meet the requirements of this specification, shall be remedied by the bidder by providing an installed fence in compliance with the specification with no additional charge to Purchaser.

Note:
 11A & 11B - Relaying to be as required for
 Windfarm tap line. Relaying required may
 be 21 function, 87L function, 87B function,
 or other. Fiber optic communications may
 be required.

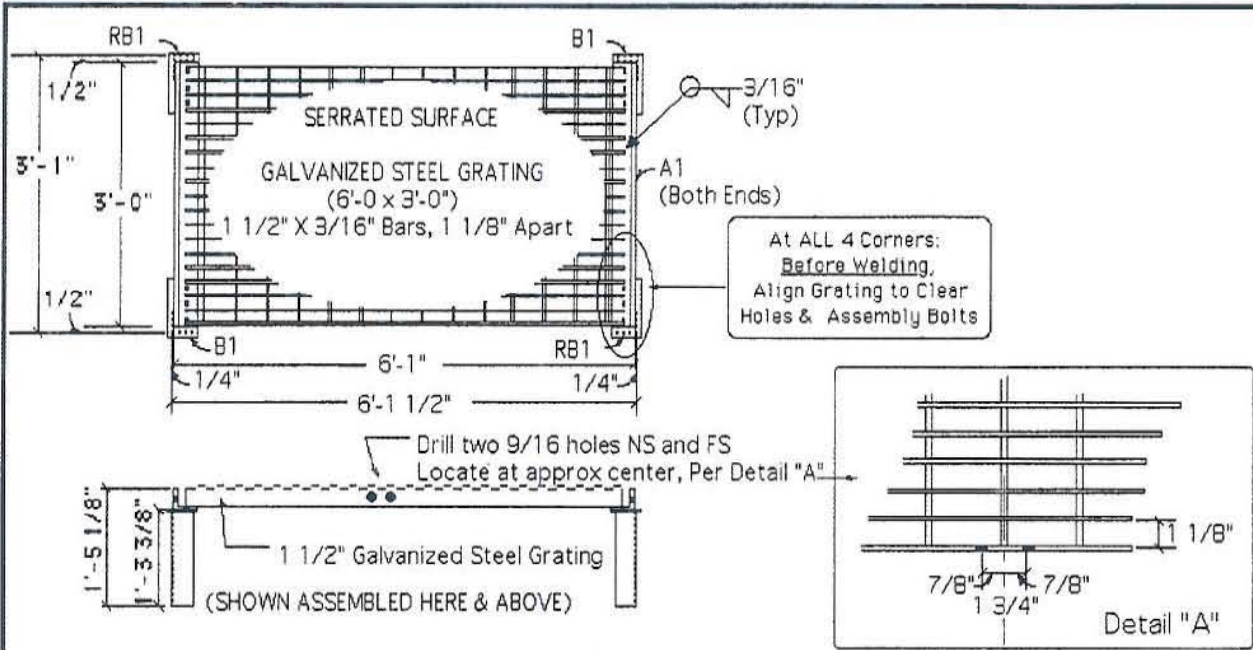


Exhibit A1a
 MISO Project G132 Queue #37151-01
 LGIA

230kV Wishek to Ellendale Ring Bus
 RELAYING ONE-LINE

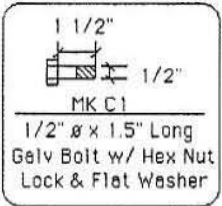
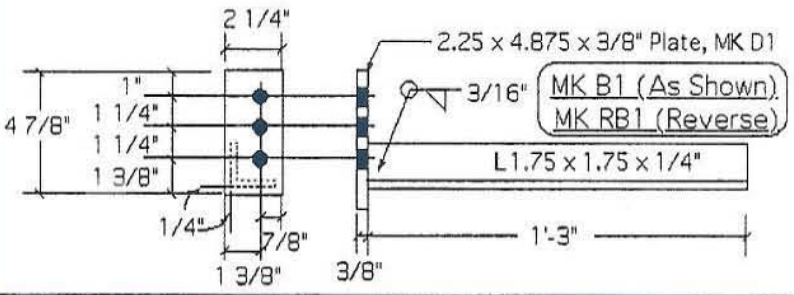
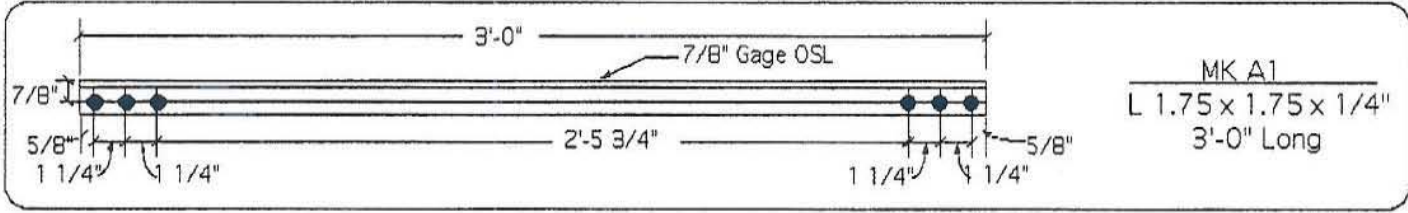
		Wishek to Ellendale Line Ring Bus	
		DRAWN BY: RRF DATE: 8/31/04	SCALE: FILE NO.: 08312004-1
APPROVED:			

RRF - 10/07/04 - Optical Current & Voltage Sensor
 RRF - 10/15/04 - Added Breaker CT's
 RRF - 11/09/04 - Changed Orientation of Ring Bus
 RRF - 11/15/04 - Rearrange Bus, add 5SVT



- MATERIAL FOR (1) Platform:**
- 1 - Grating welded to Angles (A1-Both Ends)
 - 2 - Legs welded to Bar (D1) to make MK B1
 - 2 - Legs welded to Bar (D1) to make MK RB1
 - 14 - 1/2" ϕ x 1.5" Long Galv Bolt (C1)
w/ Hex Nut, Lock & Flat Washer

- NOTES:**
- 1. All A36 or A7 Steel
 - 2. All 9/16" ϕ Holes
 - 3. All burrs, rough or sharp edges must be removed before galvanizing
 - 4. (See detail "A" notes)
 - 5. Hot-Dip Galvanize after all Fabrication & Welding.



Galv. Steel Switch Operating Platform				
				MONTANA-DAKOTA UTILITIES CO.
DRAWN BY CMF	DATE: 10/7/98	DRAWING NO: 070899-1	FILE NO: 	APPROVED CMF

MONTANA-DAKOTA UTILITIES CO. - SUBSTATION GRADING SPECIFICATIONS

General Construction Procedure

1. Locate earthwork area and stake as needed.
2. Move equipment to site.
3. Strip topsoil from earthwork area in preparation of grading activities.
4. Stockpile topsoil in areas approved by Owner's representative.
5. Begin grading operation using excavated material for fill.
 - a) Excavated material may be used for Fill material
 - b) Borrow material for Fill to be obtained by Contractor.
 - c) Excess excavated material to be disposed by Contractor.
6. Fill areas to be compacted to 90% Proctor Density.
7. Cut any ditches around site.
8. Place any required culverts prior to constructing any access road.
9. Construct and complete access roads.
10. Return stockpiled topsoil on any areas which were disturbed by earthwork activities outside of newly prepared Substation pad.
11. Dispose of excess topsoil & excavated material as approved by Owner's representative.
12. After substation construction activities are completed, a 4" mat of 1"- 1 1/4" Minus crushed rock shall be placed over entire station pad within the fence and 3 feet outside the substation fence.

General Specifications

Substation site grading and surfacing under this specification shall be performed such that the workmanship shall be of first class in every respect and shall be done in a neat and workmanlike manner. Materials furnished under this specification shall be subject to approval by Owner's representative.

Contractor must conform to all State and Federal and OSHA Safety laws while performing the work covered under this specification.

When grading activities involve working near an energized high voltage substation or under energized high voltage transmission lines, special care must be exercised in maintaining safe working distances from any energized conductor. Portions of the work, which would constitute a potential safety hazard, should only be performed under the supervision of Owner's personnel by prior arrangement.

1. Location and grade staking of the site within the property lines and in accordance with Owner's drawings and these specifications shall be the responsibility of the Contractor.
2. Contractor shall be responsible for locating any underground utilities. If underground utilities exist, the Contractor shall be responsible for any damage done to these utilities.
3. Contractor shall be responsible for his own yardage calculations. The Contractor shall be responsible for a complete job as per Owner's drawings & these specifications.
4. Contractor shall strip topsoil (approximately 6") from the construction site and shall stockpile the topsoil on the Owner's property in an area approved by Owner's representative and where it will not interfere with continued grading activities.

MONTANA-DAKOTA UTILITIES CO. - SUBSTATION GRADING SPECIFICATIONS

5. All grading activities shall be performed by any recognized method of good practice to complete the job in the most expeditious manner.
6. Contractor shall take any necessary precautions to insure no damage to any existing facilities. Grade preparation activities around existing power poles shall be performed in a manner not endangering the integrity of the structure.
7. Fill areas shall be constructed in uniform lifts or layers not to exceed 7" of loose fill. Each lift or layer shall be compacted to a minimum of 90% standard Proctor Density. Watering shall be done, if necessary, to obtain optimum moisture content.
8. All compacted areas will be subject to testing by an independent test laboratory, at Owner's option. Fees will be paid by Owner.
9. Cut slopes shall not be steeper than 4:1.
10. Fill slopes shall not be steeper than 4:1.
11. Disposal of any excess material shall be the responsibility of the Contractor. No excess material shall be permanently disposed within the substation site nor on surrounding property. The method of disposal and the disposal location used by the Contractor for the disposal of excess material must have prior approval by Owner before disposal activities commence.
12. Any borrow material required for fill material must be obtained by Contractor and approved by Owner representative.
13. All grading, stockpiling of soil, and any other work, storage of equipment and driving must be limited to Owner's property, unless express arrangements have been made.
14. Culvert to be provided and placed by Contractor prior to construction of access road in such a manner as to promote free drainage under the access road. Culvert length is to be determined by onsite conditions. Culvert size is to be determined by local government entities charged with surface water drainage oversight, ie County Commission.
15. Substation access road shall be constructed as per Owner's drawings from substation site to nearby established roadway. Contractor shall place 7" of road gravel on access road as per typical cross-section. All road gravel material shall be subject to approval by Owner's representative.
16. Upon completion of the grading operation, the topsoil shall be removed from the stockpile and placed on the graded slopes outside the substation pad . Absolutely NO topsoil material shall be used as fill material within the substation site.
17. If deemed necessary by Owner's representative to restore site, all areas disturbed by grading activities outside the immediate substation pad shall be seeded by the Contractor with a grass mixture approved by the Soil Conservation Service.
18. Upon completion of grading, foundation construction, trenching, underground conduit, grounding and backfilling activities, the Contractor shall place a 4" mat of 1"-1 1/4" minus crushed rock over substation pad and 3 feet outside substation fence. All crushed rock material shall be subject to approval by Owner's representative.

Insurance Requirements

Without limiting any of the other obligations or liabilities of the contractor, the contractor shall provide and maintain, until the work is completed and accepted by the Owner, minimum insurance coverages in accordance with requirements established in Montana-Dakota Form Acord 25, which is attached hereto and made a part hereof.

MONTANA-DAKOTA UTILITIES CO. - SUBSTATION GRADING SPECIFICATIONS

It is further required that the contractor's insurer provide the Owner with prompt written notice of erosion of any policy aggregate limits, advance of any retroactive date and provide thirty days prior written notice of cancellation or non-renewal.

Copies of Contractor's North Dakota Worker's Compensation Certificated must also be provided.

The aforementioned insurance requirements certificate must be completed and returned to Owner prior to commencing work under this specification.

A completed copy of the Contractor's insurance certificate and the Contractor's North Dakota Workmen's Compensation Certificate shall be included with bid.

Contractor's License

A copy of Contractor's North Dakota Contractor's License must be provided to Owner prior to commencing work under this specification. Proof of current Contractor's License must be available for admittance to job site and must remain valid until completion of work.

Subcontractor's Documentation

It is the responsibility of the Contractor to whom this work is awarded to provide Owner with Insurance Certificate, Worker's Comp Certificate and North Dakota Contractor's License for any and all Subcontractors performing work under this specification. Proof of Subcontractor's Contractor License must be available for admittance to job site and must remain valid until completion of work.

Consideration of Bids

Until final award of the contract is made, Purchaser reserves the right to reject any and all bids, waive any informalities or accept any bid or bids which, in the opinion of Purchaser's engineers, will serve the best interest of Purchaser. Purchaser also reserves the right to accept or reject any alternatives that may serve its best interest.

Any exception to any part of these specifications must be noted in the bid.

Any material or installation workmanship provided under this specification, which does not meet the requirements of this specificaion, shall be remedied by the Contractor in compliance with this specification with no additional charge to Purchaser.

**GENERAL SPECIFICATION
THREE POLE, GROUP OPERATED, DISCONNECT SWITCHES
15.5-362KV, 600-4000 AMP**

It will be assumed that the manufacturer is quoting in strict conformance with these specifications unless the quotation includes a statement and description of proposed exceptions.

1.0 SCOPE

This specification covers the general requirements for outdoor, 3-pole, group operated air switches and accessories as described herein.

2.0 APPLICABLE STANDARDS

The switches shall comply with the latest revisions of the following standards. The specific job technical requirements and this specification shall take final precedence in the event of conflict:

- 2.1 ANSI Standards C37.30, C37.32, C37.34 and C37.35
- 2.2 NEMA Standard SG-6, latest revision

3.0 BASIC RATINGS AND SWITCH TYPES

This specification covers the following switch types:

- Vertical break
- Single side break
- Center break
- Center break "V"
- Double end break
- Vertical Reach

- 3.1 Temperature rise of the switch shall be in accordance with ANSI C37.30-1971.
- 3.2 The rated withstand and radio influence voltages shall be as shown in Table A for installations below 3,300 ft. altitude. Altitude correction factors per ANSI C37.30-1971 Table I will apply for higher altitudes.
- 3.3 The momentary current withstand shall be as shown in Table B.

RATED WITHSTAND VOLTAGE
TABLE A

Rated Voltage KV RMS	Impulse 1.2 x 50 Micro Sec Wave KV Crest	60 HZ KV MS		Radio Influence Test Volt. KV	Limit of Riv Micro Volts @ 1 MH
		Wet 10 Sec.	Dry 1 Min.		
15.5	110	45	50	9.4	--
25.8	150	60	70	15.7	--
38.0	200	80	95	23.0	--
48.3	250	100	120	29.3	--
72.5	350	145	175	44.0	--
121	550	230	280	73.4	500
145	650	275	335	88.0	500
169	750	315	385	102.5	500
242	900	385	465	147.0	500
242	1,050	455	545	147.0	500
362	1,300	525	610	220.0	500

General Group Operated Switch Specification - 091801

MOMENTARY CURRENT WITHSTAND
TABLE B

Continuous Current Rating (Amperes) RMS	Momentary Asymmetrical Current Rating (Thousands of Amperes) RMS	Three Second Rating (Thousands of Amperes) RMS **
600	40	25.00
1,200	61	38.12
1,600	70	43.75
2,000	100	62.50
3,000	100	62.50
4,000	120	75.00

**Obtained by dividing momentary rating by 1.6.

4.0 SPECIFIC REQUIREMENTS

4.1 Mounting

The switches shall be mounted on the switch stands shown on Purchaser's drawings.

4.2 Coordination

The switches shall be fully coordinated (open gag withstand voltage at least ten percent (10%) greater than line to ground withstand voltage.) If higher BIL level insulators are specified for extra-creep, the vendor shall supply spill gags on one end of the switch, except in case of bypass or bus transfer switches. The vendor shall include spill gags on both ends.

4.3 Insulators

Insulators supplied, if specified on the specific project requirements, shall be in accordance with latest revisions of ANSI C29.8 and C29.9 and shall conform to the following table. Insulator color to be ANSI #70 gray. Insulators to be sectional types at 550KV BIL and above.

