Appendix A
Design Data Report

BISON I WIND PROJECT TRANSMISSION LINE
MORTON AND OLIVER COUNTIES, NORTH DAKOTA

DESIGN DATA REPORT

Project

- **Approximately 22.1 mile transmission line.**
- **Refer to Appendix E, Plan and Profile, for pole locations.**

Transmission Line

GENERAL SPECIFICATIONS

Voltage	230 kV
Height	**70 - 110 feet (wood); 80-150 feet (steel)**
Operating Capacity	629 MW
Average Span Length	900 feet
Structure Type	H-frame tangent structures
Minimum Conductor Size	1780 kcmil Aluminum Conductor Steel Supported (ACSS)
Shield Wire	7/16 inch
Right-of-Way	130 feet wide, 65 feet of right-of-way on each side of structure centerline and an additional 100 foot width to accommodate a future 230 kV transmission line
Average Pole Depth	10 to 12 feet
Average Pole Diameter	3 feet
Foundation Type	Direct imbed

Associated Facilities

GENERAL SPECIFICATIONS

Project Substation	
Substation Voltage	230 kV/34.5 kV substation
Approximate Substation Footprint	3 acres
Right-of-Way to be acquired (includes operation and maintenance building)	10 acres
Equipment	One 230/34.5 kV transformer, switchgear and control house, circuit breakers, surge arrestors, ring bus
Square Butte Substation Improvements	
Equipment	Addition of high-voltage switches, circuit breakers, power wiring, foundations and supporting structures, conduit, cable, and control equipment all within the existing fenced enclosure

Appendix B
Studies and Assessments
(Please refer to the October 2009 Application)

Appendix C
Agency Letters
(Please refer to the October 2009 Application)

Appendix D
December 2009 SHPO Correspondence

December 3, 2009

Merlan E. Paaverud, Jr.
State Historic Preservation Officer
Attn: Review and Compliance
State Historical Society of North Dakota
North Dakota Heritage Center
612 East Boulevard Avenue
Bismarck, ND 58505

RE: NDSHPO REF.: 09-0662 PSC Minnesota Bison I Wind Farm, Transmission Line(s), and Ancillary Facilities (T140-141-142N R83-84-85-86W, Morton and Oliver Counties)

Dear Mr. Paaverud:

We are writing to inform your office of a 3-mile route revision of the proposed 22.3-mile Bison I Transmission Line associated with the Bison I Wind Farm (Project) in Morton and Oliver counties, North Dakota (Figure 1). The revised route segment is located in T142N R84W Sections 34, 35, 36; and T142N R83W Section 31 (Figure 2). Project information has been previously reviewed by your office under the reference given above. The information provided below is for your review and comment, as appropriate.

The Bison I Transmission Line is subject to North Dakota Public Services Commission (NDPSC) review and no federal agency has regulatory authority over any aspect of this project; therefore, consultation under Section 106 of the National Historic Preservation Act (NHPA) is not required. However, MP understands that the NDPSC, per North Dakota Century Code (NDCC) 49-22-09, must consider the effect of the proposed route on existing historic facilities and structures, and paleontological and archaeological sites.

Minnesota Power (MP) intends to submit an application to the NDPSC for a Certificate of Corridor Compatibility and a Route Permit in mid-December 2009. A decision on the Certificate and Route Permit is expected in January 2010. Jerry Lien of the North Dakota Public Service Commission has indicated that SHPO concurrence is not need at the time of submittal or at the time of the hearing, but must be provided prior to construction. The North Dakota Public Service Commission has indicated they would like to see a plan for the revised Class III Resource Inventory incorporated into the mid-December 2009 submittal.

Between April and July 2009, HDR Engineering, Inc. (HDR) completed archival and field review of components of the Bison I Wind Farm site and provided a summary report to your office. HDR conducted fieldwork in August and September of the same year for the proposed Bison I Transmission Line. HDR proposes to complete additional research and survey for the revised route segment as soon as possible. All data gathered for the wind farm site and transmission line (original and revised) will be

incorporated into a single Class III report and submitted to you for your review and comment. MP is aware that Project construction cannot occur in areas that have not received review, and that you will need adequate time to review and comment on the Class III Report.

As documented in our previous correspondence and reporting, HDR and MP believe that a Class III Resource Inventory (in the form of a Class III Report) is appropriate to understand project effects to the resources that may be identified within the proposed route. HDR will review the archival information for the vicinity of the revised route segment to understand previously identified resources. Field review will include an approximate 200-foot wide corridor, centered on the revised route segment, that is sufficient to accommodate adjacent construction areas. As project development and refinement occurs, MP anticipates additional coordination with your office and reporting.

Please do not hesitate to contact me if you have any questions or comments on this letter or the cultural resources work for the Project or the transmission line. I am available at 763.278.5992 or Stephen.sabatke@hdrinc.com.

Sincerely,

HDR ENGINEERING, INC.

Stephen Sabatke
Principal Investigator

Enclosures: Figure 1: Project Vicinity Map, Proposed Transmission Route, Bison I Wind Project
Figure 2: Reroute Vicinity Map, Proposed Transmission Route, Bison I Wind Project

Cc: Jim Atkinson, Minnesota Power
Patrick Fahn, North Dakota Public Services Commission
Lydia Nelson, HDR Engineering, Inc.
Paul Picha, State Historical Society of North Dakota

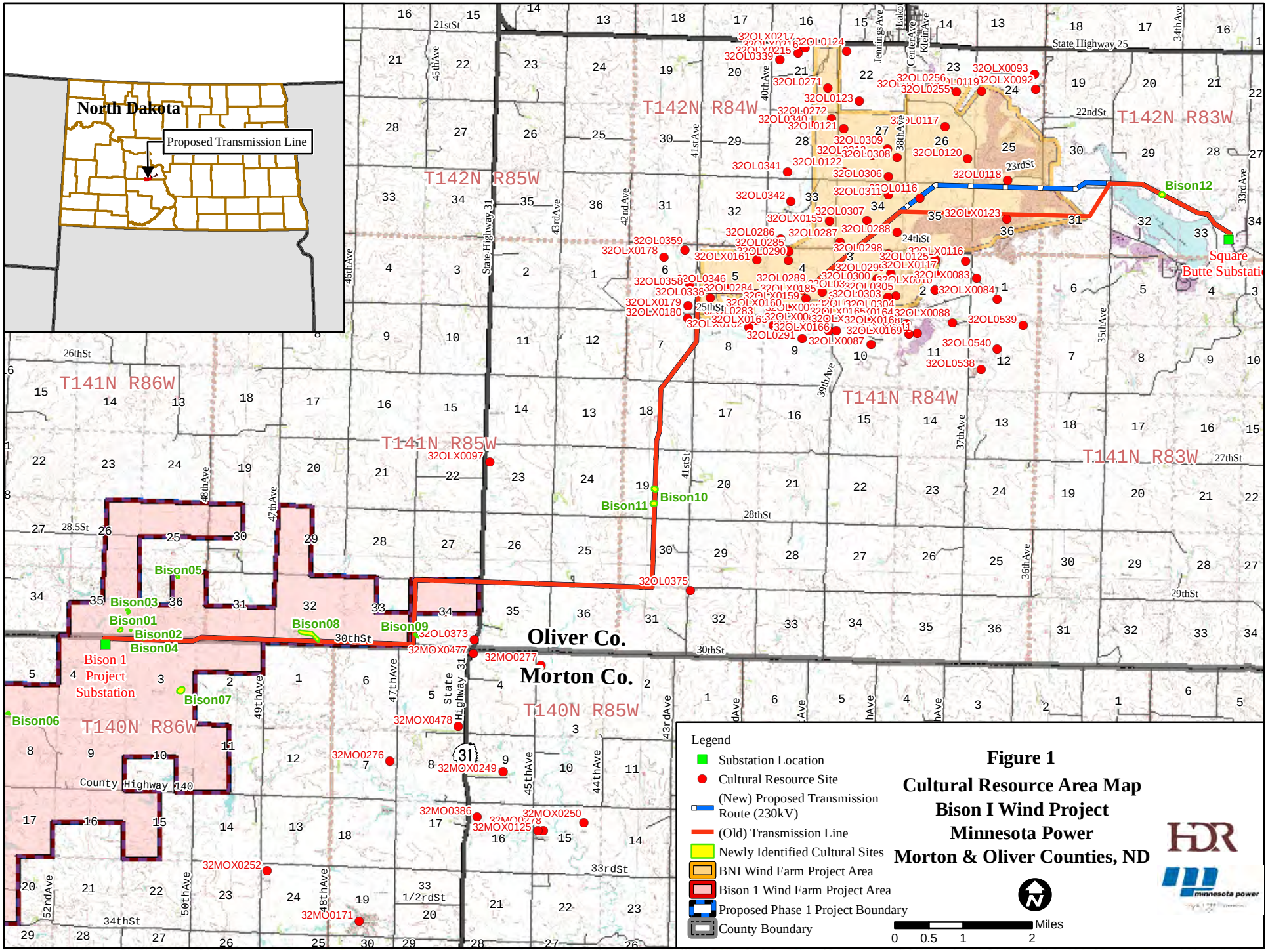

Figure 1
Cultural Resource Area Map
Bison I Wind Project
Minnesota Power
Morton & Oliver Counties, ND

Map Document: (Z:\MinnPower\106316\map_docs\mxd\Cultural Resources\OHT_CulturalResources_LetterSize.mxd)
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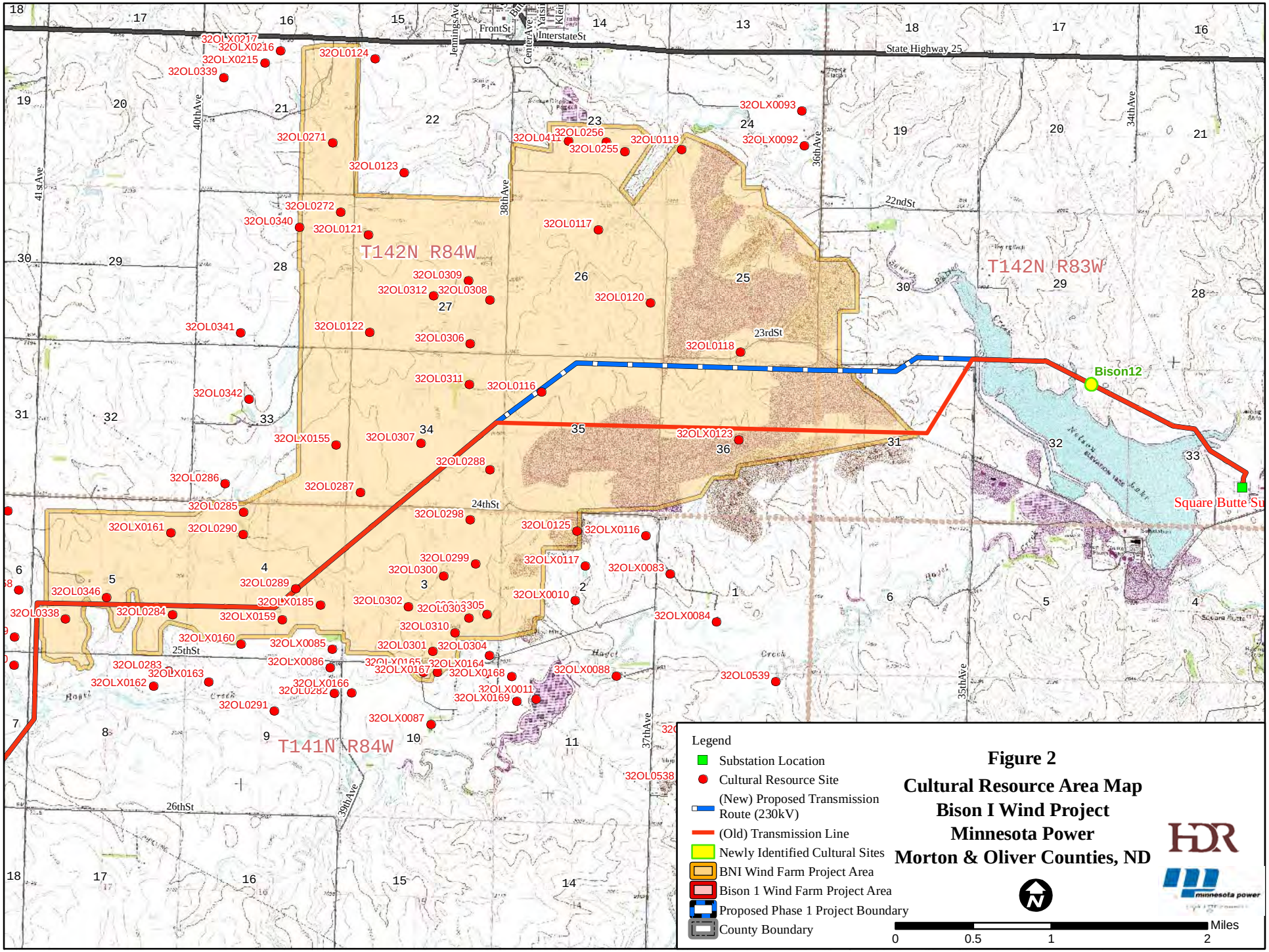

Figure 2
Cultural Resource Area Map
Bison I Wind Project
Minnesota Power
Morton & Oliver Counties, ND

Map Document: (Z:\MinnPower\106316\map_docs\mxd\Cultural Resources\OHT_CulturalResources_LetterSize.mxd)
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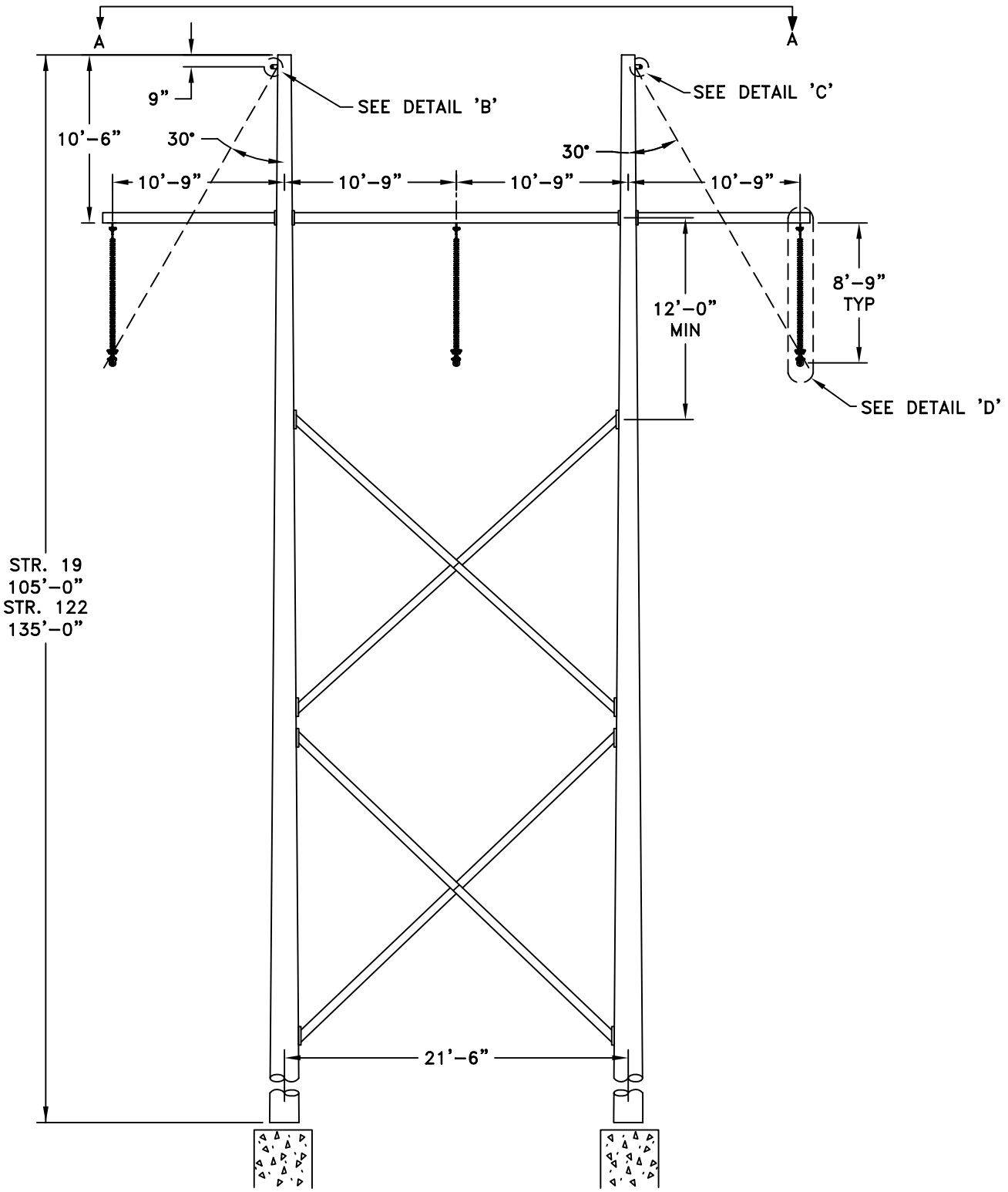
Appendix E
Plan and Profile



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		SHEET 1 OF 3	DB-E444-P497

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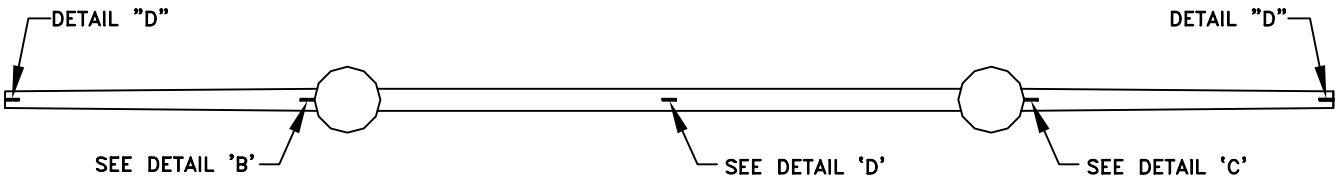
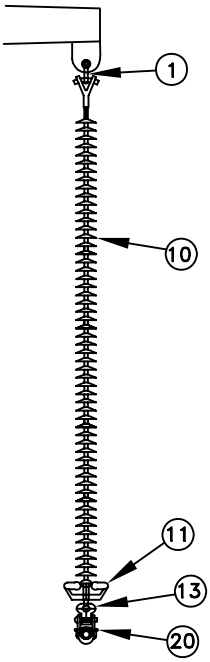


SECTION B–B



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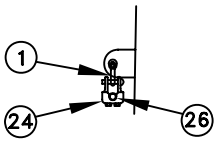

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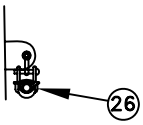

DETAIL "C"

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		SHEET 2 OF 3	DB-E444-P497

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BILL OF MATERIAL

ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	4	Anchor Shackle
10	3	Suspension Insulator 230KV L=101" RTL=12.5 KIP
11	3	Corona Ring Dia=8"
13	3	Socket Eye
20	3	AGS
24	1	Suspension Clamp for 7/16" ST
25	1	OPGW Suspension with Clevis
26	1	Armor Rod for 7/16" ST
		POLES AND FIXTURES
	* 2	Poles
	* 1	Crossarm Between Poles W/Mounting Hardware
	* 2	Crossarms Outside Poles W/Mounting Hardware
	* 2	X-Brace Assemblies W/Mounting Hardware

* Material included as part of structure assembly
Member Sizes and Mounting Hardware
Quantities and Dimensions to be
Determined by Structure Manufacturer

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 19,122 TYPE HF-TANG STR. B.O.M.
		SHEET 3 OF 3 | DB-E444-P497

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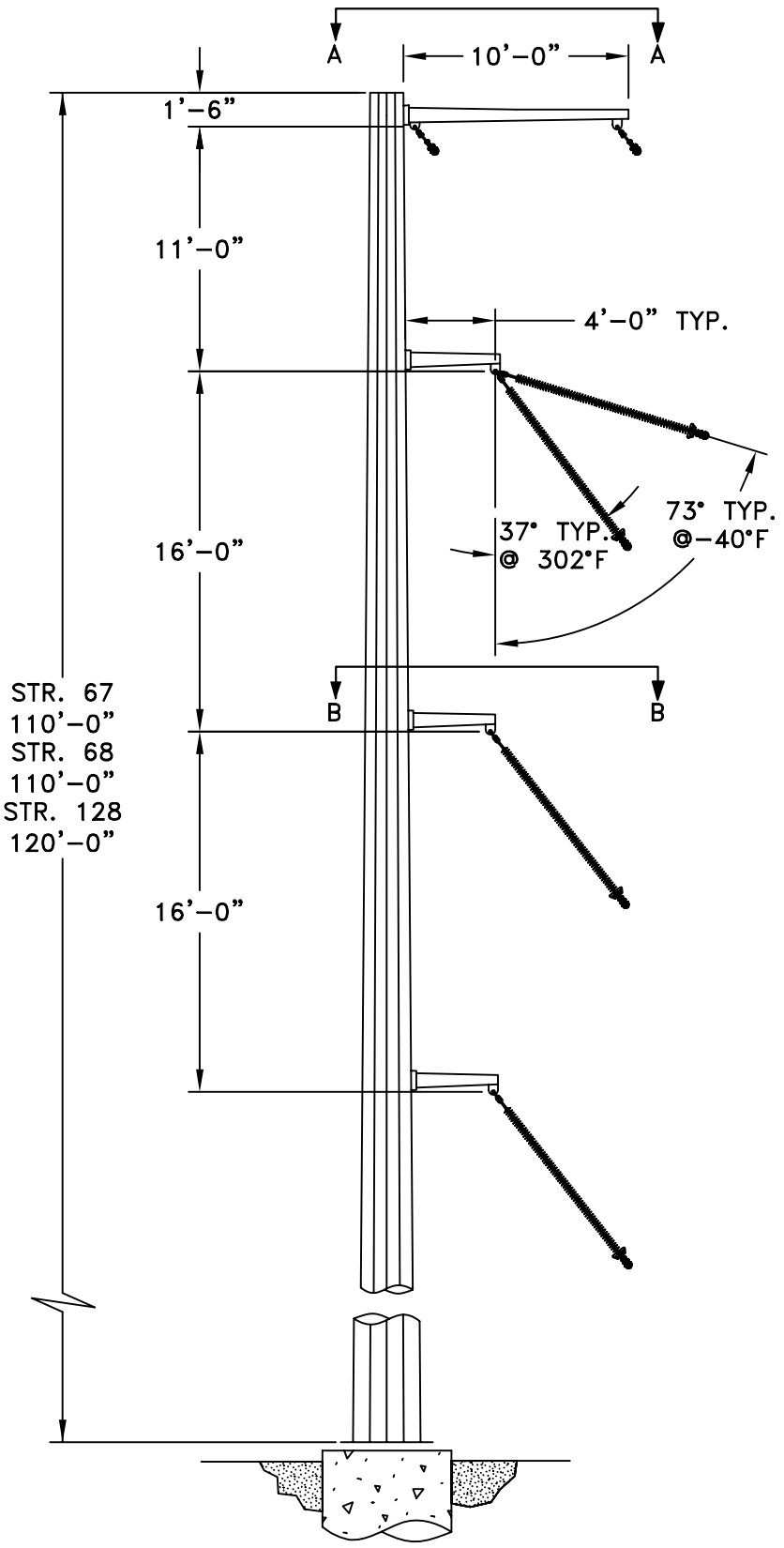

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		SHEET 1 OF 4	DB-E444-P498

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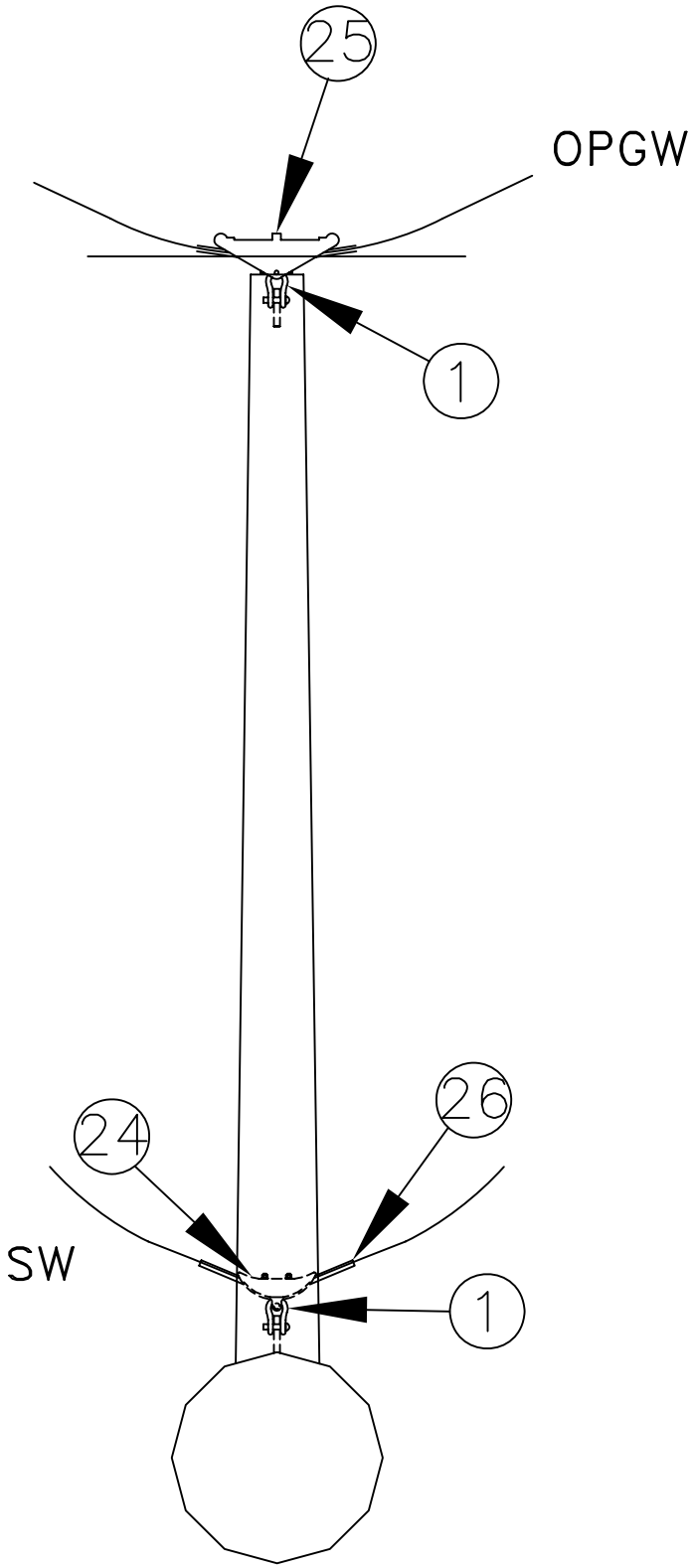