INSULATORS
TABLE C

KV	BIL	POST
15	110	TR 205
25	150	TR 208
38	200	TR 210
48	250	TR 214
72	350	TR 216
121	550	TR 286
145	650	TR 288
169	750	TR 291
242	900	TR 304
363	1,300	TR 368

4.4 Live Parts

4.4.1 Live parts of the switch may be either copper or aluminum.

4.4.2 Exposed contacts shall be self-wiping, silver to silver. All other current carrying contacts, including hinged end contacts, shall be silver to silver, unless sealed and insulated from contamination and corrosion. Internal sealed contacts may be either silver to silver or silver to copper. All exposed contacts, both fixed and moveable, shall be replaceable in the field. Silver to silver contact surfaces to utilize dissimilar alloys of silver to prevent galling. Minimum thickness shall be .005 inches or .010 inches if applied by brazing.

4.4.3 Any switch with blade end jaw contacts running perpendicular to the switchblade shall be reverse loop type jaw contacts.

4.4.4 No braided shunts will be permitted.

General Group Operated Switch Specification - 091801

4.5 Terminal Pads

Terminal pads shall be flat NEMA standard two-hole or four-hole (9/16" round holes drilled on 1 3/4" centers) per Table D. Terminal pads other than aluminum shall be silver or tin plated.

TERMINAL PAD SPECIFICATIONS
TABLE D

KV	Amps	Number of Pad Holes	Length	Dimensions in Inches Width	Thickness
15-72	600	2	3	2	5/8
15-169	1,200	4	3	3	5/8
121-169	600	4	3	3	5/8
121-242	1,600	4	4	4	5/8
121-242	2,000	4	4	4	5/8
121-242	3,000	4	4	4	5/8
242	4,000	6	4	6	1
363	---	---	---	---	---

4.6 Operation

- 4.6.1 Switch blades shall be under positive control at all times and the travel from the fully closed to the fully open positions shall be accomplished with one smooth continuous motion.
- 4.6.2 Vertical break switches rated 15.5KV-72.5KV shall have spring counterbalance devices to counterbalance the weight of the blades when required for proper operation. Vertical break and vertical reach switches rated 121KV and above shall include counterbalances. Counterbalances housing may have weep holes.
- 4.6.3 Vertical break switches, vertical reach switches, and double side break switches shall operate to produce a wiping pressure contact by blade rotation within contacts.
- 4.6.4 Vertical break, vertical reach, and double side break switch current carrying parts shall over toggle in the closed position. Switch blade must be field adjustable to provide 90-95° (slight over-travel) angle between contact surfaces on blade and stationary contacts.
- 4.6.5 Switch must be capable of proper operation without periodic or routine maintenance, and without application of any nonpermanent lubrication. Switch must be operationally impervious to blowing dust and dirt.

4.7 Operating Mechanism

- 4.7.1 The operating mechanism shall mount on the switch stands shown on Purchaser's drawings.
- 4.7.2 The operating mechanism shall have positive adjustable stops in both open and closed positions.
- 4.7.3 The rotating insulator stack on each switch pole and the outboard bearings to provide smooth and trouble free operation of the switch. Double side break and center side break switches rated 362KV shall have switch bearing housing which are an integral part of the welded galvanized steel base assembly to minimize insulator and bearing deflection. Rotating insulator and outboard bearing types to be per Table E.

BEARING SPECIFICATIONS FOR ROTATING INSULATORS AND OUTBOARD BEARING
TABLE E

KV	Amp	Sleeve Bearing (Conditional Acceptance)	Sealed Stainless Steel Ball or Roller Bearings and Stainless Steel Races Top & Bottom
15-38	Thru 1600	All	All
48-72	Thru 1600	Vertical Break Only	All
121-363	Thru 1600	---	All
15-363	Above 1600	---	All

General Group Operated Switch Specification - 091801

- 4.7.4 All steel shall be stainless or galvanized after fabrication, including fasteners.
- 4.7.5 Galvanized steel control and interphase pipes shall be of sufficient size to minimize twist in the torsional operating pipes and sag in push-pull interphase pipes. Group operated switches 363KV and above, and/or phase spacings exceeding 16 feet, and/or requiring higher than usual operating efforts shall have double interface push-pull control pipes. All control pipes to have piercing screws at all rigid coupling points.
- 4.7.6 The length of each interphase rod and of the group control rod shall be adjustable to allow proper alignment of the switch. All push-pull control pipes to have turnbuckle type adjustments on at least one end for increasing or decreasing length. Switch poles mounted on individual switch stands to have torsional operating mechanism. Torsional operating pipes to have slip-fit type coupling between poles.
- 4.7.7 The operating mechanism shall have "open-close" indicators and provisions for padlocking in both open and closed position. Motor mechanism, when used, to be lockable in coupled and uncoupled positions also.
- 4.7.8 The maximum operating effort shall be 50 lbs. For a swing handle operator with maximum length of 36", or 35 lbs. for a manually operated gear mechanism with maximum handle length of 15" at ambient temperatures of -40°F to 120°F. All switches, 121KV and above, to have gear operated mechanism.
- 4.7.9 All switches shall include provisions for the adjustment of each individual switch pole. These provisions shall be of a continuously adjustable threaded type for correction of any misalignment in the switch insulators and bases (jacking screws).
 - 4.7.9a It shall be mechanically impossible, after final adjustment has been made, for any switch to remain in a partially open or closed position at the completion of an operator cycle. Switch pole mechanisms to be intrinsically stable in fully open or closed position. Under no circumstances shall a switch close on its own once it has been fully opened.
 - 4.7.9b Center break "V" switch rotating insulators are to be turned by sealed, permanently lubricated gears located within the switch base. Operating rod linkages between the two rotating insulators will not be acceptable.

5.0 ACCESSORIES

- 5.1 All switches shall be equipped with standard arcing horns, unless some other special interrupting device is specifically specified, and standard arcing horns are not required with this device.
- 5.2 Switch operating mechanisms to include a flexible braided ground strap.
- 5.3 All fasteners shall have provisions for locking via lock washers, locking nuts, cotter pins, or other securing means.

6.0 SHIPPING REQUIREMENTS

- 6.1 Switches shall be shipped with all live parts and bearings assembled and bolted into position on the bases with blades securely wired closed into the contacts. Each 3-pole switch shall be crated in a manner suitable for stacking. Operating pipes and interphase bars shall be shipped unassembled and banded together, one set per switch properly identified and protected against damage. All other loose parts for each switch shall be shipped in a wooden box properly identified. Switches rated 48.3KV and below shall include insulators assembled, when insulators are specified to be included.
- 6.2 High strength bolts, when required, shall be color coded for easy identification, and the drawings shall be marked to indicate where the high strength bolts are to be used.

General Group Operated Switch Specification - 091801

7.0 DRAWING REQUIREMENTS

- 7.1 Drawings to be supplied with bid: (One set of the following)
 - Outline drawings of switch and accessories
 - Descriptive information describing contacts, bearings and ratings
- 7.2 Drawings to be supplied for approval: (Three sets of the following)
 - Outline drawings of the switch and accessories.
 - Outline drawings of mechanism showing mounting on switch stand.
 - Descriptive information describing contacts, bearings and ratings.
- 7.3 Record drawings to be supplied: (Five sets of the following)
 - Outline drawings of switch and accessories
 - Outline drawings of mechanism showing mounting and switch stand.
 - Assembly and adjustment instructions
 - Renewal parts lists for switch and accessories.

8.0 CONSIDERATION OF BIDS

Until final award of the contract is made, the purchaser reserves the right to reject any and all bids, waive any informalities, or accept any bid or bids which, in the opinion of the purchaser's engineers, will serve the best interest of the purchaser. The purchaser also reserves the right to accept or reject any alternates that may serve his best interest.



SPECIFICATION GUIDE

Combined Voltage and Current Optical Sensors For Metering NXVCT 138kV, 230kV, 345kV, 500kV

General

This specification covers free standing combined optical current and voltage sensors for use on a 60Hz system and at system voltages 138kV, 230kV, 345kV and 500kV. The units shall be suitable for ambient temperatures of -40°C to $+50^{\circ}\text{C}$ at 138kV, 230kV, 345kV class, and -40°C to $+40^{\circ}\text{C}$ at 500kV class. All equipment shall be designed, constructed, and tested in accordance with the requirements of the latest published standards of IEC or IEEE, except where otherwise specifically indicated by the Purchase Order or this specification and addenda.

Reference Standards

- IEEE Std. 4 IEEE Standard Techniques for High-Voltage Testing
- IEEE C57.13 IEEE Standard requirements for instrument transformers
- IEC 60044-1 Instrument Transformers - Part 1: Current transformers
- IEC 60044-8 Instrument Transformers - Part 8: Electrical current transducers
- IEC 60060-1 High Voltage test techniques
- IEC 60255-5 Electrical relays - part 5: Insulation tests for electrical relays
- IEC 60270 Partial discharge measurements

General Technical Requirements

1. Current and voltage sensors design shall be based on all passive elements. Hybrid design is not acceptable.
2. Current sensor measurement system shall be based on interferometric principle, which can provide self-correcting capability to minimize temperature and vibration influence on accuracy of measurement, and producing normalized signal.
3. Voltage sensor measurement system shall be based on electrical field measurement around Pockel's cell, with features to minimize temperature and pollution influence on accuracy of measurement, and producing normalized signal.
4. Current sensors shall have a continuous primary current rating of up to 3000 amps and a 63kA symmetrical 1-second short time rating.
5. Primary voltage and current ratio to be specified on each release.
6. Optical cabling with factory terminations shall be supplied with optical units. Standard length of optical cables is 100m (300ft). Additional length up to maximum of 400m (1200ft) is optional.
7. The optical sensors shall have a basic impulse level (BIL) as specified in the section below titled "System Specifications".
8. The sensors shall have accuracy better than 0.2% for metering applications.
9. CT head shall have clamps to accommodate suitable for Purchaser two four-inch, four-hole NEMA connectors for horizontal or vertical takeoff. If requested, the optional clamps design should accommodate either 25mm (1") flexible cables or tubular bus up to 100mm (4") diameter.
10. Means for grounding of optical sensors shall be provided.
11. Suitable means for lifting the optical metering unit shall be provided.
12. The insulator shall be a lightweight composite type of light gray color, the base made of galvanized steel unpainted, and CT head shall be painted white.
13. Sensor electronics shall be capable of being powered by AC or DC voltage specified on each release.
14. The sensor shall not use SF6 gas or oil insulation. Nitrogen at low pressure shall be used to provide barrier to moisture ingress and assist maintaining specified BIL. To monitor gas pressure a gauge and pressure switch with alarm contact shall be provided in accordance with the Standard.

NXVCT System Description

The combined Optical Current & Voltage Transducer system shall be intrinsically safe, with low maintenance and long service life. Output to be suitable for connecting to standard revenue meter HEA (High Energy Analog) interface and easily upgradeable within the same subrack, to digital interface in the future. The optical sensors technology should have the following advantages over conventional technology:

- High accuracy
- Wide bandwidth
- Wide dynamic range
- No ferro-resonance
- Lightweight column with Composite Insulator
- Intrinsically Safe, Environmentally Friendly Design
- No SF6 or oil-cellulose insulation
- No mechanism for explosion
- Low Maintenance
- Measurement accuracy over dynamic range not affected by temperature changes and vibration

1. NXVCT System Overview

The NXVCT system should consist of three subsystems:

- Column assembly
- Fiber Cable Assembly including Cable Management Box with Fiber Optic cable connectors or splices, wire terminals and sensors if required for proper system operation
- Electronics Modules housed in the subrack suitable for installation in 19" standard control rack or cabinet

2. Subsystem Components

2.1 Column Assembly

The column assembly includes insulator column with base, current sensor head, E-field sensors and fiber cables, and shall be suitable for installation on support structures in substation yard.

2.1.1 Composite Insulator Column

The exterior of the insulator column should be made of silicon rubber, with a fiberglass interior layer. The column's hollow core to be filled with pressurized nitrogen gas. This preserves a moisture-free environment and assists to insulate the HV bus from ground.

2.1.2 Base

The base provides support for the column assembly, interface for mounting the column assembly onto support structure, the termination point for fiber cables inside the insulator column, the mechanical interface for pressure gauges and temperature sensor if required.

2.1.3 Current Sensor

The multi-functional current sensor to be located on top of each column assembly. The polarization maintaining (PM) fiber current sensor encircles the conductor. When current flows, a magnetic field is generated. This field changes the polarized light that is traveling through the fiber inside the current sensor. The amount of change shall be directly proportional to the current flowing through the bus.

2.1.4 Voltage Sensor

Three E-field sensors, mounted within the hollow column assembly, shall be used to detect the electric field generated by the voltage on the bus. Optical fiber must be used to connect the E-field sensors to the feed-through plate located at the bottom of the insulator column.

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2.1.5 Fiber Cable Assembly

The fiber cable assembly includes fiber optic and copper cables and a cable management box (CMB). The copper cable connects the temperature and pressure sensors from the column to the CMB, and to the electronics subrack in the control room.

2.1.6 CT Subrack

The current transducer measurement subrack sends light signals to the current sensors on the column assemblies. It then processes the light returning from the current sensors. Polarization change of the light waveform on the returning path is calculated to assess the Faraday shift (angle) corresponding to the primary current.

The CT subrack has the following modules: power supply unit(s) with either DC or AC input as required, one status/alarm module, 3 CT modules with LEA outputs, and 3 CT amplifier modules. CT and amplifier modules are designed as plug-in and are not meant to be serviced in the field.

2.1.6.1 Power Supply Unit

The Power Supply Unit (PSU) provides dc voltages required by the other modules in the subrack. Outputs of the PSU modules are ± 6 V and ± 12 V. The PSU module has two LED indicators: Green – Power On, Red – Maintenance Required

2.1.6.2 Status/Alarm Module

The status/alarm module monitors all the modules on the CT subrack, and provides single-point access to information about the status of the modules.

The status/alarm module has two indicators:

- Green – Power On
- Red – Maintenance required, Data Invalid, Ancillary Maintenance Required, Data Invalid Ancillary Failure)
- Status code: a seven-segment, single digit, numerical display
- Status port: a DE-9 (serial) port

The back of the status/alarm module has contacts for:

- Maintenance required (MR) relays
- Data invalid (DI) relays
- Column temperature sensor
- Column pressure monitor

The back of the status/alarm module has ports for:

- IRIG-B input (BNC)
- RS-232 (DE-9), reserved for future use
- Ethernet (RJ-49), reserved for future use
- RS-485 (DE-9), reserved for future use

2.1.6.3 Current Sensor Module

There are three current sensor modules located in the CT subrack. Each current sensor module has:

- Green LED - Power On
- Red LEDs - Maintenance required & Data Invalid
- Fiber optic connection port
- Low Energy Analog (LEA) output ports at the rear of the subrack

2.1.6.4 Current Amplifier Module

There are three current amplifier modules located in the CT measurement subrack, which are used to supply high energy analog (HEA) outputs from the LEA output of the current sensor module. The current amplifier modules contain the following:

- three LEDs:
 - Power: green

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- Maint Req'd: red
- Data Invalid: red
- high energy analog (HEA) output ports at the rear of the subrack

2.1.7 VT Subrack

The VT sensor subrack generates and sends light signals to the E-field sensors in the column assemblies. Light returning from the E-field sensors is processed in the VT subracks. Properties of the light waves in the returning path are used to determine the strength of the electric field inside the column assembly core. This result yields the voltage on the HV bus.

The VT subrack has the following modules: power supply unit(s) with either DC or AC input as required, one status/alarm module, 3 VT modules with LEA outputs. VT modules are designed as plug-in and are not meant to be serviced in the field. To service HEA interface to meters additional Amplifier Subrack is required.

2.1.7.1 Power Supply Unit

The Power Supply Unit (PSU) provides dc voltages required by the other modules in the subrack. Outputs of the PSU modules are ± 6 V and ± 12 V. The PSU modules have two LED indicators: Green – Power On, Red – Maintenance Required

2.1.7.2 Status/Alarm Module

The status/alarm module monitors all the modules on the CT subrack, and provides single-point access to information about the status of the modules.