SECTION A–A

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		SHEET 2 OF 4	DB-E444-P498

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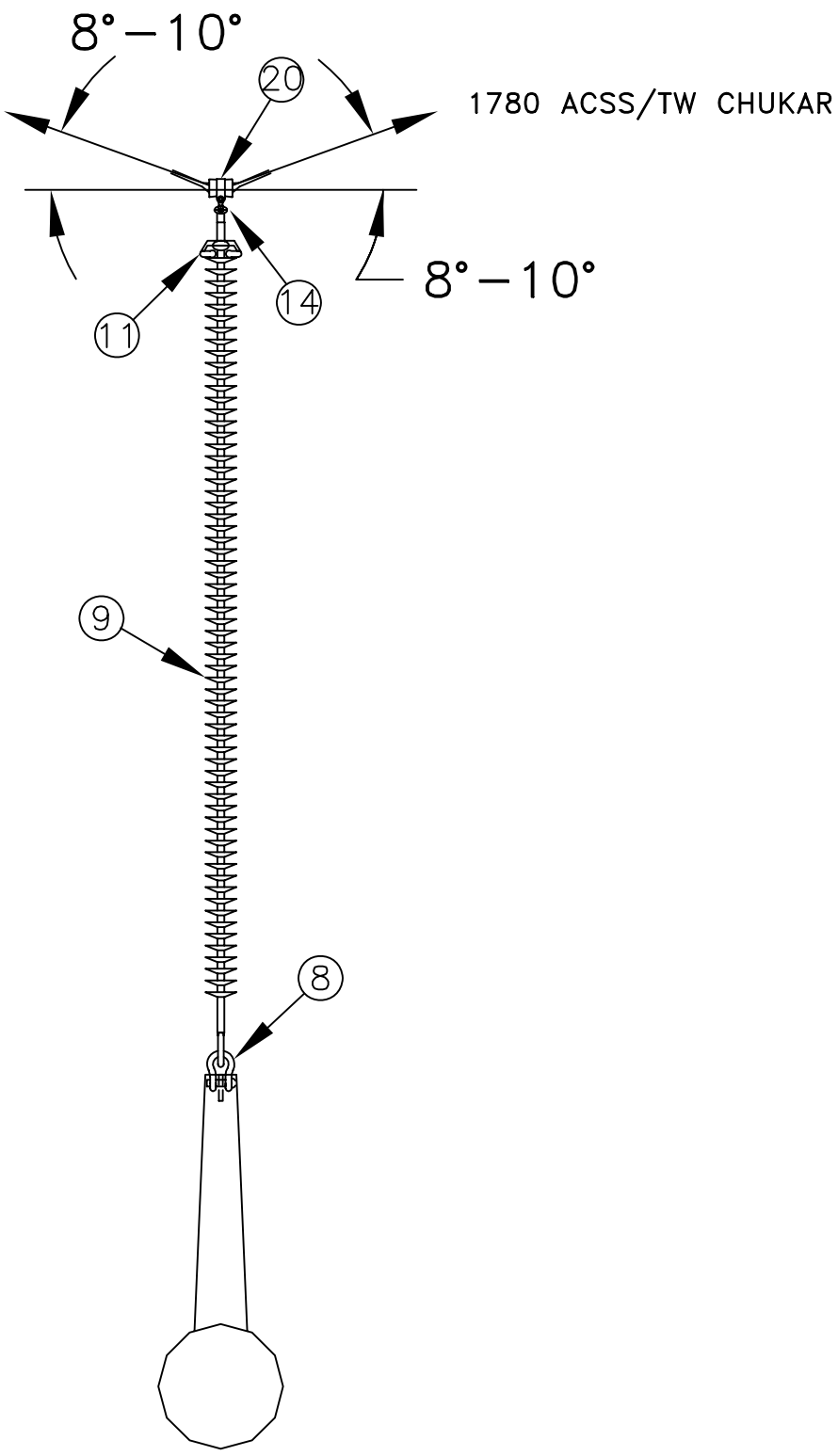

SECTION B–B

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 67,68,128 TYPE SC-MA STRUCTURE ASSEMBLY SHEET 3 OF 4 | DB-E444-P498

FILE:

BILL OF MATERIAL

ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	2	Anchor Shackle
8	3	Anchor Shackle
9	3	Suspension Insulator 230KV L=106" RTL=25 KIP
11	3	Corona Ring Dia=8"
14	3	Socket Clevis
20	3	AGS
24	1	Suspension Clamp for 7/16" ST
25	1	OPWG Suspension
26	1	Armor Rods for 7/16" ST

* Material included as part of structure assembly

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 67,68,128 TYPE SC-MA STR. BILL OF MATERIALS	
		SHEET 4 OF 4	DB-E444-P498

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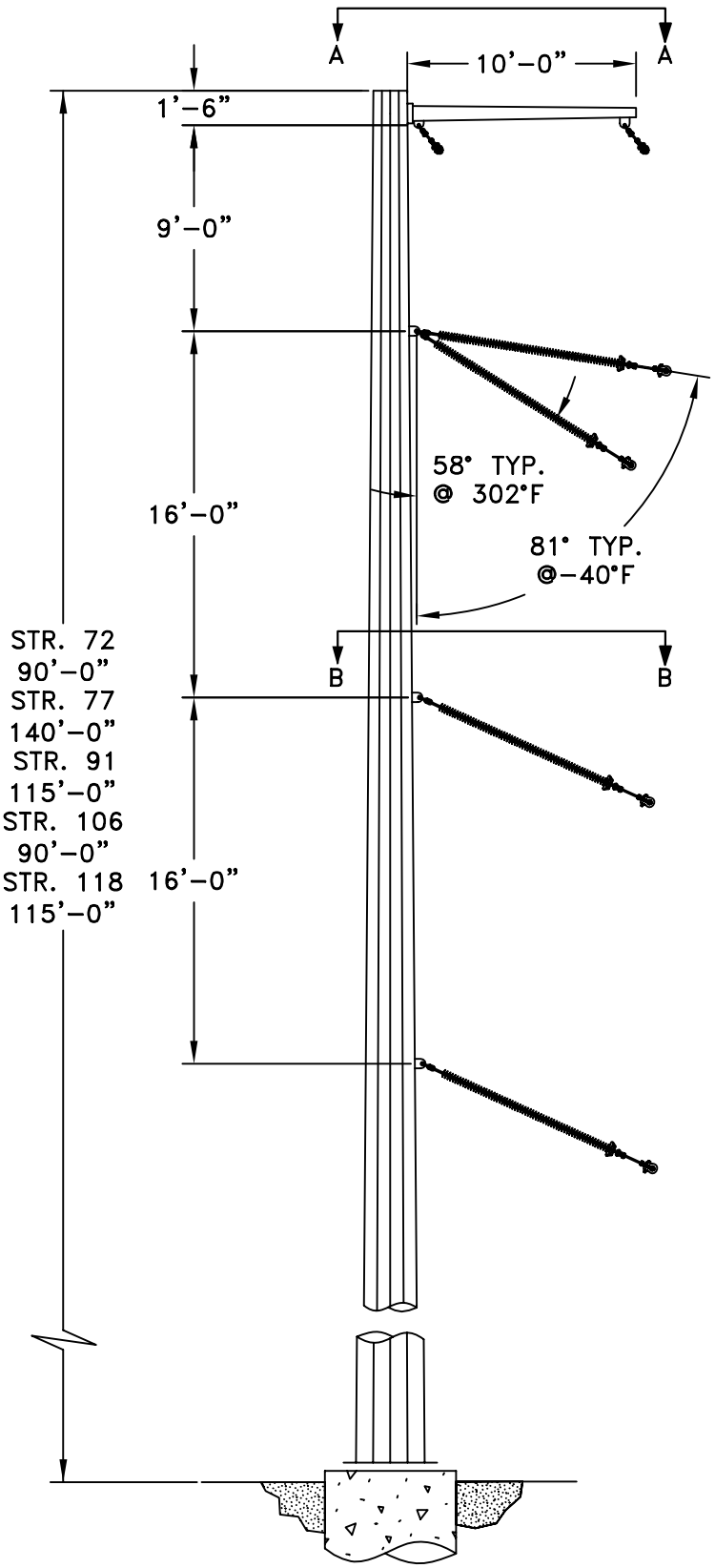

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		SHEET 1 OF 4	DB-E444-P499

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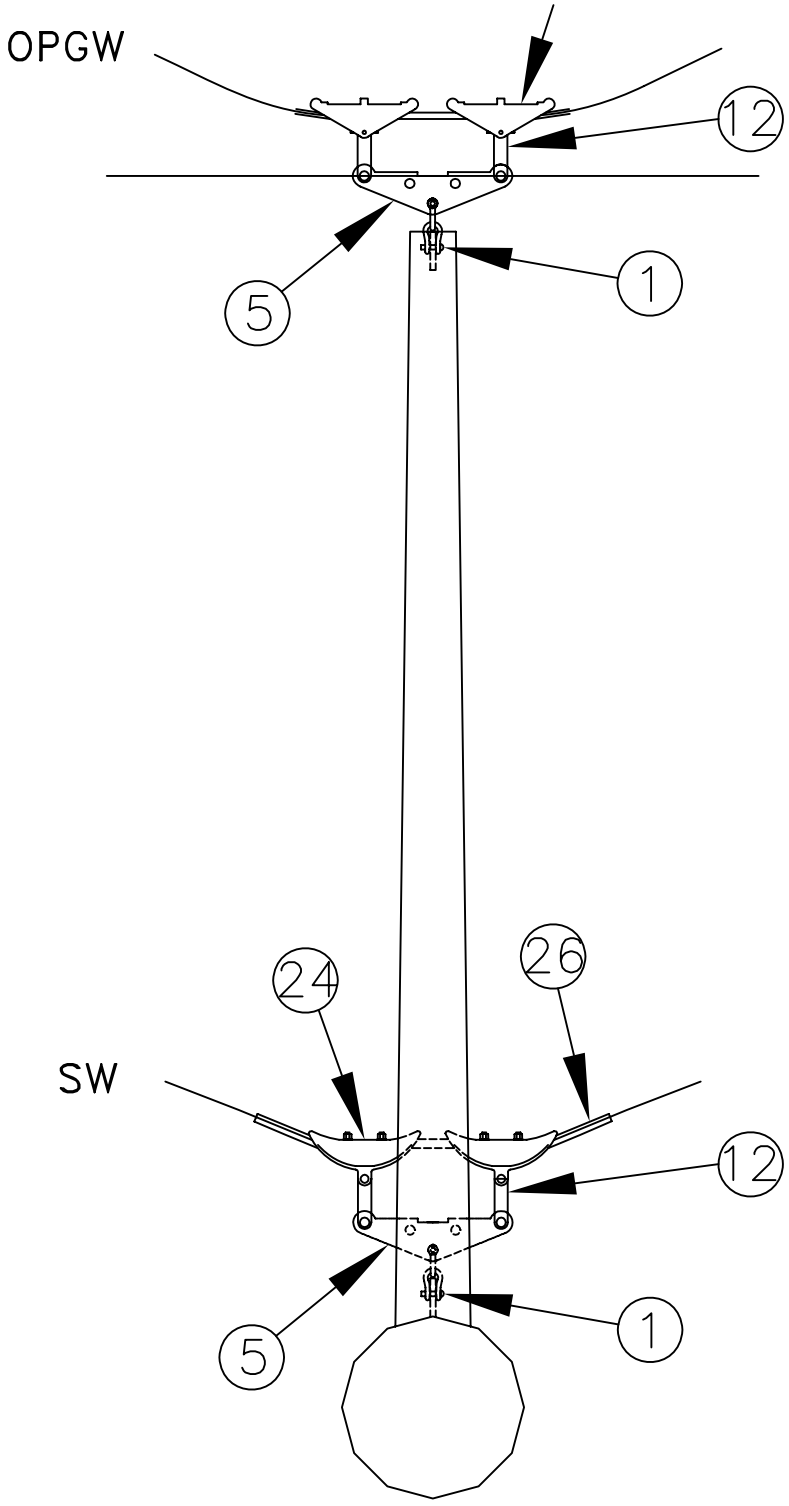

SECTION A–A

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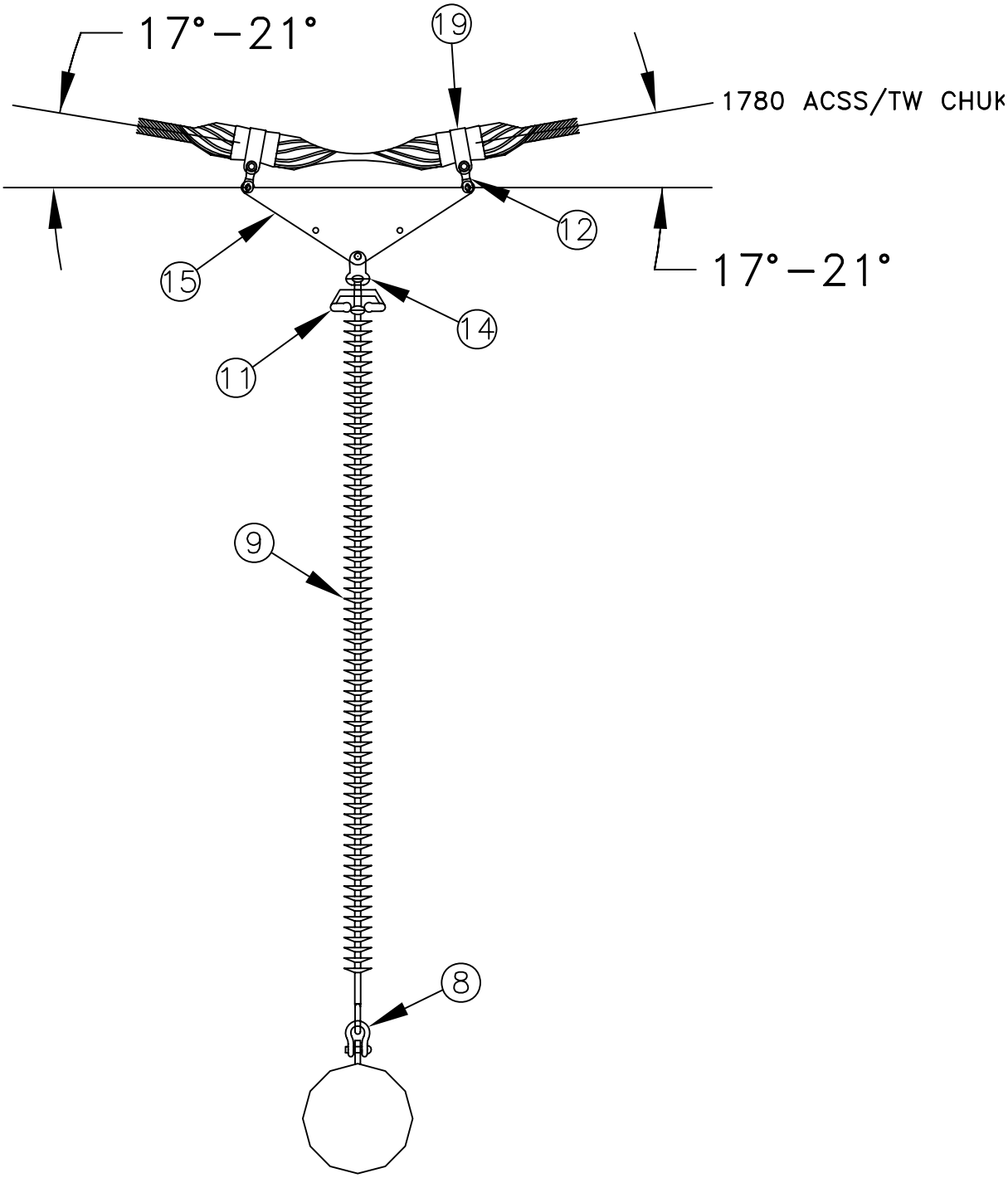
FILE:



SECTION B–B

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FILE:

ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	4	Anchor Shackle
5	2	Yoke Plate
6	1	OPGW Double Suspension
8	3	Anchor Shackle
9	3	Suspension Insulator 230KV L=106" RTL=25KIP
11	3	Corona Ring Dia=8"
12	10	Clevis Eye
14	3	Socket Clevis
15	3	Yoke Plate
19	3	AGS Double
24	2	Suspension Clamp for 7/16" ST
26	1	Armor Rods for 7/16" ST

* Material included as part of structure assembly

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO STR. #'s 72,77,91,106,118 TYPE SC-HA STR. BILL OF MATEF SHEET 4 OF 4 | DB-E444-F

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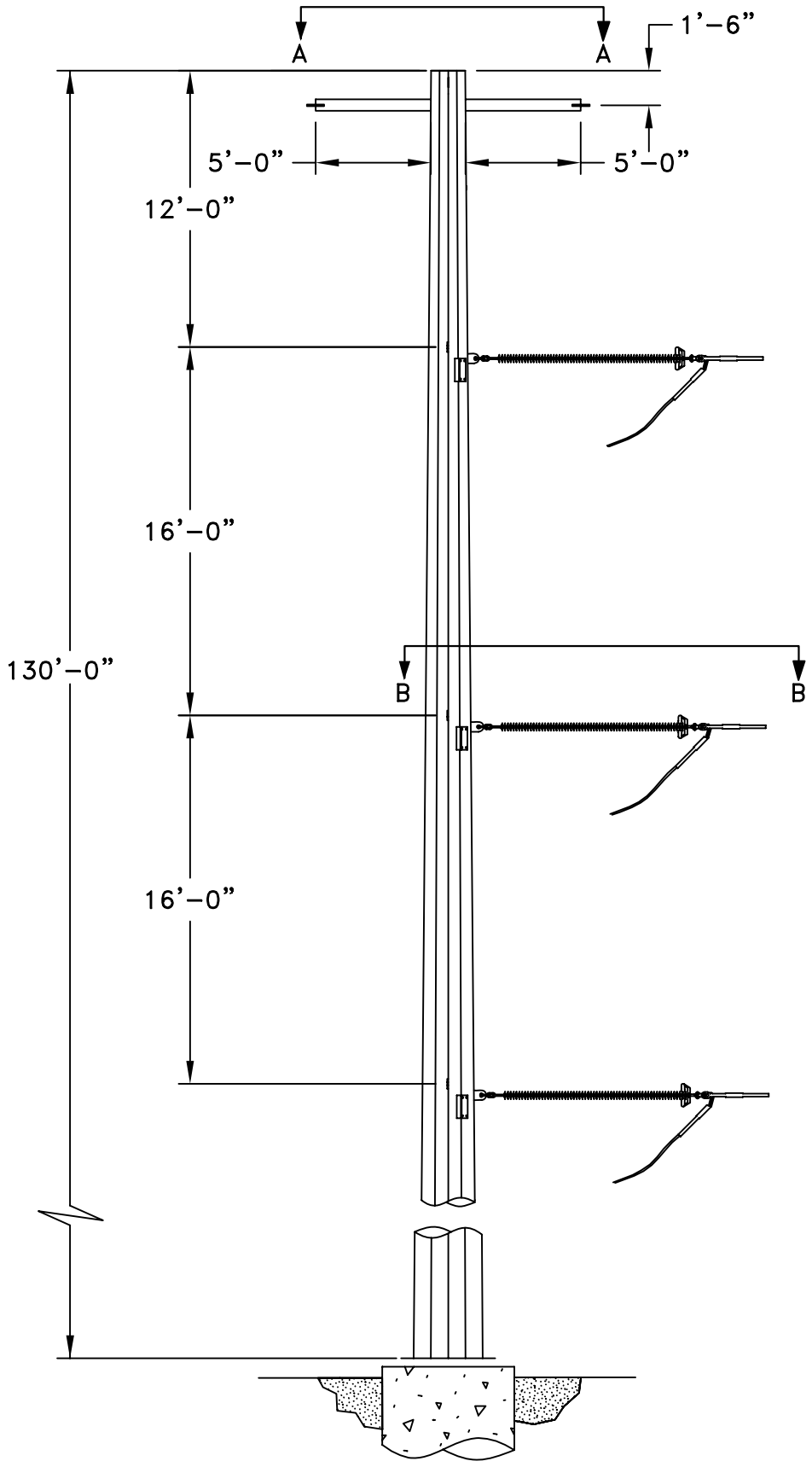

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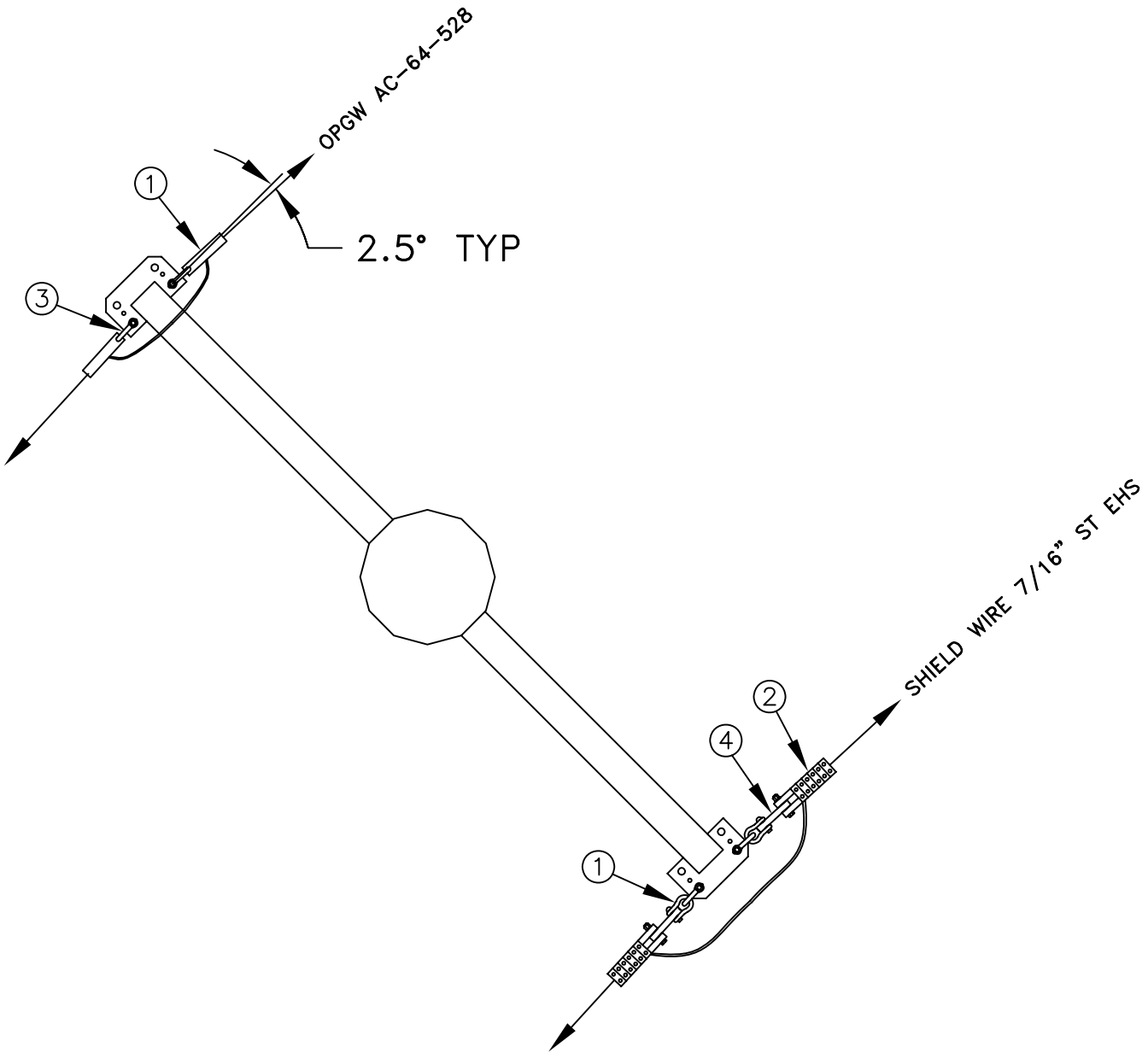

SECTION A–A

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 102 TYPE SC-DE-5 DEG. STR. ASSEMBLY SHEET 2 OF 4 | DB-E444-P500