The status/alarm module has two indicators:

- Green – Power On
- Red – Maintenance required, Data Invalid, Ancillary Maintenance Required, Data Invalid Ancillary Failure)
- Status code: a seven-segment, single digit, numerical display
- Status port: a DE-9 (serial) port

The back of the status/alarm module has contacts for:

- Maintenance required (MR) relays
- Data invalid (DI) relays
- Column temperature sensor
- Column pressure monitor

The back of the status/alarm module has ports for:

- RIG-B input (BNC)
- RS-232 (DE-9), reserved for future use
- Ethernet (RJ-49), reserved for future use
- RS-485 (DE-9), reserved for future use

2.1.7.3 Voltage Sensor Module

There are three current sensor modules located in the CT subrack. Each current sensor module has:

- Green LED - Power On
- Red LEDs - Maintenance required & Data Invalid
- Fiber optic connection port
- Low Energy Analog (LEA) output ports at the rear of the subrack

2.1.7.4 VT Amplifier Subrack

The VT amplifier subrack provides high energy analog (HEA) voltage output. The subrack consists of the following modules:

- Power supply modules (PSMs)
- Status/Alarm
- Three voltage amplifiers

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2.1.8 Merging Unit – Digital Output to IEC 61850 (Future)

Connections are provided at the rear of each subrack for connection to a merging unit module to enable digital connectivity to relays. The module will have the following ports:

- Ethernet (RJ-45)
- RS-485 (DE-9)
- GPS input (BNC)

2.1.9 System Diagnostics

The system and module status of the CT subracks is indicated by three LEDs on the front panel of each of the subracks. There are five conditions to monitor the status:

- Normal Operation
- Normal Maintenance
- Immediate Maintenance
- System Initialization
- No Power

System diagnostics offers to identify the status code of the 7-segment display on the status/alarm module and refer to the table for fault detailed subsystem diagnostics and procedures with the use of Control Panel software.

3. Control Panel Software

Control Panel Software is an intuitive interface between the subrack electronics and the user. It is to be installed on a laptop computer, which can be moved to different locations and connected with different NXCT systems.

3.1 System Requirements

- Pentium 166MHz processor
- 32MB RAM
- 1GB HD with 10MB free disk space
- Serial port RS-232
- 9-pin serial cable
- Blank floppy disks
- Windows® 95 or higher

3.2 Software Architecture

Control Panel Software is organized into four menus containing drop-down lists of commands to configure exact parameters of the sensor and communication interfaces. Features of the software include:

- Main Screen with:
 - Menu bar
 - Status bar messages
 - Status board date and time display
 - Number and caps lock display
- The menus include
 - File
 - Communication
 - View
 - Help
- Module view has information about:
 - Present status
 - Parameters
 - Upload all
 - Upload single parameter
 - Download single parameter
- Registry information (system ID & configuration)

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- Alarm History Reports
- System Security

System Operational Requirements

1 Reliability and Dependability

The system should require no regularly scheduled maintenance. The electronics shall be designed with self-diagnostic capabilities and will indicate a "Maintenance Required" status via contact closures. Redundancy at a system level mitigates the risk of any active component disrupting the system. System and subsystem status is initially indicated by LEDs on the subrack front panels. Fault conditions on subracks are further indicated by the LEDs on the individual modules, and can be diagnosed through Control Panel configuration software by connecting a laptop to the port on Status/Alarm module.

2 Standard Type Tests

NXVCT standard type tests are listed below.

- Short time current
- Temperature rise test
- Lightning impulse test
- Switching impulse test
- Wet test
- RIV test
- EMC tests: emission
- EMC tests: immunity
- Accuracy test
- Vibrations test
- Low voltage components withstand test
- Test for proper anti-aliasing
- Test for accuracy vs. harmonics

Optical VCT Metering System Performance Specifications

The NXVCT meets the performance and feature specifications listed in the table below:

1. Column Technical Specifications

Parameter	Performance Rating	
Maximum Rated Current	3 kA _{rms}	
Insulation class per IEC 60044-8, sec. 5.1.6	Y (45 °C rise)	
Customer Selectable turns ratio	3000:1, 2000:1, ... etc. without field calibration	
Short-Time current withstand* 1 s per IEC 60044-8, 5.1.4.1.2	63 kA _{rms}	
Dynamic Current* ($I_{dyn} = 2.7 \times I_{In}$)	170 kA _{peak}	
Accuracy Classes (LEA)	Class	Dynamic Range
CT for Metering	IEC 0.2S or IEEE 0.3	5% - 150%
VT for Metering	IEC 0.2	2% - 200%
Accuracy Classes (HEA)		
CT for Metering	IEC 0.2S	5% - 150%
VT for Metering	IEC 0.2	50% - 120%
Altitude	<1000 m	
Outdoor temperature range	-40°C to +50°C typical (+40°C for 500kV)	
Solar radiation	1000 W/m ²	
Wind Speed	34 m/s (76 miles/hr)	
Insulation requirements	As per clause 6.1 of 60044-7	
Pollution Class	Class II (III and IV available if specified)	
Radio Interference	< 250 μV	

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Partial Discharge	<10 pC @ U_m and <5pC @ $1.2 \times U_m/\sqrt{3}$			
Voltage Class	138 kV	230 kV	345 kV	500 kV
Column Height	2164mm	3025mm	3300mm	4600mm
Creepage Distance	3219mm	5390mm	6390mm	9290mm
Rated primary voltage (p-p)	138 kV _{rms}	230 kV _{rms}	345 kV _{rms}	500 kV _{rms}
Maximum Systemvoltage (U_m)	145kV _{rms}	245 kV _{rms}	362 kV _{rms}	550 kV _{rms}
BIL	650 kV _{peak}	1050 kV _{peak}	1300 kV _{peak}	1800 kV _{peak}
Rated power frequency withstand	275 kV _{rms}	460 kV _{rms}	575 kV _{rms}	750 kV _{rms}
Switching Impulse Withstand (wet)	---	---	950 kV _{peak}	1175 kV _{peak}
Wet power frequency Withstand	275 kV _{rms}	460 kV _{rms}	---	---
Static mechanical withstand, Per IEC 60044-8, table 9, load Class II	3000 N	4000 N	4000 N	6000 N
Mass of Insulator Assembly	145kg / 320Lb	250kg / 550Lb	318kg / 700Lb	695kg / 1530Lb
Seismic qualification	0.5g horizontal, 0.4g vertical			
Adaptable clamp to bus	Application dependent			
Service life (Reliability)	>30 years			
Fiber length	Up to 400m			

2. Opto-Electronic Subrack Technical Specifications

3 dB Bandwidth (frequency response)	0.5 to 6 kHz DC*
Random Noise Amplitude (SNR)	<14 mA/ $\sqrt{\text{Hz}}$ (Metering)
Rated time delay	<50 μs
Indoor temperature range	-5 °C to 40 °C up to 95% humidity non-condensing
EMC compliant	Per IEC 60044-8, IEEE C37.90.1, IEEE C37.90.2, IEEE C37.92
DC offset	3mV
Input voltage	70-150VDC, 90-260VAC
Warm-up time	<60 sec
Wake-up time	None
Bridging Time during input voltage failure	>50ms
Transportation	Per ISTA Impact test – procedure 1A Drop method Per ISTA 1.) Vibration Test – Method B (1.1G _{rms})
HEA output voltage & burden	69V _{rms} , 115V _{rms} & 5k Ω at 0.9PF
HEA output current & burden	1A _{rms} & 5k Ω at 0.9PF
Output overrange - voltage	1.1 for 500kV; 1.2 for 138kV, 230kV, 345kV
Output overrange - current	1.5 for all voltage classes
Output voltage protection	Short circuit protection on LEA
Alarms Contacts	2 wire dry relay, form A contact

* AC currents to 6 kHz can be measured with the DC CT, but with lower accuracy.

230KV SF6 CIRCUIT BREAKER SPECIFICATIONS

MONTANA-DAKOTA UTILITIES CO.

A Division of MDU Resources Group, Inc.

Specifications follow for 3 circuit breakers, shall be delivered to:

_____ Substation

GENERAL SPECIFICATIONS

Circuit breakers shall be outdoor type, SF6 puffer, single pressure, dead-tank design, three pole, single throw, trip-free in any position, 60 Hz, electro-pneumatically, electro-hydraulically or electro-spring operated. The preferred mechanism is electro-spring operated.

All breakers and their component parts on this order shall be designed, drawn, configured, furnished, manufactured and wired to be identical and interchangeable.

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.

Circuit breakers and associated equipment covered by these specifications, and all tests applied thereto, shall conform to the latest standards of ANSI and NEMA.

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 breaker operating mechanism shall not be thermally limited within the ambient operating temperature range of the breaker.

The following shall be included with each breaker:

Eighteen relaying type bushing current transformers, three per bushing, minimum of C800 accuracy class fully distributed windings, multi-ratio 2000:5 amp maximum ratio, terminated at short-circuiting terminal boards mounted in a common control cabinet. Bushing current transformers shall have a minimum thermal load factor of 1.5 at 40°C ambient.

Dual, fully independent trip circuits.

Weatherproof housing for each mechanism and control cabinet, with provisions for conduit entrances on bottom side for Purchaser's use in field installation.

Weatherproof conduit and wiring between bushing current transformers, mechanism and control housing.

Where applicable, automatic air or hydraulic compressor/pump-reservoir equipment for mechanism, mounted in mechanism housing. Motor elapsed running time meter (indicating to tenths of an interval with an hour-meter supplied on pneumatic mechanisms and a minute-meter supplied on hydraulic mechanisms), low pressure alarm contacts, and pressure gauge.

Compressor/pump motor suitable for operation from a 1Ø-240/120VAC source. Spring charging motor of spring operated breakers to operate normally from 1Ø-240/120VAC source, but shall have a throw-over scheme for operation on 125 VDC upon loss of AC. Throw-over scheme shall include a 3 minute capable time-delay relay to alarm on transfer to 125 VDC with automatic alarm reset when condition is no longer present. Alarm shall be wired to terminal boards and marked for customer use.

The capacity of the stored energy system shall be sufficient for five close-open operations at full interrupting rating, without the benefit of compressor operation.

Compressor capability shall be sufficient to return the system from lockout to normal (fully-charged) pressure within one-half hour, and from zero pressure to normal within 2 hours.

Electro-spring operated mechanisms shall be supplied with an alarm contact indicating that the spring is not fully charged. This alarm shall have a 3 minute delay with automatic alarm reset when condition is no longer present. Alarm shall be wired to terminal boards and marked for customer use.

Constant operation cabinet heaters, rated for 120/230 VAC, shall be required to maintain all cabinet interiors at an average temperature of 3-5 degrees F above ambient.

In addition, cabinets containing moving mechanisms or devices affected by temperatures below 0 degrees F, shall have thermostatically controlled heaters sufficient to keep those components at least 20 degrees F above their minimum operating temperatures or 0 degrees F, whichever is greater. All cabinet heaters shall be mounted in base of cabinet and screened to prevent physical contact. Commonly available strip bar heaters are preferred for all cabinet heat.

All thermostats shall be adjustable dial type thermostats. Thermostats used to control breaker tank heaters shall also be remote sensing bulb type to reflect actual outdoor ambient or heated tank temperatures.

Tank heaters rated for 120/240 VAC, sufficient to allow for full interrupting capacity operation down to -50°C with a 20 mph wind, with no allowance for heating of gas medium due to flow of current thru the interrupters. Location and wattage of tank heaters should be included with bid.

Tank heater monitor & alarm system to provide a three minute time delayed alarm for loss of AC supply to heaters. Also, tank heater current monitor relay with a 3 minute time delay alarm for loss of current to heater during heater operation. Tank heater failure alarms shall automatically reset when the alarm condition is no longer present. Alarms shall be wired to terminal boards and marked for customer use.

One fused and ground-fault protected 20A, 120VAC, duplex outlet conveniently located in each mechanism or control cabinet.

Mechanical temperature-compensated SF6 gas pressure switch or density gauge with alarm and cutoff contacts on each independent gas system.

In addition to mechanical SF6 pressure gauge(s), Consolidated Electronics SM6-0 Gas Density monitor shall be included for monitoring of each independent gas system. It must be noted that the Consolidated Electronics SM6-0 SF6 Gas Density monitor is **NOT** acceptable for use as a control device. The SM6-0 Gas Density monitor is to be only used for remote interrogation and backup monitoring of gas system.

- SM6-0 shall be mounted at a location allowing easy reading of the display and full access to the unit while the breaker energized. Mounting inside mechanism or control cabinet is preferred.
- All alarms and electrical connections from the SM6-0 shall be wired to terminal boards in the breaker cabinet and identified to customer use.
- Should SM6-0 be mounted outside the control cabinet, a spare conduit (1/2" min.) shall be installed between SM6-0 and control cabinet to accommodate communications equipment.
- Power to the SM6-0 shall be routed through an interrupting device (ie. - spring-loaded momentary cutoff switch), conveniently located in the breaker control cabinet to allow for hard reset of SM6-0

All gas pressure gauges shall be visible with the containing cabinet door closed.

Rupture disk on each gas system for release of excessive gas pressure.

The SF6 system shall be supplied with separate shut off valves to each interrupter. All SF6 devices shall be piped to a common manifold to allow for filling or testing from a single connection point without affecting the SF6 pressure in all of the interrupters. There shall also be a main shut off valve for the SF6 system.

Socket type relays must be labelled on both the relay and on the socket (or on panel near the socket) if they are not interchangeable or have settings.

Manual trip-close control switch (without indicating lamps) mounted in breaker control cabinet.
(NO common terminals between close and trip contacts are permitted.)

DC negative (-) from both trip and close circuits shall be available for customers use.

Knife switches with separate fuses for heaters and motor control power.

Knife switches with separate fuses for breaker open and close circuits.
(NO common terminals between close and trip circuits are permitted.)

If each pole has an individual wiring or control cabinet, all three such cabinets shall be wired and laid out identically, then wired to the master control cabinet.

Permissive device located in mechanism cabinet to block operation of mechanism during maintenance.

Minimum of 14 "a" and 14 "b" spare auxiliary switches.

Bushings shall be light gray polymer, rated 900 KV BIL, with standard 4 hole NEMA pads or 1 1/2" - 12 threaded studs for connections. Quotation must clarify bushing top connection. If quoted breaker is equipped with threaded studs, breaker must furnish stud connectors to NEMA 4 hole pads. Quotation must also indicate alternate pricing for porcelain or composite bushings.

Paint to be light gray ANSI # 70.

Mechanical "OPEN"- "CLOSE" position visual indicator.

Manual tripping device.

All provisions needed to easily mount Doble TDR 9000 travel analyzer transducers on all three poles simultaneously.

Provisions for pulling vacuum and provisions for adding SF6 gas to the breaker, without de-energizing the breaker. Gas system will have isolation ball valves to isolate each pole from the gas system. SF6 connections shall be DIL0 type.

Operation counter visible with the control cabinet closed. Operation Counter shall advance upon breaker opening operation.

Stands for circuit breakers to be furnished with two grounding pads at diagonally opposite corners including provisions for attachment of a 4/0 stranded copper conductor, when the grounding conductor must be extended up the stand for device grounding.

All interrupting poles, mechanism and control housing shall be mounted on a common structural base.

One complete set of special tools, and maintenance closing device per substation.

All additional standard features and accessories not mentioned above.

ADDITIONAL ITEMS

Quotation must itemize and include one set of the following per station:

- A. Spare tank heater, including all hardware, accessories and special tools to replace tank heater in the field.
- B. Spare bushing.
If breaker requires more than one style of bushing, include the price of each style.
- C. Recommended spare parts and itemized price of each recommended item.

ELECTRICAL RATINGS

Ratings shall be in accordance with ANSI C37.06 table 4a (K=1)

Voltage rating, KV nominal.....	242
Minimum continuous current rating, amps.....	2000
Interrupting rating, symmetrical, KA*.....	40
Interrupting time, cycles.....	3
Reclosing time rating, cycles.....	20
Basic impulse insulation level, KV.....	900
Closing control voltage, VDC.....	125
Tripping control voltage, VDC.....	125
Compressor motor voltage, 1Ø VAC.....	120/240
Cabinet heater and accessory voltage, 1Ø VAC.....	120/240
Tank heater voltage, 1Ø VAC.....	120/240
Ambient temperature range*.....	+40° C to -50° C

***COLD WEATHER PERFORMANCE**

Breakers shall be capable of interrupting a minimum of 40KA symmetrical current and shall be suitable for continuous duty in accordance with ANSI Standards at ambient temperatures in the range of +40°C to -50°C, with no allowance for the heating effects due to load current flow through the circuit breaker. In addition to the ANSI Standards the -50°C rating must be met with a 20 mph wind velocity.

Under these conditions the breaker must be capable of a reclosing duty cycle of the following as per the latest published ANSI Standard C37.06:

O---0.0sec---CO---0.33sec---CO---10.0sec---CO---30.0sec---CO---90sec---CO.

If cold weather requirement cannot be met, bidder must note the exceptions and state the lowest temperature rating that the manufacturer can provide. Bidder must also state whether this rating takes into account heat loss due to any wind.

LEAK RATE REQUIREMENTS

A quantitative leak rate test must be performed on the breaker with a criteria of 1% or less per year on entire breaker. Any expense to the company to maintain the leak rate of 1% for a period of 12 months must be reimbursed in total by the breaker manufacturer.

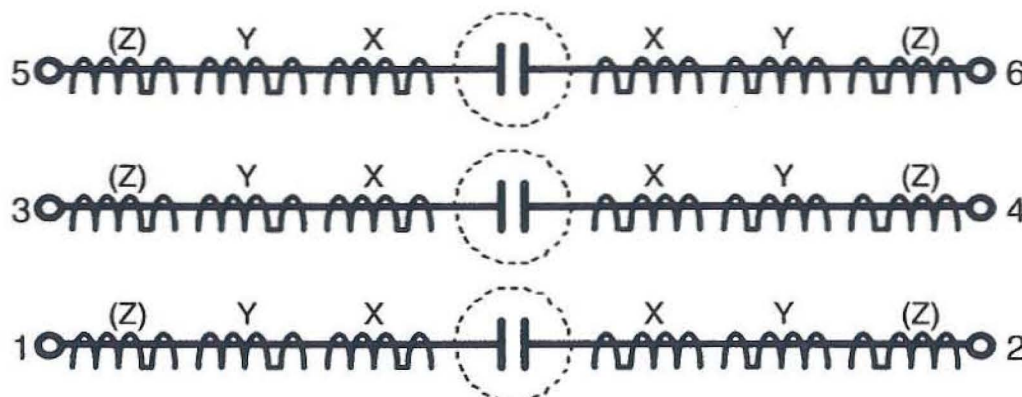
The breaker tanks and associated castings shall be warranted against cracks and leaks due to defects in workmanship or materials that cause annual leak rates in excess of 1% for a period of five years and shall be replaced at the manufacturers expense, (labor and materials).

If leak rate requirements and associated warranty periods cannot be met, bidder must note the exceptions and leak rate, along with associated warranties that the manufacturer can provide.

BUSHING CURRENT TRANSFORMER DESIGNATIONS

Breaker bushings and current transformers shall be designated as follows:

Typical Breaker Top View –Showing Bushing & Current Transformer Designations.



This sketch indicates only the designations for bushings & CT's. See written specification for the actual number & location of CT's.

Indicate relative position of control mechanism and/or connection cabinet

CT connection drawing must show actual arrangement of terminal blocks for customer connection, & CT ratio table(s).

SHIPPING CONSIDERATIONS

Breakers to be shipped with partial internal SF-6 gas pressure to eliminate the need for evacuation of the pole unit for installation.

All 3 breakers, associated parts and pieces must arrive at the destination in one shipment. Breakers shall be tripped by truck to jobsite, and delivery must be coordinated with purchaser to provide for unloading.

PRINTS AND INSTRUCTIONS

Five copies of instruction book and the following listed documentation (as applicable) shall be sent to:

Electric Transmission Engineering Manger
Montana-Dakota Utilities Co.
400 North Fourth Street
Bismarck, ND 58501

- Documentation:
- Breaker Wiring Elementary Diagrams
 - Breaker Connection Diagrams
 - Breaker Outline Drawings
 - Connection diagrams properly identified for current transformers, with ratio correction factors and secondary excitation curves.
 - Full set of test data for each breaker including representative time/travel curves

Drawing approval will be required. Drawings shall be furnished in Autocad format.

CONSIDERATION OF BIDS

Until final award of the contract is made, the Purchaser reserves the right to reject any and all bids, waive any informalities or accept any bid or bids which, in the opinion of the Purchaser's engineers, will serve the best interest of the Purchaser. Purchaser also reserves the right to accept or reject any alternatives that may serve his best interest.

Any and all exceptions to any part of these specifications must be noted in the bid.

NOT TO BE INCLUDED WITH SPECIFICATION:

Preferred manufacturer is Mitsubishi Electric Power Products, Inc

Preferred style is MEPP1 200SFMT40E.

Positron telephone line isolation equipment, to withstand up to 50KV GPR; 130 VDC input power, equipped for up to two dial circuits (loop start) and up to five dedicated 4-wire data circuits (up to 64kb/sec data rate); mounting dimensions 31"W x 14"H x 10"D.

Montana-Dakota Utilities Co. Relay Requirements Ellendale WF 230kV Substation

First Prepared: 11/04/2004
Last Revised: 11/12/2004

Introduction:

This specification describes the general requirements for protective relaying required at a 230kV, 3-circuit breaker ring bus substation arrangement, to be established approximately 1/3 the line distance west of the Ellendale Jct Substation toward the Wishek Jct substation, on the 230kV Ellendale to Wishek transmission line.

Relaying requirements for Ellendale WF to Ellendale Jct:

Two primary relay schemes are to be installed. The two schemes are to be POTT communications assisted utilizing one common frequency shift tone power line carrier communication channel. The POTT frequency shift tone channel is 1/2 of a dual frequency shift tone channel such that if both tones are "keyed" or "received", a direct trip will result, which is used for breaker failure remote tripping. A direct trip receive shall assert inputs into the two line protective relays for breaker tripping.

First relay to be a SEL-421-1415X1651HX

This relay will be used POTT with weak-in-feed & echo, step-zone-distance, sync-check & line/bus permissive, high speed auto-reclosing, out-of-step blocking, breaker failure initiation, etc.

2 - Megger/States FMS style test switch, P/N 193R-330EH-ST, Pos. A: FMS-10E-ST; Pos. B&C: FMS-10A-ST, 19" rack mount; 3U high; 30 switch test switch block, Pos. A: 4P6C; Pos. B&C: 10P; stud terminals, all switch handles to be "Black", and with standard Black cover

1 - Megger/States FMS style test switch, P/N 193R-330A-ST, Pos.A;B&C: FMS-10A-ST, 19" rack mount; 3U high; 30 switch test switch block, Pos.A;B&C: 10P; stud terminals, all switch handles to be "Black", and with standard Black covers

Second relay to be a SEL-311C-014232546X

This relay will be used POTT with weak-in-feed & echo, step-zone-distance, sync-check & line/bus permissive, high speed auto-reclose initiation, out-of-step blocking, breaker failure initiation, etc.

1 - Megger/States FMS style test switch, P/N 193R-330EH-ST.

1 - Megger/States FMS style test switch, P/N 193R-330A-ST.

Breaker Failure relay to be SEL-501-003X561BXB

This relay to provide breaker failure protection for up to two circuit breakers.

2 - Electric Switch series 24 type LOR-7810D Lockout Relay, 10 Decks, 30-140 VDC Coil, Hand Reset

2 - Type ET-16 Red indicating lamp

2 - Megger/States FMS style test switch, P/N 193R-330EH-ST.

Relaying requirements for Ellendale WF to Wishek Jct:

Two primary relay schemes are to be installed. The two schemes are to be POTT communications assisted utilizing one common frequency shift tone power line carrier communication channel. The POTT frequency shift tone channel is 1/2 of a dual frequency shift tone channel such that if both tones are "keyed" or "received", a direct trip will result, which is used for breaker failure remote tripping. A direct trip receive shall assert inputs into the two line protective relays for breaker tripping.

First relay to be a SEL-421-1415X1651HX

This relay will be used POTT with weak-in-feed & echo, step-zone-distance, sync-check & line/bus permissive, high speed auto-reclosing, out-of-step blocking, breaker failure initiation, etc.

2 - Megger/States FMS style test switch, P/N 193R-330EH-ST.

1 - Megger/States FMS style test switch, P/N 193R-330A-ST.

Second relay to be a SEL-311C-014232546X

This relay will be used POTT with weak-in-feed & echo, step-zone-distance, sync-check & line/bus permissive, high speed auto-reclose initiation, out-of-step blocking, breaker failure initiation, etc.

1 - Megger/States FMS style test switch, P/N 193R-330EH-ST.

1 - Megger/States FMS style test switch, P/N 193R-330A-ST.

Breaker Failure relay to be SEL-501-003X561BXB

This relay to provide breaker failure protection for up to two circuit breakers.

2 - Electric Switch series 24 type LOR-7810D Lockout Relay, 10 Decks, 30-140 VDC Coil, Hand Reset

2 - Type ET-16 Red indicating lamp

2 - Megger/States FMS style test switch, P/N 193R-330EH-ST.

Relaying requirements for Wind Farm Tap:

SEL protective relay devices for bus/line/step-up transformer - to be determined

Interconnection protective relay(s) to be SEL-351-71H35546XX

This relay(s) to provide the following functions: 81UF, 81OF, 27, 59, 59G, 46, 47. The relay(s) may also be utilized to provide other protective functions as may be appropriate. To maintain substation station power, it is recommended that this relay(s) trip low voltage circuit breakers.

1 - Megger/States FMS style test switch, P/N 193R-330EH-ST.

1 - Megger/States FMS style test switch, P/N 193R-330A-ST.

The following are required for each 230kV circuit breaker:

See "Switchboard Design Specifications" for additional details on the following items:

1 - 43R selector switch.

1 - Sync-selector switch

1 - 52CS - breaker control switch

Indicating lights

Other required devices:

1 - SEL-2030-00X30XXXXX Communications Processor

All above devices to be connected to this device for dial-up remote access.

1 - Starcomm Modem, part number: 240-0199

For use with above SEL-2030

1 - Schweitzer Engineering SEL-C220 serial cable, 1.5 ft long

For SEL-2030 to Starcomm Modem

3 - Panel meters: SATEC PM130P-U-5-1AC-00-00 POWERMETER 120VAC 5A
120VAC-PS

All protective devices to be GPS Satellite-Controlled clock synchronized. Arbiter Model 1084C/10/01 with 110-275 VDC terminal power strip w/surge withstand and LCD back light. For rack mounting. Include antenna, cables and mounting.

D20 RTU 2 Modems/ME/IAB/2SB/1KR-4K12
Failover Power Supply
84" Cabinet

1 - D20 RTU - Contains the following equipment:

- 1 WESDAC D20 202 BIN MODEM 520-0120
- 1 TELENETICS 2 Wire dial Up 2400 Bd 580-0773
- 1 D20ME (2M Flash,512,1.5M,VME) 526-2005
- 1 WESDAC D20A 32 Analog 511-0101
- 2 WESDAC D20S 64 Status 507-0101
- 1 WESDAC D20K 32 Control 508-0101
- 1 WESTERM D20AB (Barrier) 517-0328
- 2 WESTERM D20SB (Barrier) 517-0327
- 1 WESTERM D20KR (DB25) 517-0143
- 4 WESTERM KI2 (Barrier) 517-0147
- 1 D20 FULL VME BIN (MX) 500-0280
- 4 Cover plate 10.3" 953-3016
- 1 Cover plate 5" 953-3018
- 1 WESTERM D20M (Chassis mount (1) VME) 517-0230
- 1 D20 POWER SUPPLY (20-60Vdc) 580-0296
- 1 FAILOVER 110Vac/125VDC – 24Vdc 580-0719
- 4 D.20 CABLE ASSEMBLY 977-0089/12
- 4 CONTROL CABLE ASSEMBLY (72") 977-0069/72
- 2 RS-232 CABLE ASSEMBLY 977-0098/24
- 1 WESTMAINT CABLE (DB9 – DB9) 977-0048/96
- 15 WESTERM DUCT PANEL 560-0008
- 1 D.20 Terminator 977-0049
- 32 ANALOG SCALING NETWORK (std val) 530-0050
- 1 NEMA 12 84" 2 RACKS 955-4904
- 1 Drawing Pocket for fixed frame cabinets 955-4805
- 64 RELAY 10A 28V 2C-24V 410-0039

SOFTWARE APPLICATIONS

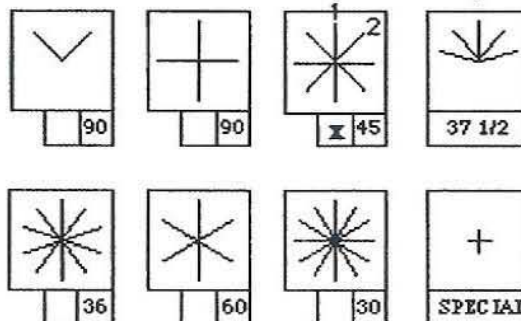
- New Software Based on SAB1575/00

_____ SUB STATION
SWITCHGEAR SUMMARY

MARK NO.	QTY.	DESCRIPTION	DEVICE NO.
	1	Synchronizing Switch - GE SB1 Model # 16SB1CF9 with Removable oval handle, Model # 16SB1CC7	SS

ON SB-10 SWITCHES MARK LAT. STAGES WITH A DOT (.)		CONTACT ARRANGEMENT MARK "X" FOR CLOSED CONTACT	
CONTACTS HANDLE END ODD EVEN	HANDLE POSITIONS (BACK VIEW)		
	2	1	
1	X		
2	X		
3	X		
4	X		
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			

MARK HANDLE POSITIONS (FRONT VIEW)



CIRCUIT MARK R-CRAUL-C	SYNCHROSCOPE
1	OFF
2	ON

NOTE - SEE INSTRUCTIONS FOR LATERAL ACTION

ROTATING ACTION

MAINTAINED ALL POSITIONS

SPRING RETURN ACTION

S.P. FROM CCW POS. S.P. FROM CW POS.

FROM POS. TO FROM POS. TO

MAINT. POS.

PULL TO LOCK IN POS.

HANDLES

KNURLED

OVAL

PISTOL GRIP

LEVER

ROUND

RADIAL

L. PISTOL GRIP

NONE

ESCUTCHEON

STANDARD

~~OR-DONOR~~

TARGET

KEYED FOR

REMOV. HANDLE

REMOV. IN POS.

NONE

SPECIAL _____

COVER (NEMA D)

*WATERTIGHT (NEMA III IV)

*DUSTTIGHT (NEMA V)

*OIL FILLED (NEMA VIII)

EXPLOSION PROOF (NEMA VII CLASS 1 GRD)

*FAB. METAL (NEMA D)

*SURFACE MTC.