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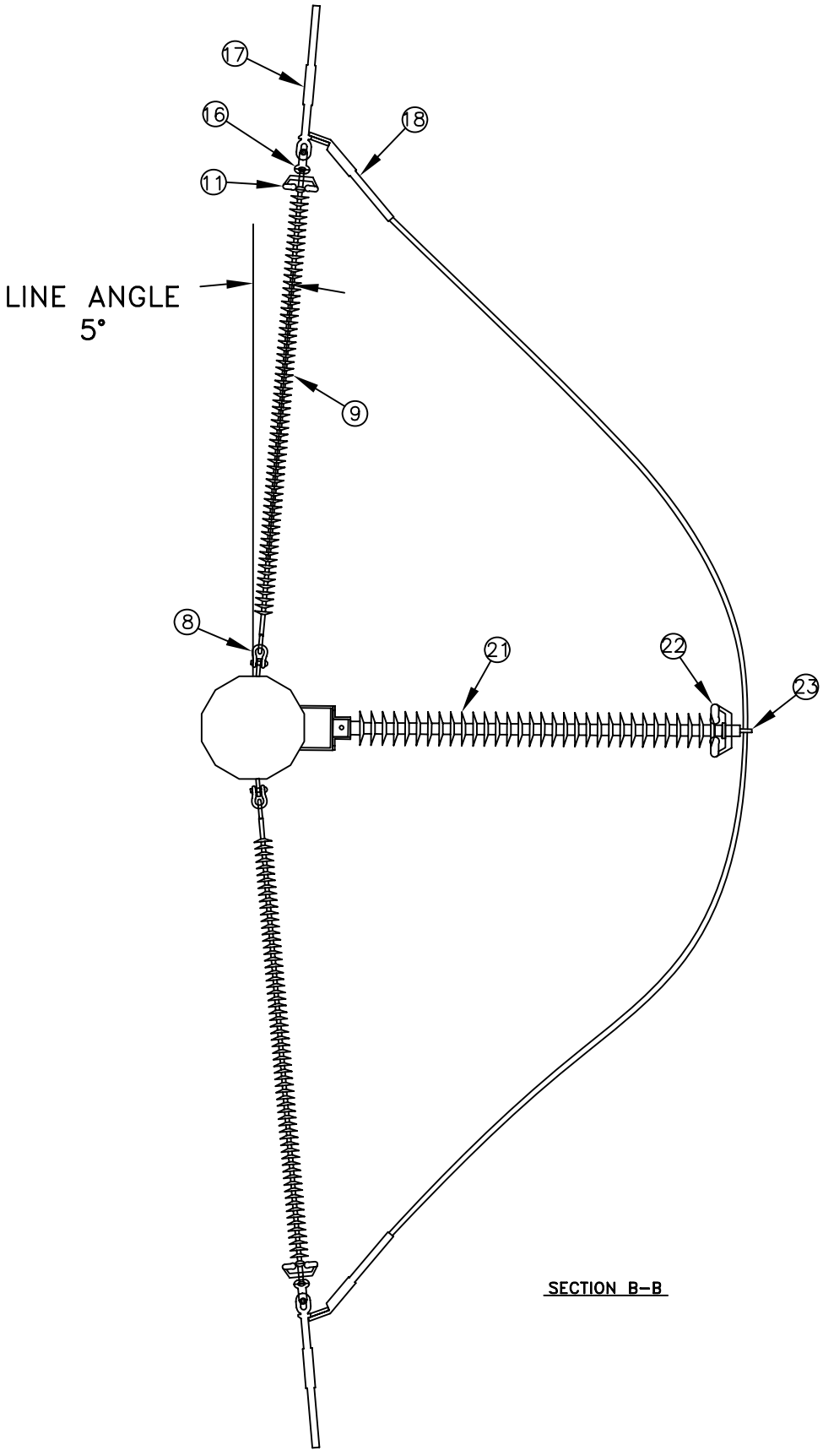

SECTION B–B

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FILE:

BILL OF MATERIAL

ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	6	Anchor Shackle
2	2	Dead End Bolted for OPGW
3	2	Dead End Bolted for 7/16" ST
4	2	Dead End Link Plate
8	6	Anchor Shackle
9	6	Suspension Insulator 230kV L=106" RTL=25KIP
11	6	Corona Ring DIA=8"
16	6	Socket Y-Clevis
17	6	Dead End Assembly for 1780 CHUKAR ACSS/TW
18	6	Terminal Connector (included with the Dead End Assembly)
21	3	Post Insulator 230kV Flat Base
22	3	Corona Ring DIA=12"
23	3	Jumper Loop Clamp

* Material included as part of structure assembly

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 102 TYPE SC-DE-5 DEG. STR. ASSEMBLY
		SHEET 4 OF 4 | DB-E444-P500

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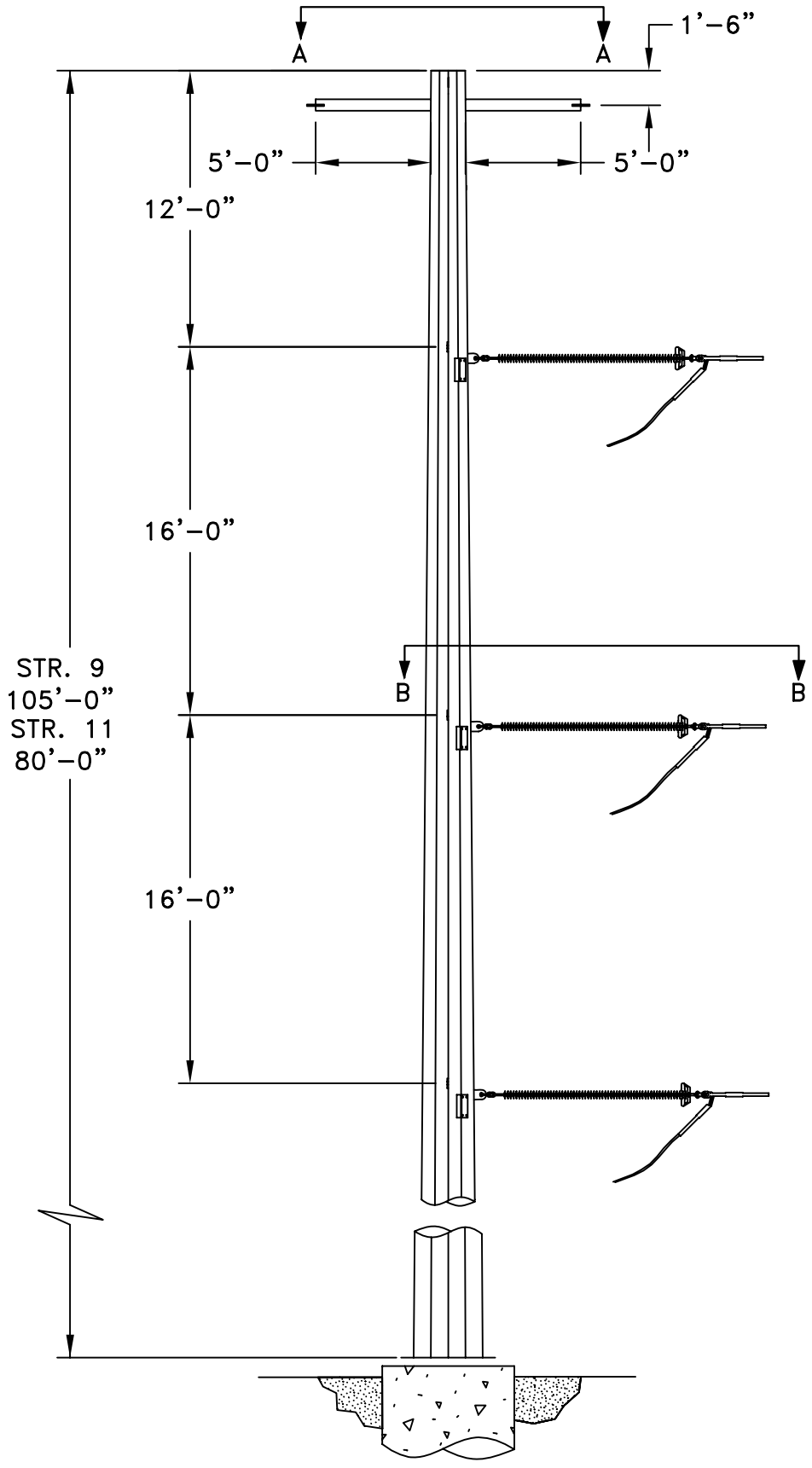

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		SHEET 1 OF 4	DB-E444-P501

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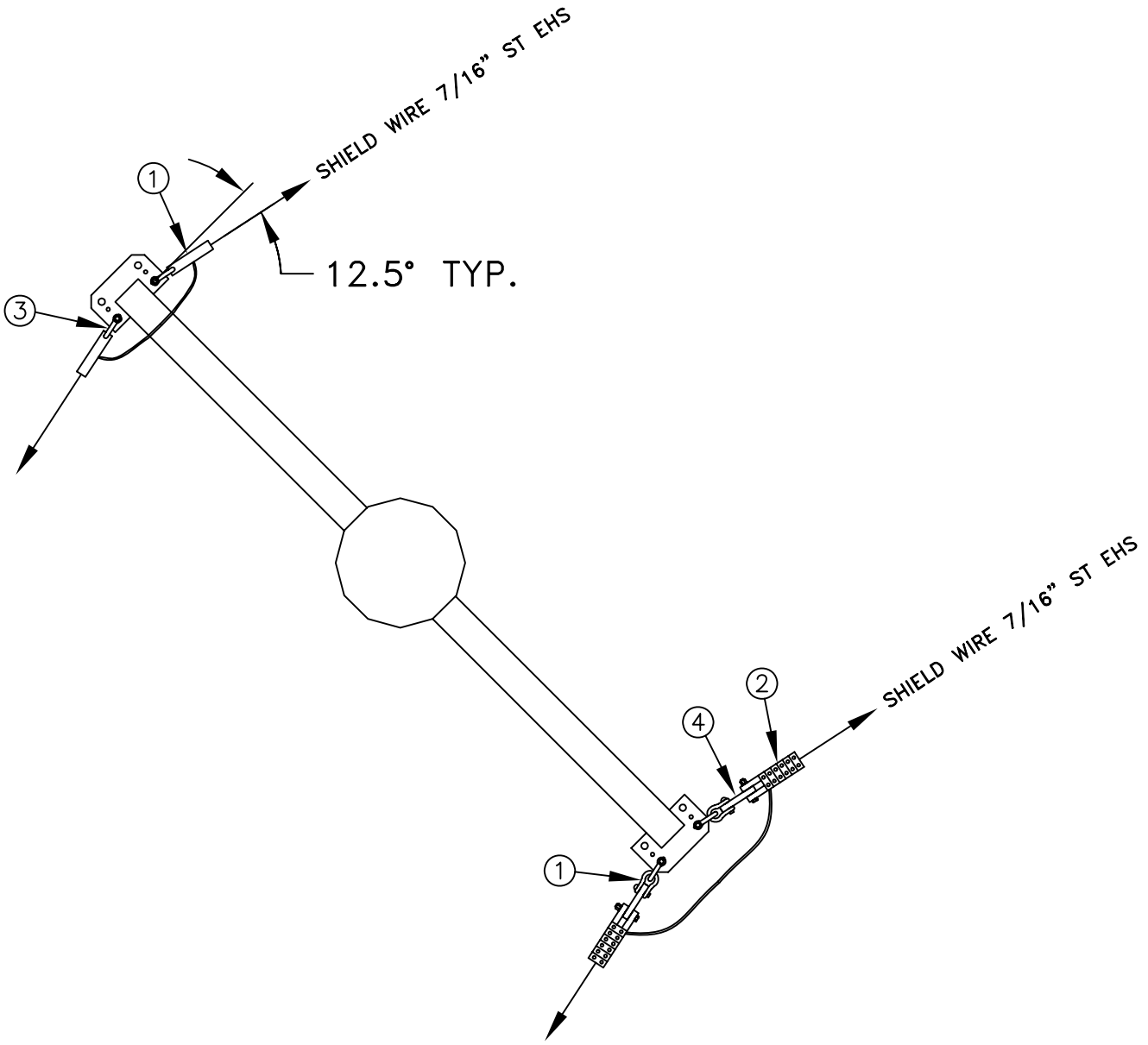

SECTION A–A

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 9,11 TYPE SC-DE-25 DEG. STR. ASSEMBLY	
		SHEET 2 OF 4	DB-E444-P501