PANEL THICKNESS 1 INCH

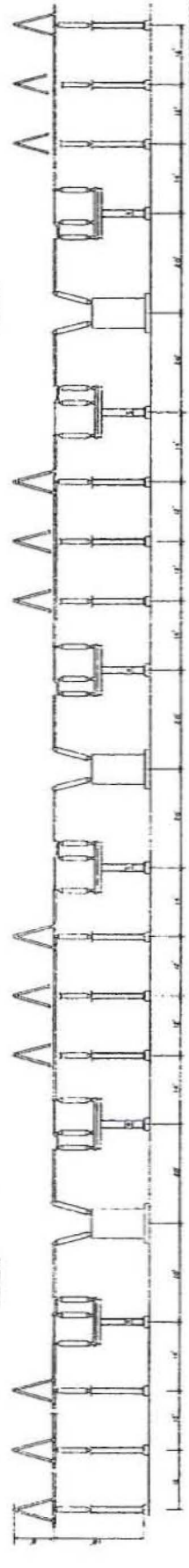
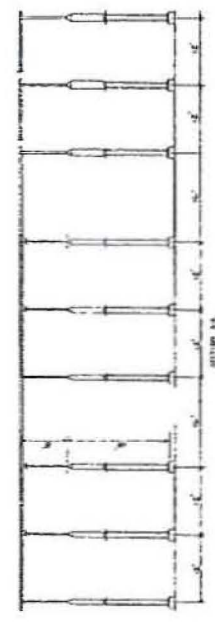
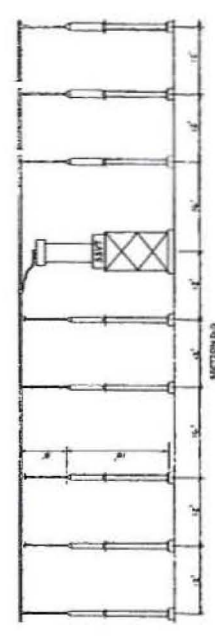
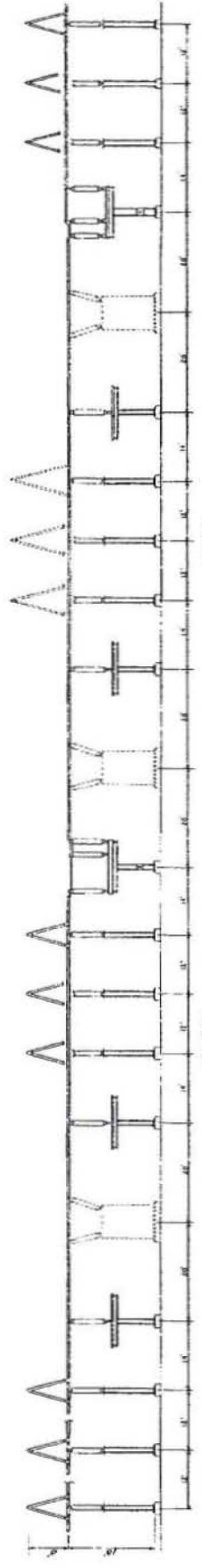
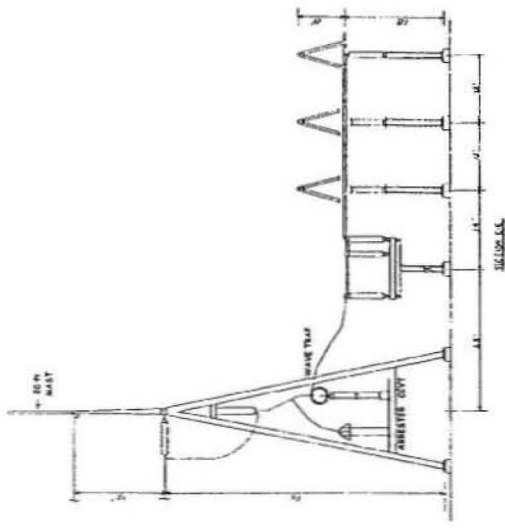
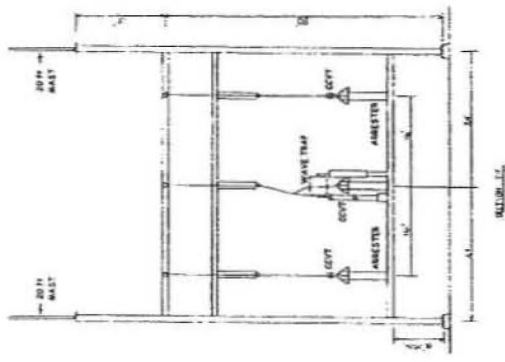
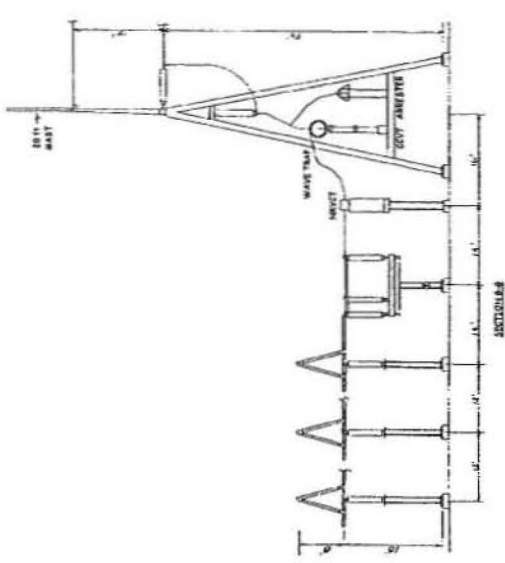
FILL OUT BELOW FOR SB-10

LATERAL ACTION

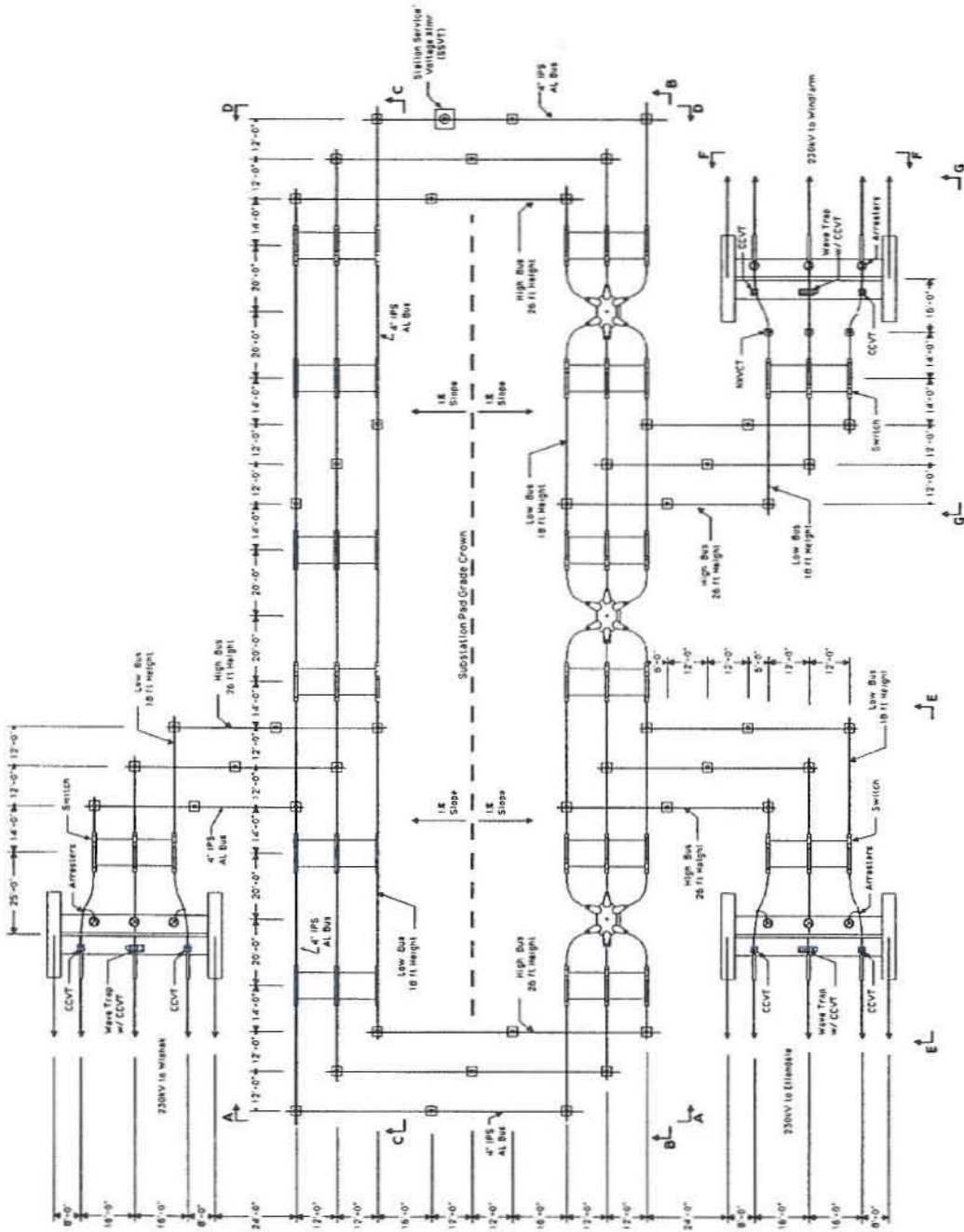
NO ROTATING WHEN	IN	OUT
MAINTAINING (IN & OUT)		
SPRING RETURN TO	IN	OUT
PUSH	PULL	IN POS. _____
TO CLOSE CONTACTS		
TO OPEN CONTACTS		

(CROSS OUT THE ACTION WHICH DOES NOT APPLY)

SPECIAL REMARKS _____



SECTION 1.1
SECTION 1.2
SECTION 1.3
SECTION 1.4
SECTION 1.5
SECTION 1.6
SECTION 1.7



Wishak to Ellendale Line
230kV Ring Bus for Windfarm

MD	Wishak to Ellendale Line Ring Bus	SCALE	1" = 16'
DRAWN BY	MONTANA-DAKOTA UTILITIES CO.	DATE	4/25/04
DATE	4/25/04	PROJECT NO.	04292004-1
DATE	4/25/04	PROJECT NO.	04292004-1

REF - 11/15/04 - Change Orientation of Ring Bus, add SSVT

Revised 02/02

SUBSTATION SIGN SPECIFICATION

SIGN	SIZE (1)	MATERIAL (2)	LOCATION (3)
<u>CAUTION</u> (4) Face shield, apron and rubber gloves required when handling batteries or adding water	10 x 14	Non-Conductive	Vicinity of battery
Safety Sign #10-02-229-P-4 (Plastron)		World Wide #CX229F-4 (Fibertex)	
<u>DANGER</u> No smoking, matches or open lights	10 x 14	Non-Conductive	Vicinity of battery
Safety Sign #10-01-018-P-4 (Plastron) World Wide #DX-18F-4 (Fibertex)		Stonehouse #93BDN20 (Lxsigns) Electromark #S167-FG	
<u>DANGER</u> No smoking beyond this door	10 x 14	Self-Adhesive	Battery room doors
Safety Sign #10-01-521U-2 (Durapress)		World Wide #DX-521R-2 (Presstex)	
<u>NOT AN EXIT</u> (4)	10 x 14	Self-Adhesive	Doors which do not lead directly outside
Safety Sign #10-50-014U-2 (Durapress) World Wide #GX-1014R-2 (Presstex)		Stonehouse #44BWD36 (Vinyl)	
<u>EXIT</u>	10 x 14	Self-Adhesive	Doors which lead directly outside
Ready Made #G-7544 (Vinyl) Stonehouse #44BRD21 (Vinyl)		Safety Sign #10-50-213U-2 (Durapress) World Wide #GX-1213R-2 (Presstex)	
<u>FIRE EXTINGUISHER</u>	4 x 18 4 x 20 4 x 24	Self-Adhesive	Vicinity of or on fire extinguisher
Ready Made #AD-502 (Vinyl) Stonehouse #44JWF19 (Vinyl)		Safety Sign #04-55-021U-2 (Durapress) World Wide #7021R-2 (Presstex)	
<u>FIRST AID KIT</u>	7 x 10 6 x 6	Self-Adhesive	Vicinity of first aid kit or cabinet containing first aid kit
Safety Sign #07-50-001U-2 (Durapress)		World Wide #GW-1001R-2 (Presstex)	
<u>DANGER HIGH VOLTAGE</u> <u>KEEP OUT</u> w / manzap	14 x 20	Porcelain Enamel, steel	By substation fence entrance gate(s) with approximately equidistant distribution around the fence (on larger fences, spacing not to exceed approximately 100')
EXAMPLE IS ATTACHED			
<u>WHEN ENTERING A SUBSTATION</u> (4)	14 x 20	Fluorescent Cardboard	Conspicuous when entering

MDU

SUPPLIER (NOTE: \$20.00 Minimum order)	Electromark 1-800-842-1052	Fax 1-800-842-0081
Note 1: Other sizes acceptable upon approval	Ready Made 1-800-544-2440	Fax 1-800-222-1934
Note 2: Other materials and methods of fastening are acceptable upon approval	Safety Sign 1-800-321-8855	Fax 1-800-654-5535
Note 3: For material determination only	Stonehouse 1-800-525-0456	Fax 1-800-255-0883
Note 4: Optional sign.	World Wide 1-800-222-7744	Fax 1-800-882-4477

Revised 02/02

Must Comply with ANSI Z535 Standard



14" x 20" Porcelain Enamel, Steel

SWITCHBOARD SPECIFICATION APPENDIX "A"

Substation Switchboard Label Code

FRONT PANEL DESIGNATION

4AQ1 - Typical Front Panel Address
(4) - Panel Number
(AQ) - Device Identification & Location
(1) - Wiring terminal

4AQGI - As above, except Green indicating lamp associated with device
4AQ - Wiring terminal 1

DEVICE LABELS:

A - 1st letter
 A-Y - 2nd letter
 then after exhausting A labelling
B - 1st letter
 A-Y - 2nd letter

FUSE LABELS:

F - 1st letter
 A-Y - 2nd letter

TERMINAL BOARD LABELS:

T - 1st letter
 A-Y - 2nd letter
Terminal boards mounted in columns to be numbered consecutively from top to bottom.

AUX PANEL DEVICES:

X - 1st letter
 A-Z - 2nd letter
Does NOT include fuses or terminal boards!

REAR PANEL DESIGNATION

4CL1 - Typical Rear Panel Address
(4) - Panel Number
(CL) - Device Identification & Location
(2) - Wiring terminal

4CLR2 - As above, except Red indicating lamp associated with device
4CL - Wiring terminal 2

DEVICE LABELS:

C - 1st letter
 A-Y - 2nd letter
 then after exhausting C labelling
D - 1st letter
 A-Y - 2nd letter

FUSE LABELS:

U - 1st letter
 A-Y - 2nd letter

TERMINAL BOARD LABELS:

R - 1st letter
 A-Y - 2nd letter
Terminal boards mounted in columns to be numbered consecutively from top to bottom.

AUX PANEL DEVICES:

Y - 1st letter
 A-Z - 2nd letter
Does NOT include fuses or terminal boards!

Following letters may be used in device labelling:

A, B, C, D, E, F, H, J, K, L, M, N, P, Q, R, T, U, W, X, Y

Following letters may NOT be used in device labelling:

G (confused with 6), I (confused with 1), O (confused with 0),
S (confused with 5), V (confused with U), Z (confused with 2),

SWITCHBOARD DESIGN SPECIFICATIONS
MONTANA-DAKOTA UTILITIES CO.
A Division of MDU Resources Group, Inc.

*******GENERAL DESIGN*******

These specifications describe the basic requirements for the design of electric substation control switchboards.

DEVICE SELECTION

Whenever possible, standard devices should be chosen from the list of "Preferred Materials for Switchboard Design". "Alternates" indicate device makes that are nearly equal in preference, while "Substitutes" should only be used when preferred devices are unobtainable, when it's necessary to conform with existing construction, or for another good reason.

DRAWINGS

Drawing approval will be required.

All drawings will be digitally reproducible in AutoCAD format and be acceptable to the purchaser. Scaled drawings shall be sized to print to scale on 22" x 34" paper prints:

The following drawings are required in association with the switchboard: **control cable connection diagrams** (from any device or equipment, to any device or equipment, where multi-conductor cabling is to be installed), **elementary (schematic) diagrams** (these drawings are to indicate exact wire between exact device terminals), **switchboard assembly diagrams** (dimensions for panel pieces and how they are assembled), **relaying one line, switchboard elevation layout** (showing device physical locations with dimensions) and **switchboard wiring diagrams** (showing rear views of devices and exact wiring from a device to the remote device via device address and terminal number.)

In addition, a **Switchboard Summary** (material list) shall also be produced in MS-Word format acceptable to the purchaser and sized to properly fit standard 8 1/2" X 11" paper.

Elementary diagrams and switchgear summaries both to show all switch contact arrangements.

All elementary diagrams will be made as point to point drawings. (These drawings are to indicate exact wire between exact device terminals.) All devices shall be clearly labeled with respect to ANSI/IEEE function number and the switchboard device address and exact terminal number on the appropriate control cable, elementary or wiring diagrams. A conscious effort should be made to produce orderly elementaries that are arranged for best clarity and ease of use. The elementary drawing's clarity should be optimized at the expense of the "physical" wiring. These drawings should include all necessary information, but individual drawings should not appear "cluttered".

Where the internal details of a very complex relay or device are not necessary for the scope of a particular drawing, the relay or device be reduced to a "box" (with leads identified) on that drawing. Details on the complex device must be made available elsewhere. Generally simple coils, output contacts, switch contacts, diodes, resistors, and other "basic" elements, etc. are adequate.

Switch contacts are to be shown as "open". However, switch contact arrangements shall be shown at a logical place relative to switch usage. Example, a 43R switch contact arrangement should be shown on either the circuit breaker close elementary or on the circuit breaker trip elementary for the circuit breaker to which it belongs.

Elements of potential and current circuits should be drawn ABC or ABCN, top to bottom or left to right wherever possible.

Elementary diagrams should indicate contact assignments on all multi-contact relays e.g. 86T, 86B, 86BF, 94, etc., all control switches e.g. 52CS, SS, 79/CO, 43R, 43M, test switches, multi-contact and micro-processor based relays, all circuit breaker or other device auxiliary switches, 52a, 52b, etc.