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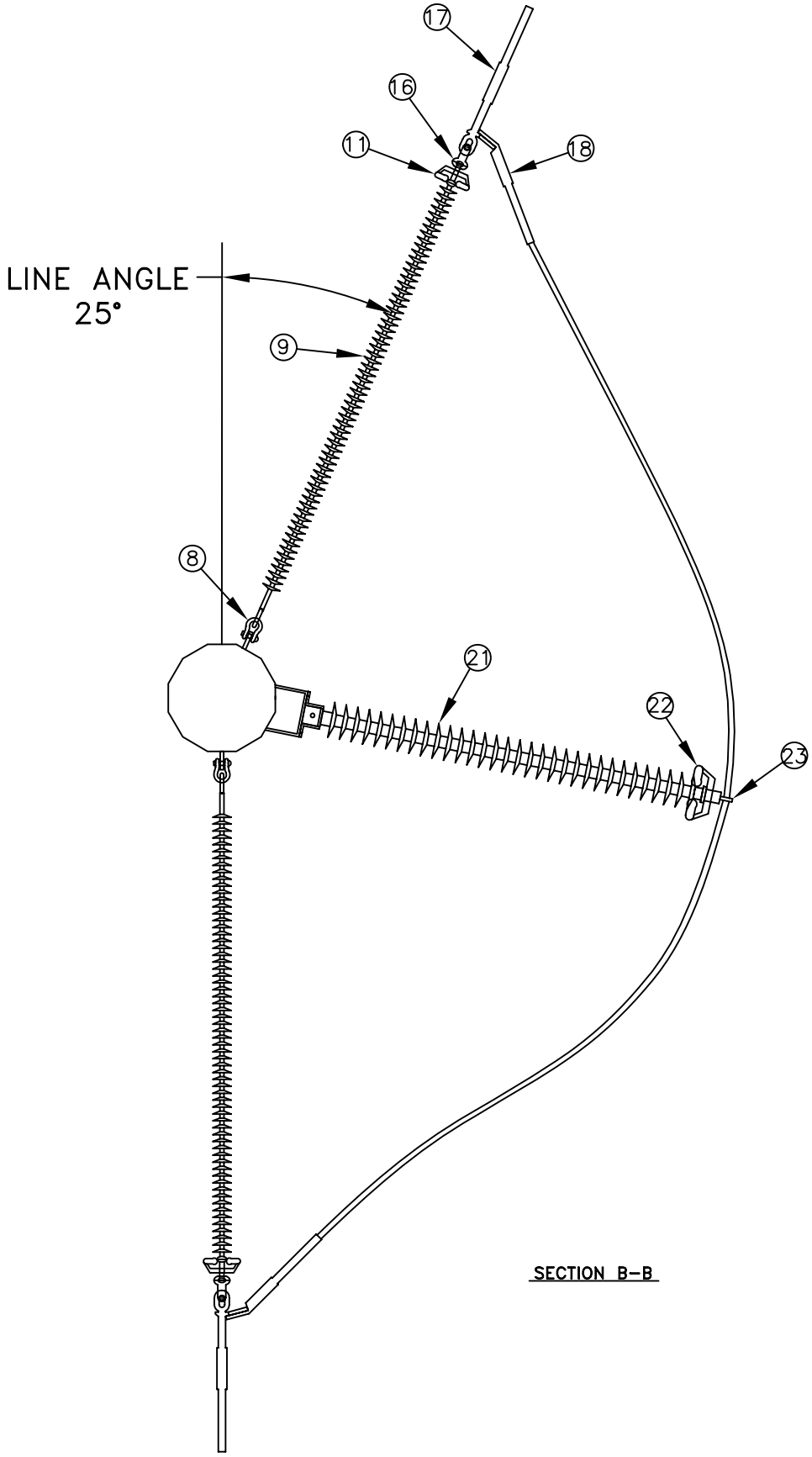

SECTION B–B

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FILE:

BILL OF MATERIAL

ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	6	Anchor Shackle
2	2	Dead End Bolted for OPGW
3	2	Dead End Bolted for 7/16" ST
4	2	Dead End Link Plate
8	6	Anchor Shackle
9	6	Suspension Insulator 230kV L=106" RTL=25KIP
11	6	Corona Ring DIA=8"
16	6	Socket Y-Clevis
17	6	Dead End Assembly for 1780 CHUKAR ACSS/TW
18	6	Terminal Connector (included with the Dead End Assembly)
21	3	Post Insulator 230kV Flat Base
22	3	Corona Ring DIA=12"
23	3	Jumper Loop Clamp

* Material included as part of structure assembly

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 9,11 TYPE SC-DE-25 DEG. STR. B.O.M.
		SHEET 4 OF 4 | DB-E444-P501

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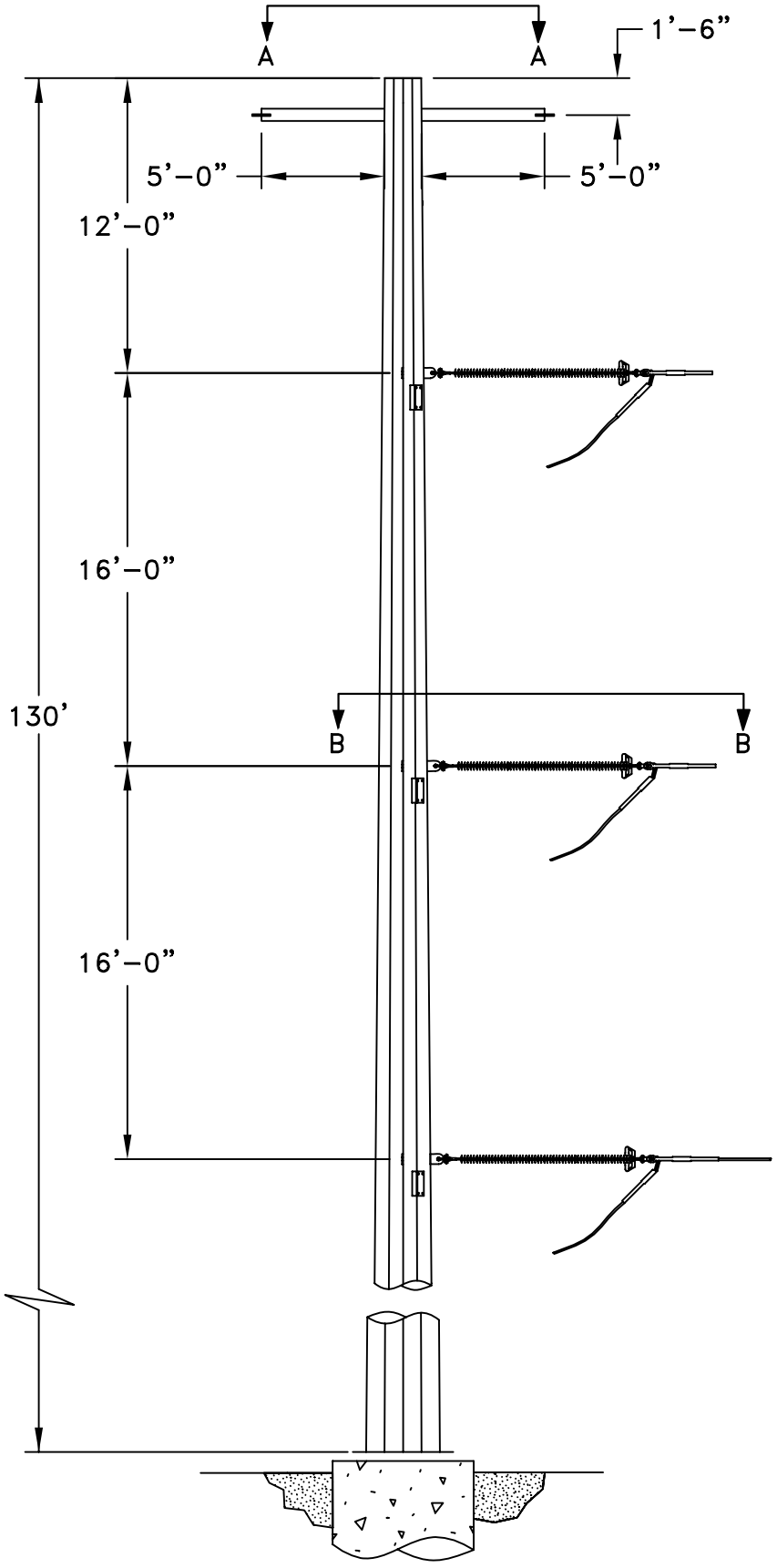

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		SHEET 1 OF 4	DB-E444-P502

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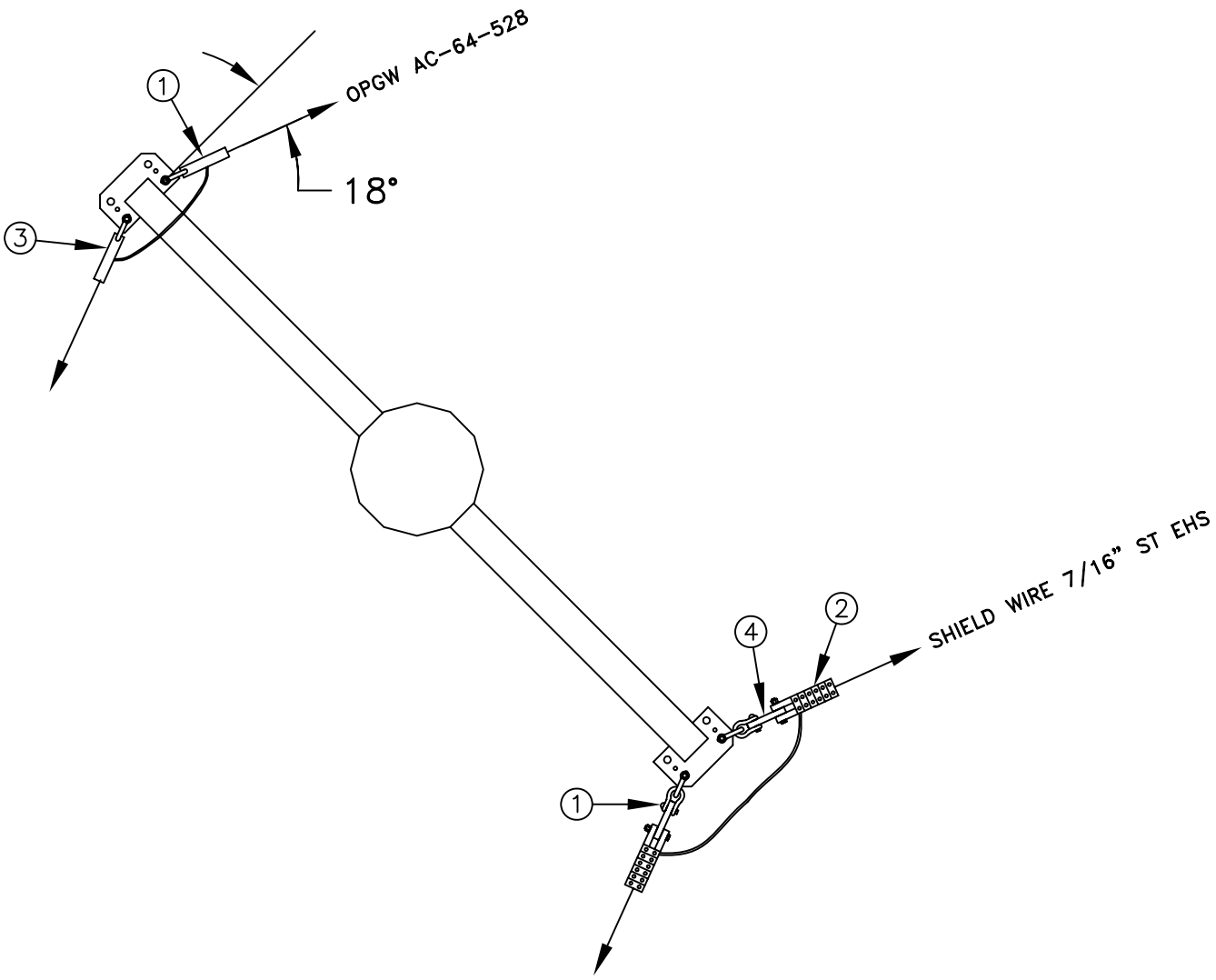