DEVICE INSTRUCTION BOOKS

5 - copies of instruction books are required for all relays, meters and other electronic devices.

CABINET CONSTRUCTION

Switchboard cabinets shall be designed and constructed in accordance with the latest revision of the "Switchboard General Specifications". Cabinets are to be 19" rack style, 3-sided with "open" rear sides. Cabinets to be a standard 47U height, 24" wide x 24" deep. Cabinets to have dress frame fronts, and full size side mounted sub-panels. Exposed sides are to be covered with solid sides. Unused areas of the front sides are to be covered by blank plates, 3U size or smaller.

Devices mounted inside the cabinet, such as transducers, surface mounted relays, auxiliary transformers, fuse blocks, terminal boards and the like that are mounted inside the cabinet, shall be mounted on a sub-panel, mounting track, mounting rail or grid, or unistrut, etc. intended for this purpose. Mounting tracks, rails, etc. may be welded in place or bolted to the cabinet rack mounting rails, or to cabinet side mounting rails such that the cabinet front face cover plates are not marred by screw heads etc.

Each cabinet to be equipped with 1/4" x 1" ground bus bar, drilled and tapped at 1" intervals for #10-32 machine screws. Ground bus bar to be mounted inside the cabinet, horizontally, near the bottom of the cabinet front. Each ground bus bar must have provision for connecting 1/0 to 4/0 stranded copper ground conductors at each end of the bus.

Cabinet finish to be painted ANSI #70 or ANSI #68 light gray.

Exact construction to be used must be shown with approval drawings. Cabinets must be rigid and self supporting. Cabinets must be designed and constructed so that reinforcements and wire ways do not interfere with subsequent maintenance or replacement of wiring or devices. In no event shall any rigid part of the cabinet or rigid-mounted device, wire way cover or other obstruction approach within 1-1/2" of wiring terminals.

CABINET ARRANGEMENT

Individual cabinets may be arranged in a single row, or (preferred) in two single rows with a single open aisle between the rear sides of opposite facing cabinets (similar to a duplex style arrangement).

The top of the cabinets is to remain essentially open to allow light to enter and free air ventilation. Any overall building/control cable entrance or any other design that blocks overhead lighting shall require additional switched AC and separate switched DC lighting to be installed inside cabinet areas.

A roofed and end capped "tunnel duplex" switchboard is not acceptable.

AUXILIARY PANELS

Fuses shall be mounted on auxiliary panels located at the top rear of the cabinet or on the cabinet sides. Other small devices will also be located on the auxiliary panels or on the cabinet sides. These devices should be arranged to best allow for future additions to be mounted on the auxiliary panels or cabinet sides. Auxiliary panels must not block working access to any devices/wiring behind them.

All swinging auxiliary panels over 28" in length should be split and hinged on both ends. All wiring is to be neatly bundled and brought to a hinged end so as not to impair the swing of the panel. Wiring to swinging auxiliary panels shall be 41 strand.

No tripping relay shall be mounted on a swinging panel.

NAMEPLATES

Nameplates shall be either engraved or commercial plasto-plate type, sizes as follows:

Panel Nameplates 3-1/2" x 1-1/2", 1/4" letters, 18 letters per line, 3-lines max.

Relay and device nameplates for devices mounted and showing on cabinet face, 2-1/2" x 1", 3/16" letters, 18 letters per line, 3-lines max.

Fuses and other devices mounted on rear of cabinet, on auxiliary mounting panels or on cabinet sides, 1-1/2" x 3/4", 1/8" letters, 15 letters per line, 3-lines max.

ORDER OF DESIGN

It is recommended that the following order be used in switchboard design:

- 1) Evaluate the basic needs, and select overall schemes to be used
- 2) Design a Relaying One-Line showing these schemes more specifically
- 3) Determine specific requirements for relays and devices required
- 4) Select and requisition relays, devices and other material needed
- 5) Design Switchboard Layout, based on standard locations and reflecting actual switchyard arrangement.
- 6) Prepare Switchboard Wiring Diagrams showing device locations, and terminal board assignments where possible.
- 7) Draw Elementaries keeping actual device locations in mind
- 8) Complete Switchboard Wiring Diagrams, according to Elementaries

*****BASIC WIRING STANDARDS*****

WIRING - GENERAL

All wiring shall be installed in a neat and workman like manner, and shall be adequately protected where necessary to maintain insulation integrity.

WIRING - CONTROL CABLES FROM REMOTE EQUIPMENT

All control cables will be brought into either the top or bottom of the switchboard depending on control house construction (overhead cable way vs house trench). Provisions must be made for routing, supporting and terminating the control cables along the outside of the appropriate terminal boards.

All terminal boards containing control cables for remote equipment should be grouped on the switchboard.

When cabinets are arranged in a "duplex" style arrangement, control functions typically go to the front cabinet, while current and potential may go to either front or rear as required. This includes breakers, CT's, PT's, transformers, supervisory and transfer trip equipment. On the switchboard wiring diagrams, these terminal boards should be labeled as to the device where the cable goes and terminals should be labeled as to the function.

All control cable conductors are to be terminated on the outside of the terminal boards (terminal board side away from cabinet front) in succession. For cables entering the switchboard from the bottom, this shall begin at the bottom terminal of the bottom terminal board (vertical position) working upward. For cable entering the switchboard from the top, this order is reversed, and connections shall begin at the top terminal of the top terminal board (vertical position) working downward.

Each 12 conductor control cable shall terminate on a single 12 circuit terminal board. Four conductor control cables bearing current circuits shall be terminated on four terminal short circuiting type terminal boards. No other connections are to be made to the outside of these terminal boards.

Where possible, connections shall be made at the switchboard or at the equipment to minimize the number of control cable conductors used. However, for circuit breakers, circuit switchers, motor operated switches, switches with position following auxiliary switches, and transformers, a minimum of 20% of control cable individual conductors should be left free for future use. Alternately, a completely spare control cable of a similar size may be installed after each 5th cable. All spare control cable conductors shall be terminated and grounded at the switchboard end. Jumpers may be used going from terminal board terminal to terminal board terminal, then the last connection shall be to the switchboard ground bus.

Color coding of 4 conductor control cable for current circuits only is BLACK – Phase A, RED – Phase B, GREEN – Phase C, WHITE - Neutral. The neutral is grounded only at the switchboard end.

Potential devices to have neutrals grounded only at the switchboard end.

Switchboard terminal boards may be used for terminating the power supply cables from the switchboard to the equipment when normal control cable gauge conductors are adequate for the ampacity required. Control cables may also be routed directly to AC or DC panel boards. DC and single phase (2 wire) AC should not be combined in a single control cable. Color coding for these cables should be the best compromise of NEMA standard colors for power circuits. For equipment requiring 3-phase or 3 wire AC, separate cables shall be used. When heavy gauge conductors are required for power distribution, these conductors or cables should be routed directly to AC or DC panel boards.

Shielded control cables provide the best electromagnetic and electrostatic shielding when both ends of the shield are grounded. However special attention must be given to protecting the shield from being damaged by heavy stray fault currents. There must be sufficient ampacity developed either by the number of shields, or by parallel ground conductors laid in the same trench. In cases where it is impractical to do this, the shield may be grounded only at the switchboard end. However it must be recognized that the electromagnetic shielding is then lost, and a possibly harmful high voltage may develop on the ungrounded shield at the equipment end of the cable. (Depending on the geometrical and electrical characteristics of the installation).

Switchboard grounding of control cable shields shall be directly connected to the switchboard ground bus.

Only Shielded control cables shall be used.

WIRING - FIBER OPTIC CABLES FROM REMOTE EQUIPMENT

1 - Fiber optic cable shall be run from a patch-panel with a 96 fiber count capacity to each circuit breaker. Patch-panel to be mounted on a control house interior wall at a convenient location for running cable to switchboard and to switchyard equipment. A minimum of 12 simplex optical fibers per cable. Fibers are to be multimode, and either 62.5µm or 50µm. Cable to be rated OFNP, Plenum rated, orange color. Cable is to be dry type, not gel-filled. Fiber optic cables are to be run in conduit with other control cables. Termination of fibers to be by MDU.

WIRING - INTER-CABINET

All interconnections between switchboard panels shall be through terminal boards, except ground bus bar. This method of interconnection will allow panels to be separated for shipment. Interconnecting wire is to go from the outside of a terminal board in one cabinet to the outside of a terminal board in another cabinet.

Interconnecting wires shall more or less start at the terminal board at the opposite vertical position from the control cable starting point. Interconnecting wires are to be connected on the outside of the terminal board.

Terminal boards for connection of RTU control, indication, and telemetering shall be grouped and arranged as shown below:

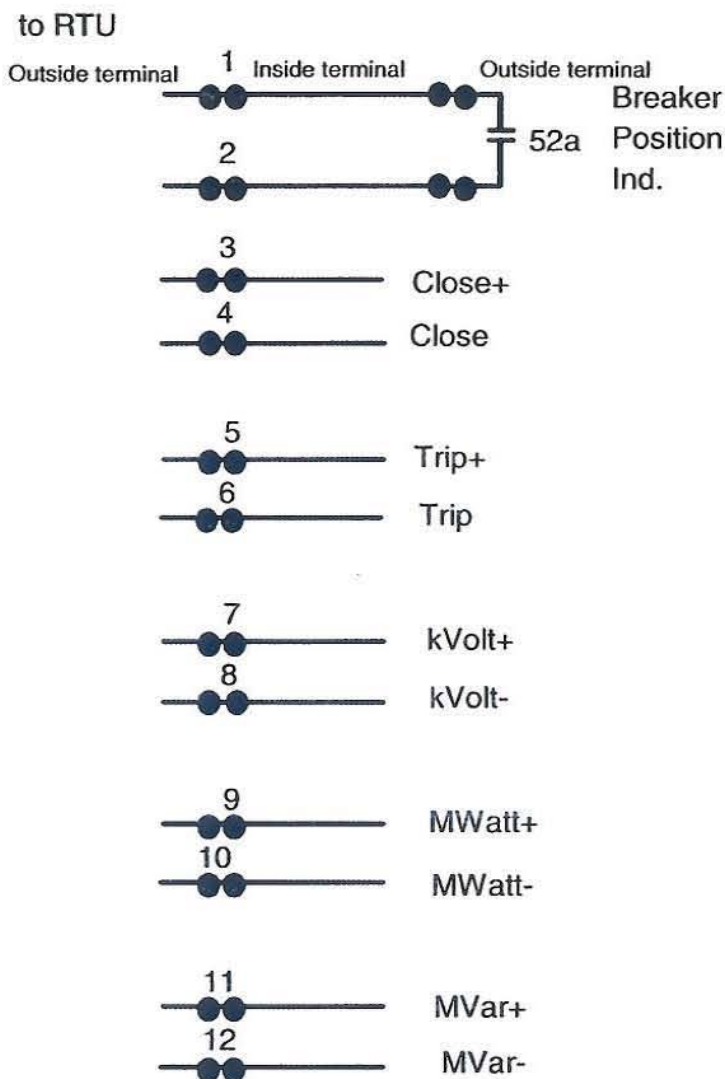
Where cabinets will be assembled in a "duplex" arrangement, wiring between front cabinets should be routed through an overhead wireway, mounted along the rear edge of the front cabinets (in-line with terminal boards). Wiring between rear cabinets should be routed through a similar wireway along the rear edge of those cabinets (in-line with terminal boards). Wiring trays are also to be provided at the top for front-to-back panel wiring, unless the building design includes a cable pit or trench system designed for minimal length wire runs between front and back cabinets.

Vertically routed wiring (control cables, inter-cabinet wiring, etc.) should be enclosed in perforated or slotted wire ways of suitable size with removable covers.

Particular attention must be made to the length and bundling of front-rear inter-cabinet wiring so that this wiring will properly fit the cable pit and buried conduit (or overhead cable tray if so designed).

Where cabinets must be separated for shipping or installation, the interconnecting wiring should be bundled and wires individually marked to facilitate reconnection at jobsite.

Circuit Breaker & Line C&I



WIRING - DEVICES

Connections should be limited to two per terminal in all cases, except control switches and hand reset lockout relays, which should be limited to one per contact.

All switchboard cabinet, device, and terminal designations shall be assigned according to the Standard Substation Switchboard Code, as shown in Appendix A.

With respect to terminal boards, potential and current circuits should be connected ABC or ABCN, top to bottom or left to right.

GROUNDING

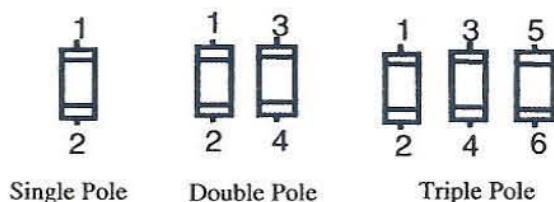
All individual circuits requiring "ground" connection should be terminated at the switchboard ground bus bar. No two individual circuit grounds should be connected together at a terminal board or other terminal. A circuit should be "grounded" at the bus bar only.

Grounding of secondary neutrals of remote switchyard devices, such as PTs, CVTs, or CTs shall be at the switchboard only. Their respective control cable neutral conductors shall be terminated at a switchboard terminal board, then the terminal board inside terminal shall be connected to the ground bus. From the terminal board inside terminal, a second conductor shall then begin the distribution of this specific neutral to all devices requiring connection to this neutral. The ground bus shall not be used to "distribute" a neutral.

FUSES

Fuses for each switchboard cabinet shall be mounted on hinged auxiliary sub-panels 8", 12" or 16" high and located at the top rear of each switchboard cabinet. Fuse sub-panels must not block the maintaining of wiring or devices behind it. Fuses should be arranged to allow for maximum additional future devices to be mounted on this panel.

Fuse terminals should be numbered as follows:



Fuses also to be identified with respect to: Fuse type and size, phase, voltage-AC, voltage-DC with (+) & (-), 3- V_o , and circuit name.

TEST SWITCHES

Test switches furnished shall be of FT-1 style test switches with "stud type terminals." FT-1 Test Switches are to be used in current and potential circuits of transducers and meters to allow testing of these devices while leaving other devices in-service. Tie/interconnection transducers shall have separate test switches from those used for tie/interchange meters. See "typical switchboard material list" for approved test switch types.

TRANSDUCERS AND PANEL METERS

Unless otherwise specified, transducers may be mounted on a sub-panel with the fuses, on a sub-panel mounted to a cabinet front plate, or sub-panel on the side of the cabinet. Cabinet location to be common with the line, etc. being metered, or in the cabinet common to the meters monitoring the same line, etc.. Watt/Var transducers are to be 3-element, 4-wire type.

Digital panel meters and transducers are to be powered from CCVT's or PT's on the line or bus being metered. Digital meter power supplies shall be unswitched, as many types of meters require a warmup time before accuracy is reached.

When pulses from WHDM's are recorded by separate devices, a 2 or 3-output isolation relay is to be used between each WHDM and the recorder leaving spare pulse outputs for SCADA-RTU. Relays are to be mercury wetted type with form C contacts. For tie/interchange meters only, new RTU installations are capable of direct digital polling access (Modbus protocol presently used).

LOCKOUT RELAYS

Lockout relays should be wired to:

- 1) Trip respective breakers or circuit switchers, etc. directly
- 2) Block auto-reclosing and drive reclosing relays to "lockout".
- 3) Block all closing of tripped breakers
- 4) Initiate breaker failure relaying (when used)
- 5) Provide indication to annunciator and RTU
- 6) Key transferred trip or carrier circuits where applicable
- 7) Short current circuits where applicable.

To facilitate maintenance, all used contacts from lockout relays should be brought out to terminal boards and terminated in succession. All normally open tripping and indicating contacts used should be wired through SPST FT-1 style test switches to allow testing of lockout circuits, and also allow test tripping of individual breakers. (Contacts wired to short circuit current circuits going to "operate" coils of relays must not be wired through test switch contacts.) Unless otherwise noted, two spare normally closed and four spare normally open contacts shall also be brought out in this fashion. Contacts on the lockout should be used in numerical order, leaving spares on the rear end. Test switches should be ABB "Flexitest" type FT-1 or similar with stud type terminals and 10 potential type poles.

Lockout relays and associated test switches shall be supplied with maximum number of contacts available on these devices.

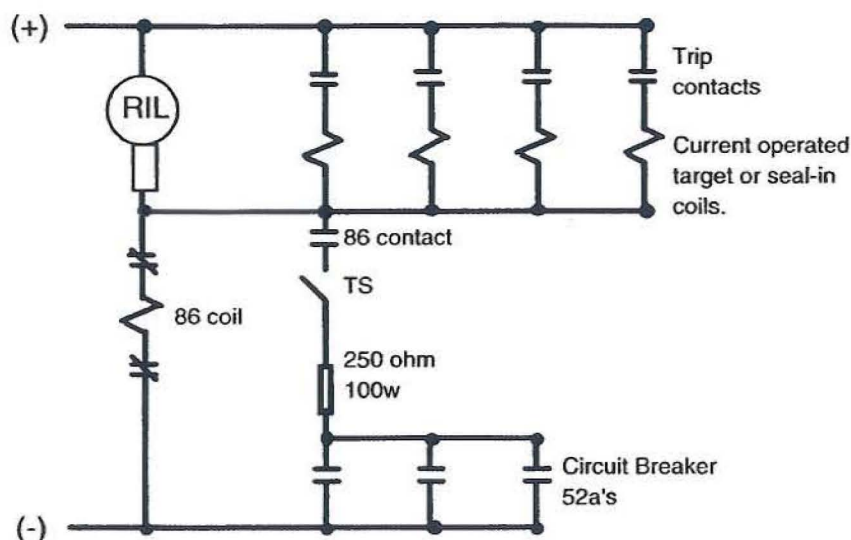
Lockout relays shall have a red indicating light located directly above them. This light shall indicate continuity of the lockout relay trip circuit.

Differential cutout switches shall be connected to short circuit appropriate terminals of electro-mechanical differential relays (if used), give indication to appropriate annunciator point if available, open the DC tripping contact circuit of the differential relay and, if all tripping of the lockout is blocked, open the red indicating light circuit to indicate an "Out of Service" condition. When micro-processor type differential relays are used, differential cutout switches shall assert a relay digital input when the cutout switch is in the "Normal" or "Differential In-Service" position.

LOCKOUT RELAY TARGET-PULL CIRCUIT

Due to the high operating speed of the type LOR relay, target setting may be unreliable on the initiating relay. For a breaker failure lockout or other lockout having only a single initiating relay, target setting will not be a concern, as there can be little doubt as to which relay initiated the trip.

However, when there are multiple electro-mechanical initiating relays that require sufficient time & current to set targets, the lockout circuit should include a provision for insuring proper targeting. This can easily be accomplished with the addition of the circuit shown below. The 52a contacts may be from one or more of the breakers or switchers that the lockout trips, as long as there is certainty of at least one of these contacts being closed before the lockout operates. Note that this circuit will not affect the proper functioning of the red light. This circuit is not required if all initiating relays used are micro-processor based.



PROTECTIVE RELAY A.C. CIRCUITS

Wherever possible, primary, secondary, and breaker failure relays shall utilize separate current transformer circuits. Otherwise, secondary and breaker failure relays may share a common current circuit. Indicating metering may be applied to CTs used in the secondary relay circuit.

A.C. potential circuits to primary relaying, secondary relaying, metering, synchronizing and fault recording devices shall all be fused separately.

PROTECTIVE RELAY D.C. CIRCUITS

For electro-mechanical and other discrete relays, primary protective relays and their associated auxiliary relays shall be fused separately from secondary protective relays and their associated auxiliary relays.

Each lockout relay circuit shall be separately fused.

Breaker failure relaying and auxiliaries shall always be placed on an individual, separately fused D.C. circuit on a per breaker basis.

Micro-processor based or other relays having separate DC power supplies shall be separately fused.

In addition to separate DC fusing, primary relay schemes are to be grouped together on one DC distribution panel circuit breaker. Separately DC fused secondary relay schemes are to be grouped together on a second DC distribution panel circuit breaker. Separately DC fused breaker failure relays and their lockout auxiliaries shall be grouped together on a third DC distribution panel circuit breaker. Separately DC fused transformer differential and sudden pressure lockout relays may be divided between primary relay and secondary relay DC distribution panel circuit breakers. Separately DC fused bus differential relays and other assorted backup relays may also be divided between primary relay and secondary relay DC distribution panel circuit breakers.

Separately DC fused annunciators, communication processors and other miscellaneous DC power supplies should be on a third DC distribution panel circuit breaker.

DC supplied to tone equipment should be grouped into primary and secondary (when two sets exist) and then each to be supplied from separate DC distribution panel circuit breakers from other equipment. Other carrier communication, and telephone communication equipment to have separate DC distribution panel circuit breakers.

TRIPPING RELAYS

Auxiliary tripping relays (when used) shall be high speed (1/2 cycle pickup) and should have a low enough impedance or should be loaded to draw sufficient current to pick up any two associated targets simultaneously. All protective relays that trip breakers shall also initiate breaker failure relays. Where necessary, a separate high speed auxiliary relay in parallel with the tripping relay coil may be used for providing breaker failure initiation for breakers being tripped. (A double unit AR is ideal for this use). The tripping and breaker failure initiate coils above should have trip coils in series with the 52a (and 86BF and 43R switch where used) contacts of the tripped breakers for allowing reset after trip.

No tripping relay shall be mounted on a swinging panel.

Auxiliary tripping relays shall be in drawout cases, preferably ABB Flexitest.

Relays used for an incoming direct transferred trip (94TT) may need to have normally closed contacts for opening the tripped breakers' close circuits. Such an arrangement is usually necessary for interlock type schemes or other instances where constant receipt of trip can hold a 94 relay in the trip position for extended periods.

All D.C. protective relay circuits shall have an indicating light showing D.C. potential. (Micro-processor based relays include indicating lights and power supply alarms to satisfy this requirement.) Wherever possible a RED indicating light should be connected in series with an electro-mechanical tripping relay coil so that the light will indicate continuity of the tripping relay coil as well as D.C. potential. On relay coils of 1-100 Ohms, use a 125 VDC red indicating light. On relay coils of 100-200 Ohms use a 120 VAC red indicating light. In cases where the tripping relay coil is shunted by resistors for target draw, or is paralleled by another relay coil, such as breaker failure initiate relay, the tripping relay coil shall be isolated on the red indicating light by use of tripping duty diodes.

There are cases where the tripping relay coil cannot be isolated, or where tripping relay coil impedance is over 200 Ohms and will not sufficiently light the red indicating light. In such cases, a WHITE indicating light rated 125 VDC is connected across the D.C. protective relay circuit to indicate D.C. potential in place of the red light.

In many cases micro-processor based relays intended for primary and/or secondary protection applications may be utilized to provide many of these auxiliary tripping functions, such as incoming direct transferred trip. This is accomplished by asserting inputs from communications equipment, etc. thus reducing the requirement for extra devices. In these cases, output contacts must match the function requirements of auxiliary relay contacts, such as maintaining a contact closed in a trip circuit, or maintaining a contact open to block breaker closing for a direct transfer tripping scheme.

BREAKER TRIP CIRCUITS

Trip circuits of circuit breakers shall be kept as clean as possible, (no unnecessary auxiliary devices). However the breaker green (open) indicating light shall be wired on the trip circuit, to show trip circuit is intact before closing.

When circuit breakers have primary and secondary trip coils, caution must be used so that proper DC polarity is applied to each trip coil to avoid magnetic flux canceling.

ALARM POINTS AND INDICATING LIGHTS

A closed contact is considered to be an abnormal condition.

Green, red, and amber indicating lights indicate "Manual", "Supervisory", and "Auto" positions respectively on 43/MSA, which is a selector switch for either a load tap changing transformer or a voltage regulating transformer. (M=Local Manual control, S=Remote Supervisory control, A=Local Automatic control)

Blue indicating lights are used in breaker control circuits to indicate "Low Pressure" or "Trouble" and are to be wired in the breaker close circuit.

Breaker position indicating lights (Red-Closed & Green-Open) are to be wired in the breaker trip circuit. The RED light shall monitor the breaker trip coil. When circuit breakers have primary and secondary trip coil circuits, there shall be one RED light utilized in each trip coil circuit.

Breaker indicating lights shall be located Green - Blue (if used) -Red, left-to right, front view, directly above 52/CS on switchboard.

Any protective relay capable of tripping a circuit breaker shall have a target, either internally or separately, to indicate specifically which relay initiated a particular trip. Where tripping can take diverse paths, target relays shall be provided to indicate which trip path was taken.

TRANSFER TRIP LIGHTS & ALARM

If the lights for guard and trip are located on the switchboard, provisions shall be made to have them fused in a non critical circuit. (See "Protective DC Circuits" above.) A red light shall indicate continuously as long as guard is received. Upon loss of guard, the red light will go out and operate a point on the annunciator. An amber light shall indicate only when a trip signal is received. A blue light will indicate a "LOS" or loss of signal.

SYNCHROSCOPE

In substations near generating plants, or where dynamic synchronism conditions may exist, lines having synch check relays shall also have provisions for breaker closing with synchroscope equipment. Manual (52CS) closing is enabled by operation of the synchronizing switch. SCADA closing contacts must be isolated from this close path.

Synchroscope equipment shall be located in a position visible from all breaker control switches. Synchroscope equipment includes synchroscope, bus and line voltmeters and two 120VAC series connected indicating lights. Voltmeters may be labeled as "Running" (system) and "Incoming" (generator).

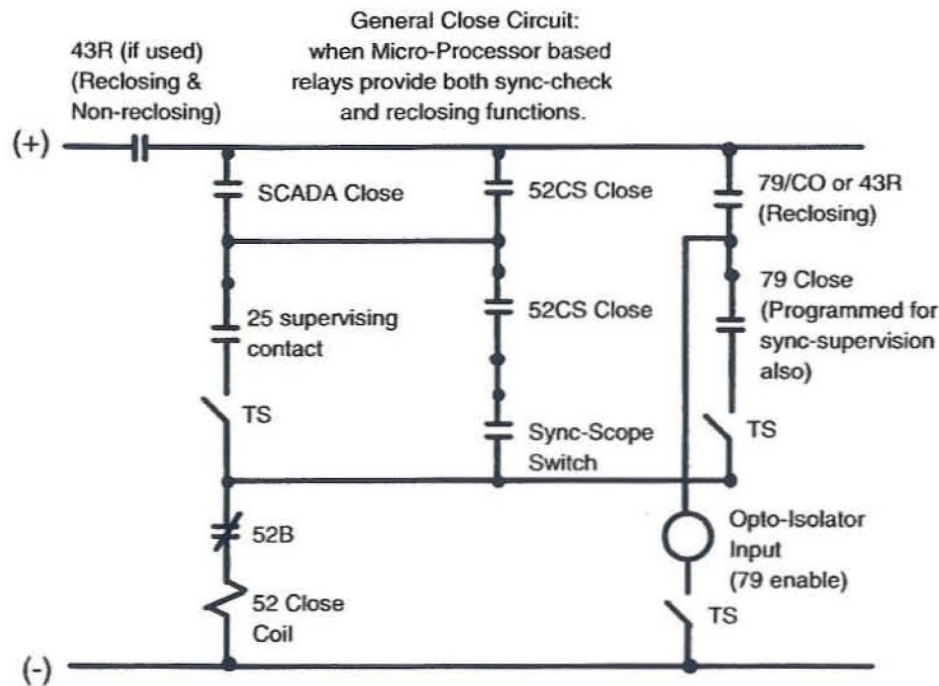
All synchroscope switches shall have a removable handle keyed alike for all breakers in a substation. Manual (52CS) closing, unsupervised by synch check relay, is enabled by operation of the synchronizing switch.

SYNCH-CHECK

Synch-check relays are to be wired to allow 52/CS or SCADA closing for Synch-check, Dead Line, or Dead Bus, regardless of position of 43R switch (if used), and regardless of automatic reclosing conditions of synchronism, dead line, etc. A tripping duty diode is may be used with relays requiring diode isolation to allow this logic in the synch-check relay wiring. Some sync-check relays do not require use of a diode.

In micro-processor based relays, sync-check functions are normally programmed in the relays when the functions are available. A 25 supervising output contact from the relay for 52/CS or SCADA closing is required. This represents a parallel close path separate from the relay closing contact.

Relay supervised synch-check closing is separate from, although parallel to a manual synchroscope assisted close. SCADA closing contacts, however, must be isolated from the manual synchroscope assisted close path. This is typically done by using two 52cs close contacts as shown in following detail.



*******SPECIFIC SCHEMES*******

OVERALL DESIGN

As an overall design standard, relaying schemes shall be straightforward and predictable in their philosophy and implementation.

Schemes should be designed to best exploit the inherent advantages in the relays to be used. Micro-processor based relaying packages are preferred for all applications.

Any unusual schemes installed must be supported by complete documentation including an explanation ON THE APPROPRIATE ELEMENTARIES.

BREAKER FAILURE

All circuit breakers 115KV and above must have breaker failure relaying. Lower voltage breakers may require breaker failure protection depending on application or substation bus arrangement. All circuit breakers in a ring bus or breaker and a half scheme shall have breaker failure relaying. Transfer tripping to remote substation circuit breakers is required at 230kV and above.

Breaker failure relaying must be able to detect a failure to interrupt current on any phase as well as the failure of the circuit breaker to operate mechanically. Note that some breaker failure relays (such as SBF1) seal-in an initiate pulse, while some schemes do not. Where such seal-in is not provided, the initiating relay (such as a 62X) must not reset with the opening of a 52a switch.

Breaker failure relays should not be initiated by SCADA or manual (52cs) trips.

One normally open contact of the breaker failure lockout relay should be connected to trip the circuit breaker. This contact will "short" across the tripping contacts of the primary protective relays and allow relays to reset without damage. This contact also represents a "last ditch" attempt to trip the circuit breaker. This means is especially preferred where micro-processor relays provide both primary relaying and breaker failure functions.

REACTOR RELAYING

Reactor banks will have control and indication of reactor breaker closing by "AUTO or MANUAL". This will allow for the same type of control as exists on our transmission voltage regulators. In the event of any control malfunction, the dispatcher will be able to place the reactors on full manual control by SCADA. The reactor breakers should now also have maintenance switches "43R" that can be used at the station to individually put each reactor breaker on manual, or easily take one out of service in our normal fashion. Note that SCADA (as well as the red "AUTO" light on the switchboard) will indicate "AUTO" close enabled if either one of the two reactor breakers is under automatic closing control.

In the case that the 230KV breakers are all opened (or one fails and 86BF operates), the reactor breakers should immediately trip to prevent unnecessary voltage depression. However this trip is only temporary and the reactors could be closed either by auto control or by SCADA or manual control following a 1.0 second, timed trip output, if they are needed.

TRANSFORMER PROTECTION

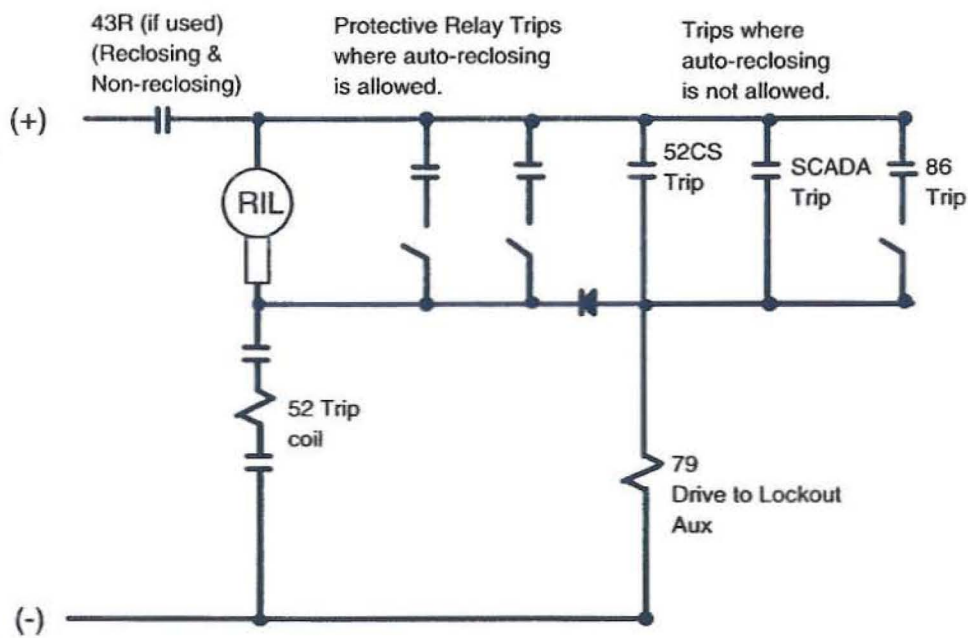
Transformer fault pressure auxiliary (63FPX) is to trip a separate lockout (86FP) from transformer differential (87T) and lockout (86T) unless a separate backup transformer differential (87T/BU) and lockout (86T/BU) exist. All power transformers are to be protected by 2-lockouts.

Transformer hot oil temperature relay (49T) is to trip appropriate breakers to remove load from the overheated transformer without de-energizing the transformer, so that station service will remain intact to power transformer fans and pumps.

Transformers having oil pumps shall have the pumps de-energized upon the operation of either a fault pressure lockout (86FP) or differential lockout (87T).

TRIPPING TO BLOCK RECLOSING WHEN USING 3 SHOT RECLOSING RELAY

When micro-processor relays are used for multi-shot reclosing, a digital input is asserted by the 52CS, SCADA or any other relay trip functions where auto-reclosing should not be allowed. This is usually done by a small auxiliary relay asserting the digital input. The small auxiliary relay is isolated from the remainder of the breaker trip circuit by a tripping duty diode. Assertion of a digital input is then programmed to drive the recloser to lockout. See following detail:



Swing sub-panel wiring is to be 41 strand.

TERMINALS - FOR SWITCHBOARD WIRE

Terminal connectors shall be as follows:

Vinyl-insulated terminals	Burndy #TP14-10 - (16-14 wire, 8-10 screw) (only when necessary)
Un-insulated terminals	Burndy #T10-38 - (16-10 wire 3/8" stud) (only when necessary)
	Burndy #YAV14 - (20-14 wire, 8-10 screw)

TERMINAL BOARDS

Terminal boards shall be as follows:

Manufacturer	12 Circuit	8 Ticket	4 Circuit Shorting
General Electric	EB25A12W	EB25A08W	EB27A04S
Buchanan	Phenolic B112	Phenolic B108	

Other types may be acceptable upon approval. Samples will be required before other types or brands are approved.

Typical Switchboard Material List

Panduit "Panduct" Wiring Duct Type E, Cat. #E 1.5 x 1.5 LG6 (32-6 foot lengths)
 - Duct Cover for above, Cat. #C 1.5LG6 (32-6 foot lengths)
 Type E, Cat. #E4X3LG6 (64-6 foot lengths)
 - Duct Cover for above, Cat. #C 4LG6
 Wire Retainers for 4" duct, Cat. #WR4-C20

Unistrut Type A4000 Channel, Greenamel Finish. (16' Lengths)

Unistrut #10-32 Nuts without Spring for A4000 Channel Cat. #A3016-1032

Triple Pole Fuse Holder:

Littlefuse LH25030-3S, or Ferraz Shawmut 20313, or Marathon F30A3SP 1

Double Pole Fuse Holder:

Littlefuse LH25030-2S, or Ferraz Shawmut 20312, or Marathon F30A2SP 1

Single Pole Fuse Holder:

Littlefuse LH25030-1S, or Ferraz Shawmut 20311, or Marathon F30A1SP 1

#10S14 Incandescent Lamp, 115-125 VAC 10 Watt (Bulbs for synch indication lights)

#5625-3 Lamp Holder, Keyless, Plastic, One piece with screw terminals, 600 volts, 660 watt

General Electric Type ET-16 Indicating Lamps:

#0116B6708G3E	(Red)
#0116B6708G3D	(Green)
#0116B6708G3B	(Blue)
#0116B6708G3W	(White)

Panel meters: SATEC PM130P-U-5-1AC-00-00 POWERMETER 120VAC 5A 120VAC-PS

Current Transducer: Scientific Columbus Model #CT-510A2, Moore PAC/0-5A/0-1MA/S/SM,
 Rochester UCX1F6, Electromagnetics CLE-202001

Voltage Transducer: Scientific Columbus Model #VT-110A2, Moore PAV/0-150 AC/0-1MA/S/(SM),
 Rochester UVX1F6, Electromagnetics CLE-201001

Watt-Var Transducer: Scientific Columbus Model #XLWV342K5A2, Moore PWV/120AC,SA-1
 Rochester WVS34U, Electromagnetics CLE-208004

Tie/Interchange meter - WHDM/VARHDM - Ametek JemStar

Potter Brumfield: Relay Type KUMP11D18, 110VDC Volt
 Terminal Sockets Type 2 27E121
 Mounting Track 3 foot lengths, Type 24A064
 Mounting Clips, Type 24A071

Burndy Hylug Wire Terminals Uninsulated for 9-10 Wire to 8-10 Screw #YAV9C-L36, No-substitute
 Uninsulated for 12-10 wire to 5/16" stud. #YAV10-T2, No-substitute
 Uninsulated for 20-10 wire to 8-10 screw, #YAV10, No-substitute
 Uninsulated for 20-14 wire to 8-10 stud, #YAV14, No-substitute
 Insulated for 16-14 wire to 4-6 stud, # TP14-6, No-substitute
 * Insulated terminals are to be used only when necessary!

ElectroSwitch series 24 type LOR-7810D Lockout Relay, 10 Decks, 30-140 VDC Coil, Hand Reset

Agastat #7012PE, 125 VDC, 10-200 Sec. on delay

Agastat #7022AE, 120 VAC, 60 Hz. 10-200 sec. off delay

ABB Auxiliary Relay Type MG-6 Style #1962-113, 24 VDC Operate Coil With Contact Cutoff,
 125 VDC Reset Coil, FT case.

ABB Auxiliary Relay Type AR Style #774B472A12. High threshold 125 VDC. Double Unit, FT case.

ABB FT-1 Flexitest Switch Style #S129A501G01S - 10 Pole Potential,
with stud terminals, PPPPPPPPPP
or, similar to States type FMS-10A-ST, with stud terminals, except with all black handles.

ABB FT-1 Flexitest Switch Style # S129A514G01S - 4 Pole Potential, 6 Pole Current,
with stud terminals, PPPCCCCCP
or, similar to States type FMS-10E-ST, with stud terminals, except with all black handles.

Megger/States FMS Style Test Switch: P/N 193R-330A-ST, Pos.A; B & C:
FMS-10A-ST, 19" rack mount; 3U high; 30 switch test switch block, Pos.A; B & C: 10P;
stud terminals, all switch handles to be "Black", and with standard Black covers

Megger/States FMS Style Test Switch: P/N 193R-330EH-ST, Pos. A: FMS-10E-ST; Pos. B & C:
FMS-10A-ST, 19" rack mount; 3U high; 30 switch test switch block, Pos. A: 4P6C; Pos. B&C: 10P;
stud terminals, all switch handles to be "Black", and with standard Black cover

Style #408C003G01 Tripping Diode, Type TRB

2 - Single sideband power line carrier systems housed in a cabinet with front and rear access, to operate with line frequencies in the 40-500 KHz range; operating temperature, -20C to +55C; 125 VDC power supply voltage; transmitter power, 100 watts; 50 ohm impedance to line tuner, single phase to ground coupling; frequency stability, + or - 5 ppm; spurious outputs, less than -60 dB; receiver sensitivity, -40 dBm; receiver selectivity, 105 dB or greater 4 KHz from either side of the operating channel; four 4 KHz Channels minimum, channel bandwidth of 300-3400 Hz; 4-wire external equipment interface with 600 ohm balanced transmit and receive impedance, adjustable from -25 dBm to +15 dBm; return loss, 26 dB or greater; distortion, 1% maximum; AGC, less than 1 dB change in audio output for an RF variation of + or - 20 dB; idle noise, -60dBmop or less.

2 - Wave traps - continuous 60 Hz current rating, 1600 amps; minimum blocking impedance, 1000 ohms, ambient temperature range, -40 to +50 C; horizontal pedestal mounting.

2 - Line tuners - wide band, phase to ground coupling; operating temperature, -40 to +60 C; up to 200 watts RF input; similar to Trench 4CL03A.

2 - Trench Electric NS40A tone relaying systems housed in a cabinet with front and rear access:

- Breaker Failure- Trench model NS40A12FA66ES2A2HJHJ; 125 VDC power and keying, 'D' logic, relay output and auxiliary relay, with dual transmitter and dual receiver test panels.
- Static Relaying - Trench model NS40A12FA11US1A4AXAX; 125 VDC power and keying, 'U' logic, relay output and auxiliary relay, with transmitter and receiver test panels.

1 - Substation line sharing switch - Teltone model M-396-B-01; 125 VDC power, 8 port., 19" rack mount.

EXHIBIT A.2

December 1, 2006 E-Mail & One-Line Diagrams

From: "Barnhart Sr., William E." <William.BarnhartSr@hdrinc.com>
To: "Raveling, Don" <don.raveling@mdu.com>
Date: 12/1/2006 3:36:41 PM
Subject: Tatanka Wind Farm - Interconnect Station Relay One line

Don,

Attached is a preliminary relay one line of the interconnect station. After you have had a chance to review, I thought we would schedule a face to face meeting to discuss the station in detail. I have included a preliminary general arrangement as I am not sure who should get it. If you have any questions, please feel free to contact me.

After you have had a review, let me know when a good time would be to meet. Thanks.

Bill

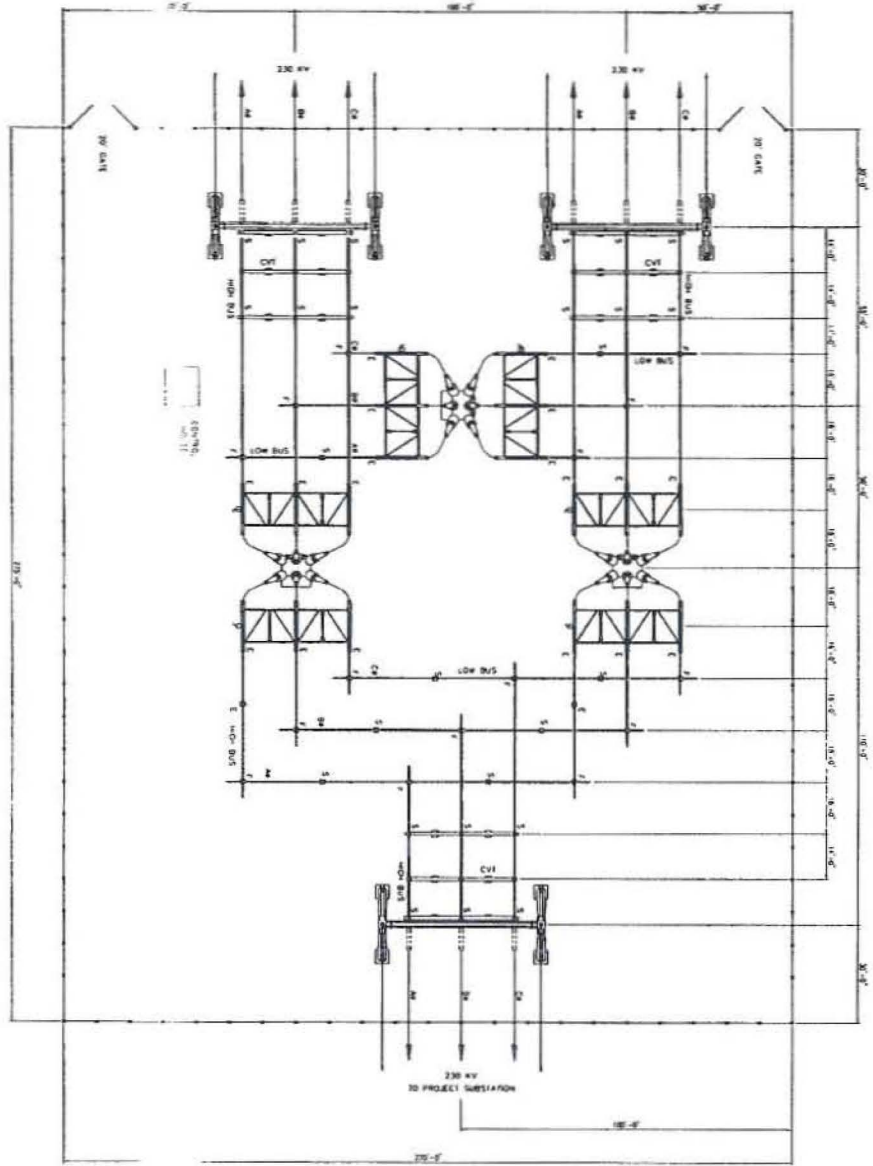
Bill Barnhart, Sr.

Senior Project Manager

HDR ONE COMPANY | Many Solutions

2913 Millennium Circle. | Billings, MT | 59102
Phone: 406.656.8100 | Fax: 406.652.2758
Email: william.barnhartsr@hdrinc.com

CC: "Ford, Henry" <Henry.Ford@mdu.com>, "Pat.Sims@mortenson.com"
<Pat.Sims@mortenson.com>, "Marcus V. da Cunha" <mdacunha@ehn-usa.com>

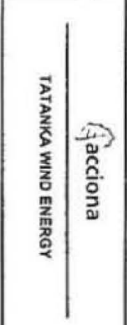


MORTENSON



NO.	DATE	DESCRIPTION
1	11.13.18	ISSUE FOR APPROVAL
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PRELIMINARY

INTERCONNECTION
SUBSTATION

DATE	REV.	BY	CHK.
11/13/18	1	JL	SL

SL-01

EXHIBIT A.3

January 31, 2007 E-Mail

From: "Barnhart Sr., William E." <William.BarnhartSr@hdrinc.com>
To: "Raveling, Don" <don.raveling@mdu.com>
Date: 1/31/2007 3:28:32 PM
Subject: RE: 013107 - G132 - Tatanka substation plan view arrangement

Don,

I think everything has changed since then. I have attached the plan that we finalized on. Depending how the transmission line comes in, we may be able to meet your interest. Right now we will have it south to north. Please don't hesitate to call if you have any questions.

Bill

Bill Barnhart, Sr.

Senior Project Manager

HDR ONE COMPANY | Many Solutions

2913 Millennium Circle. | Billings, MT | 59102
Phone: 406.656.8100 | Fax: 406.652.2758
Email: william.barnhartsr@hdrinc.com

From: Raveling, Don [mailto:don.raveling@mdu.com]
Sent: Wednesday, January 31, 2007 12:04 PM
To: Barnhart Sr., William E.
Subject: RE: G132 - Tatanka substation phasing

ABC west to east, north to south would be great for the ring bus, if possible. Have you changed the physical arrangement from drawing SL-01 dated 11/9/06? That arrangement wasn't very adaptable with respect to phasing.

Don Raveling - MDU

From: Barnhart Sr., William E. [mailto:William.BarnhartSr@hdrinc.com]
Sent: Wednesday, January 31, 2007 12:42 PM
To: Raveling, Don
Subject: RE: G132 - Tatanka substation phasing

Don,

Is ABC west to east; north to south; if possible.

Bill Barnhart, Sr.
Senior Project Manager

HDR ONE COMPANY | Many Solutions

2913 Millennium Circle. | Billings, MT | 59102
Phone: 406.656.8100 | Fax: 406.652.2758
Email: william.barnhartsr@hdrinc.com

From: Raveling, Don [mailto:don.raveling@mdu.com]
Sent: Wednesday, January 31, 2007 10:52 AM
To: Barnhart Sr., William E.; Watts, Holly
Subject: RE: G132 - Tatanka substation phasing

Bill, Holly,

The lines will dictate the phasing necessary with respect to the switching sub bus. We do like the subs to be ABC, but the arrangement you show on drawing SL-01 isn't very adaptable. However, you will have to adapt to the way the lines come into the substation. Holly will send that.

Don Raveling - MDU

From: Barnhart Sr., William E. [mailto:William.BarnhartSr@hdrinc.com]
Sent: Wednesday, January 31, 2007 7:52 AM
To: Watts, Holly; Raveling, Don
Subject: Tatanka

Good morning Holly,

Can you tell me what the phasing coming into the station will be at Tatanka. ABC west to east;

Don: Do you have a standard on your bus for phasing; ABC west to east; south to north?

Bill Barnhart, Sr.

Senior Project Manager

HDR ONE COMPANY | Many Solutions

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