SECTION A-A

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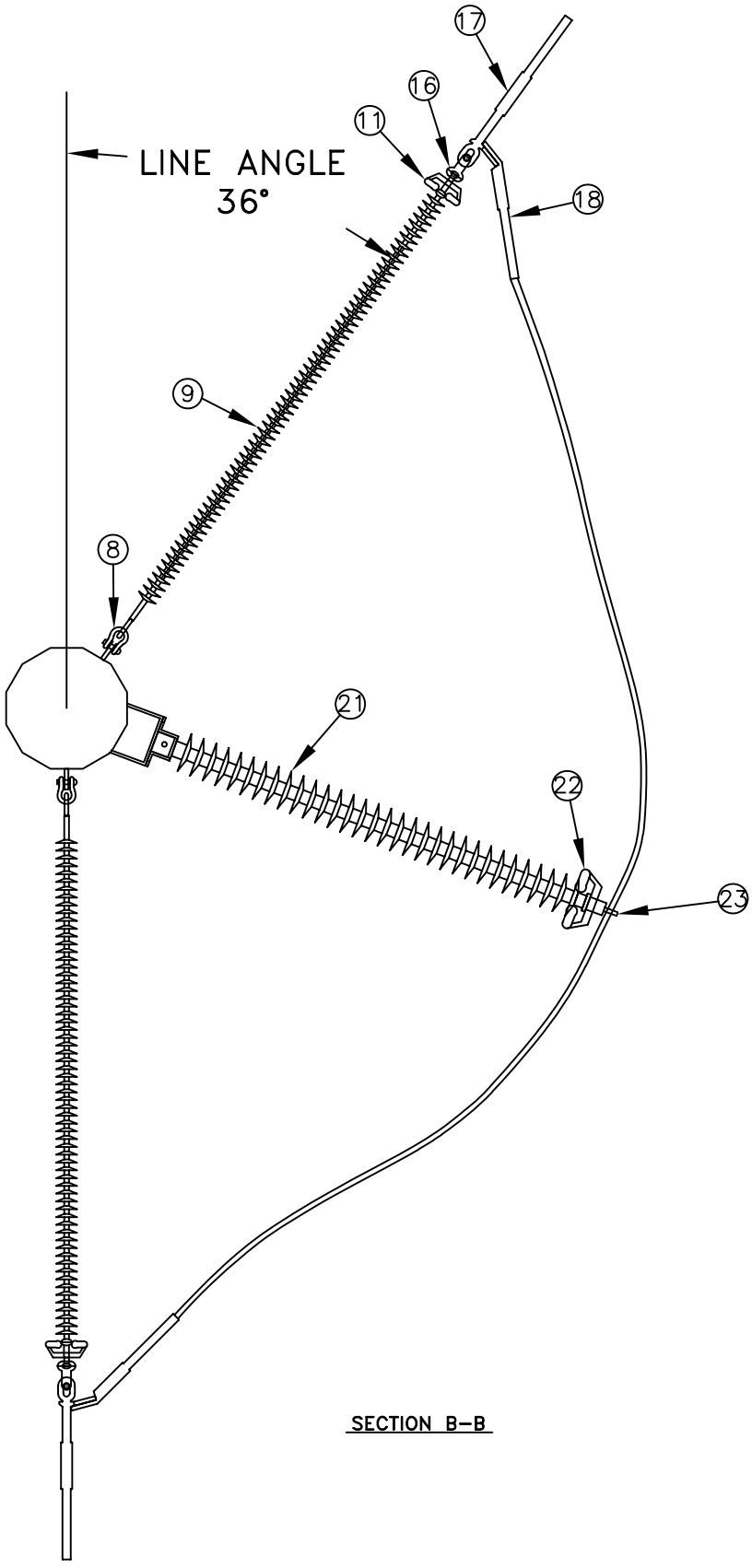

SECTION B–B

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BILL OF MATERIAL

ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	6	Anchor Shackle
2	2	Dead End Bolted for OPGW
3	2	Dead End Bolted for 7/16" ST
4	2	Dead End Link Plate
8	6	Anchor Shackle
9	6	Suspension Insulator 230kV L=106" RTL=25KIP
11	6	Corona Ring DIA=8"
16	6	Socket Y-Clevis
17	6	Dead End Assembly for 1780 CHUKAR ACSS/TW
18	6	Terminal Connector (included with the Dead End Assembly)
21	3	Post Insulator 230kV Flat Base
22	3	Corona Ring DIA=12"
23	3	Jumper Loop Clamp

* Material included as part of structure assembly

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 119 TYPE SC-DE-36 DEG. STR. B.O.M.
		SHEET 4 OF 4 | DB-E444-P502

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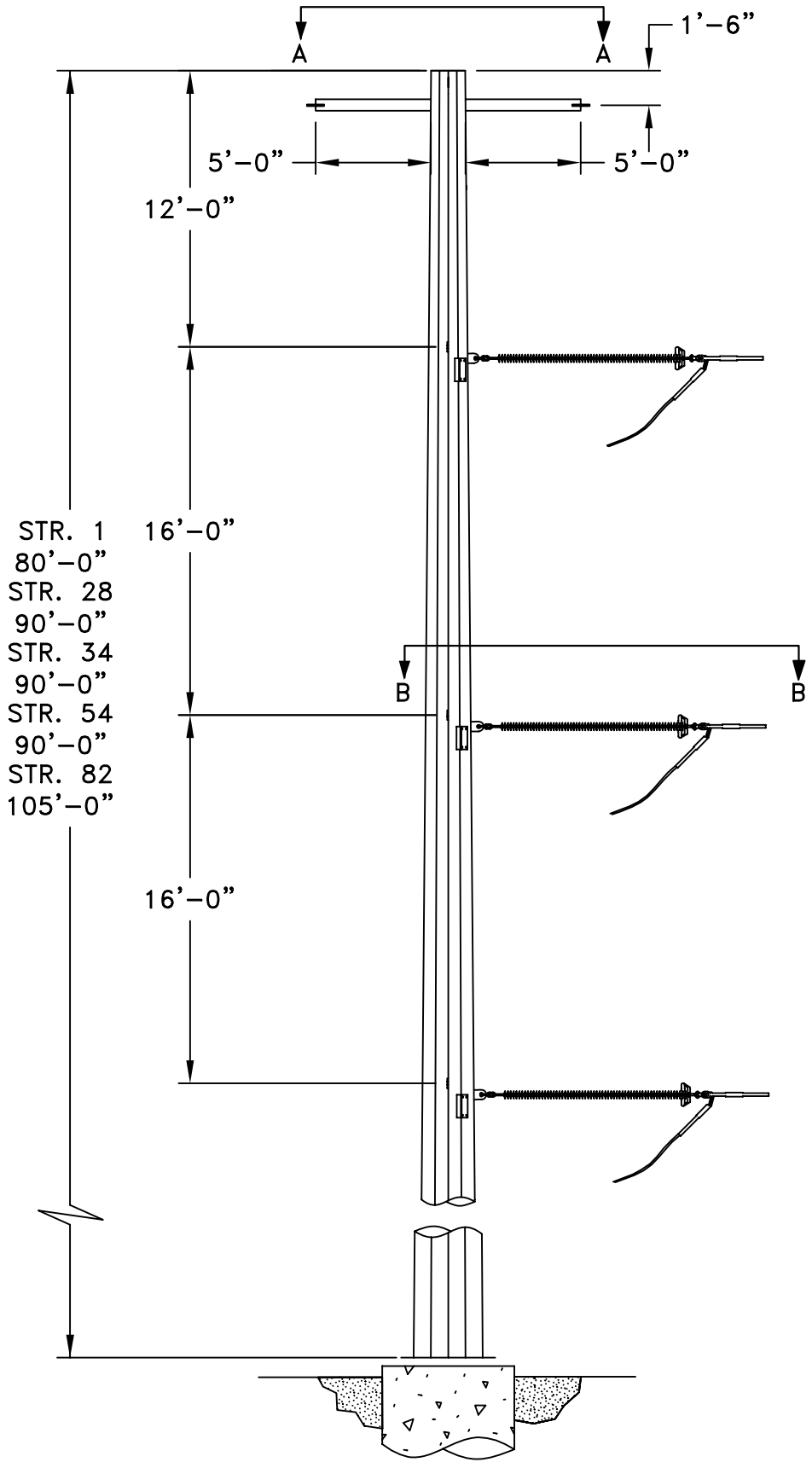

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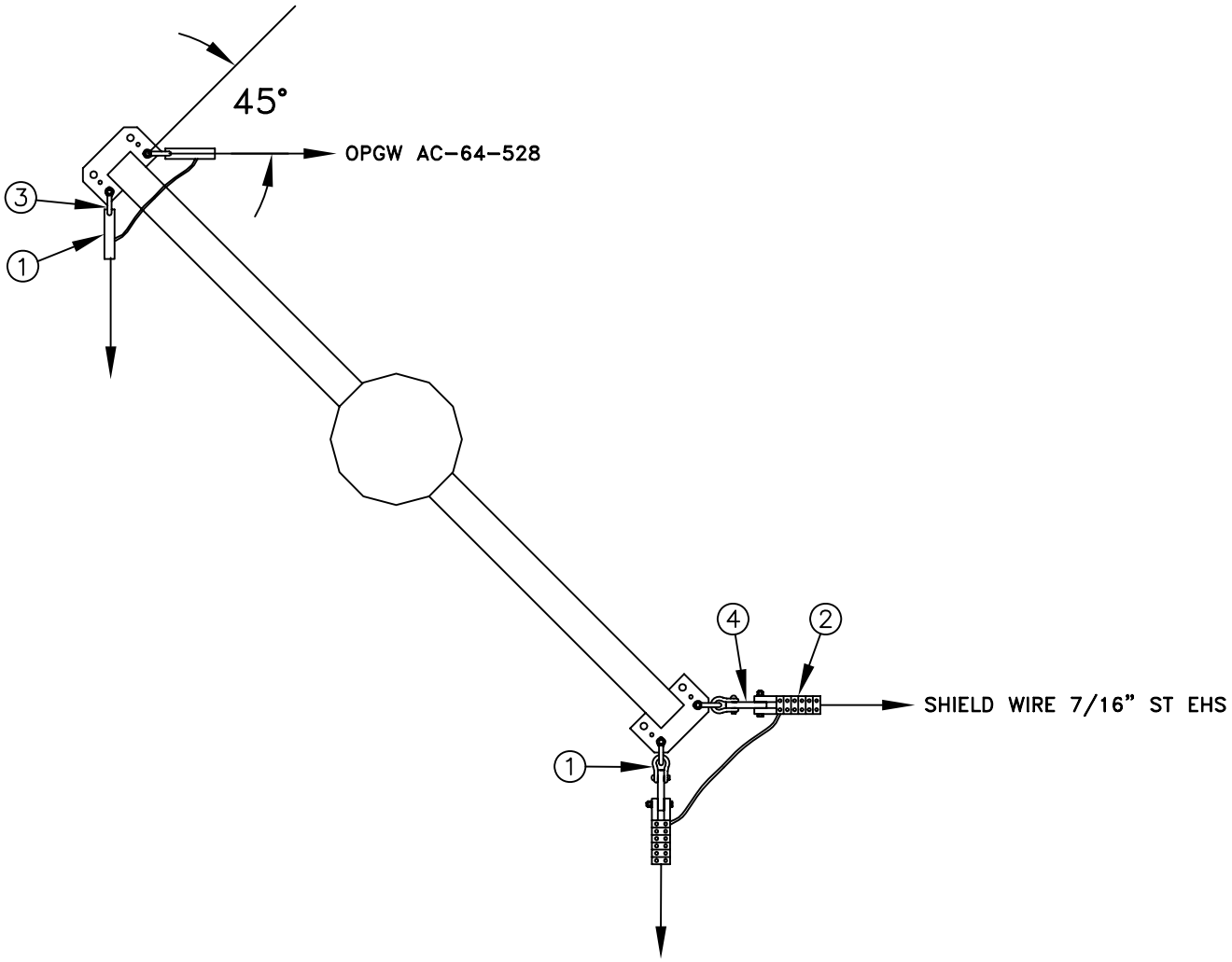
		SHEET 1 OF 4	DB-E444-P503

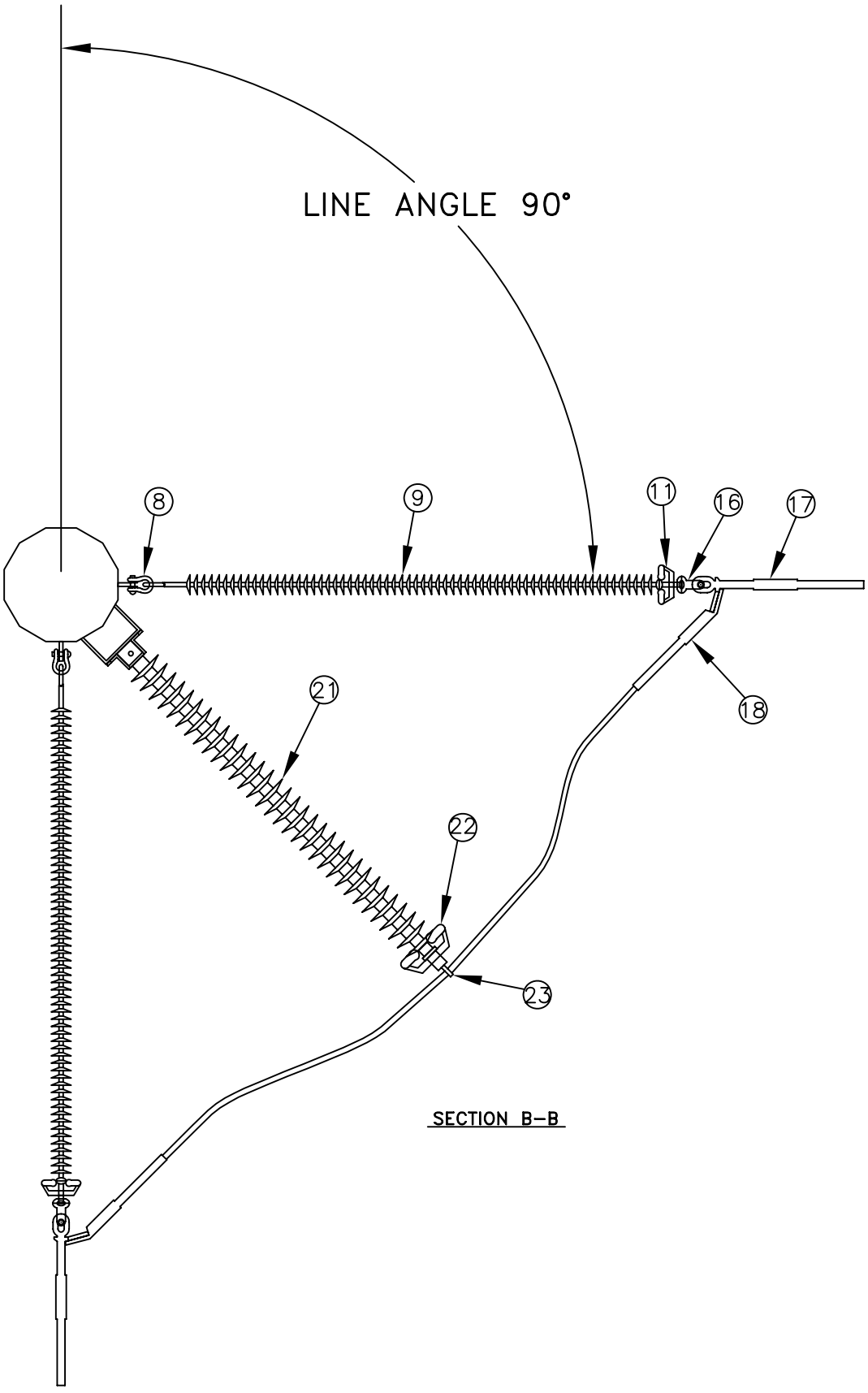
FILE:



SECTION A-A

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 1,28,34,54,82 TYPE SC-DE-90 DEG. STR. ASSEMBLY
		SHEET 2 OF 4 | DB-E444-P503

FILE:



SECTION B–B

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 1,28,34,54,82 TYPE SC-DE-90 DEG. STR. B.O.M.	
		SHEET 3 OF 4	DB-E444-P503

FILE:

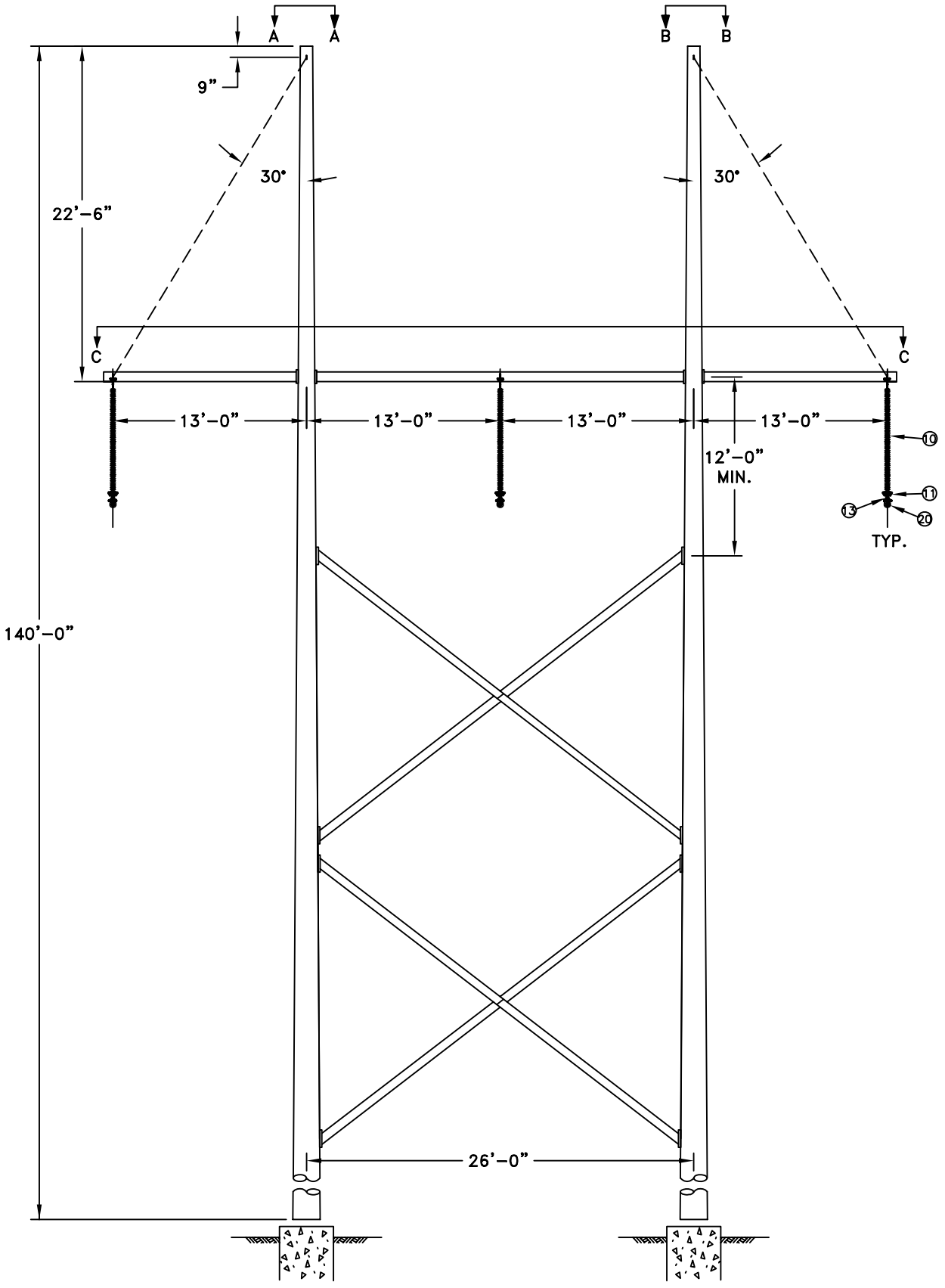
BILL OF MATERIAL

ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	6	Anchor Shackle
2	2	Dead End Bolted for OPGW
3	2	Dead End Bolted for 7/16" ST
4	2	Dead End Link Plate
8	6	Anchor Shackle
9	6	Suspension Insulator 230kV L=106" RTL=25KIP
11	6	Corona Ring DIA=8"
16	6	Socket Y-Clevis
17	6	Dead End Assembly for 1780 CHUKAR ACSS/TW
18	6	Terminal Connector (included with the Dead End Assembly)
21	3	Post Insulator 230kV Flat Base
22	3	Corona Ring DIA=12"
23	3	Jumper Loop Clamp

* Material included as part of structure assembly

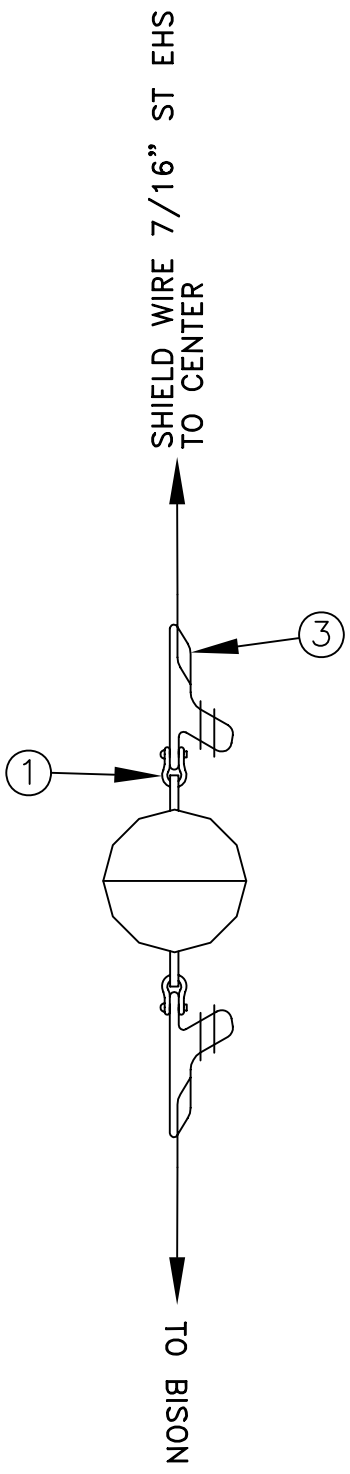
DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 1,28,34,54,82 TYPE SC-DE-90 DEG. STR. ASSEMBLY
		SHEET 4 OF 4 | DB-E444-P503

FILE:

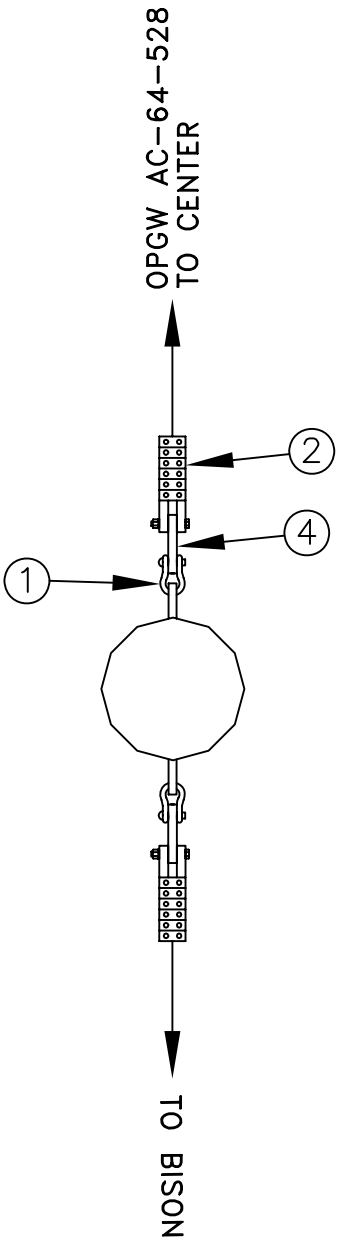


DRAWN: N.A.O./B&V CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 121 TYPE HF-DE-0 DEG. STR. ASSEMBLY	
		SHEET 1 OF 4	DB-E444-P504

FILE:



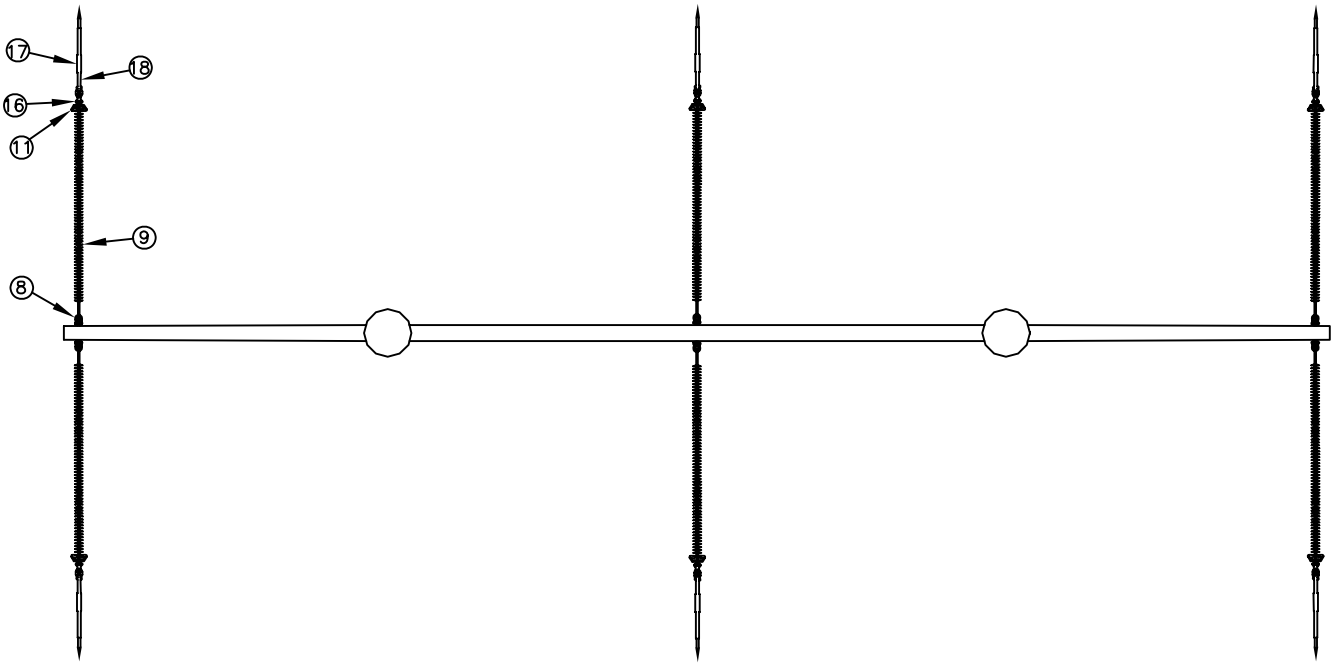
SECTION A–A



SECTION B–B

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 121 TYPE HF-DE-0 DEG. STR. ASSEMBLY	
		SHEET 2 OF 4	DB-E444-P504

FILE:



SECTION C–C

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 121 TYPE HF-DE-0 DEG. STR. ASSEMBLY	
		SHEET 3 OF 4	DB-E444-P504

FILE:

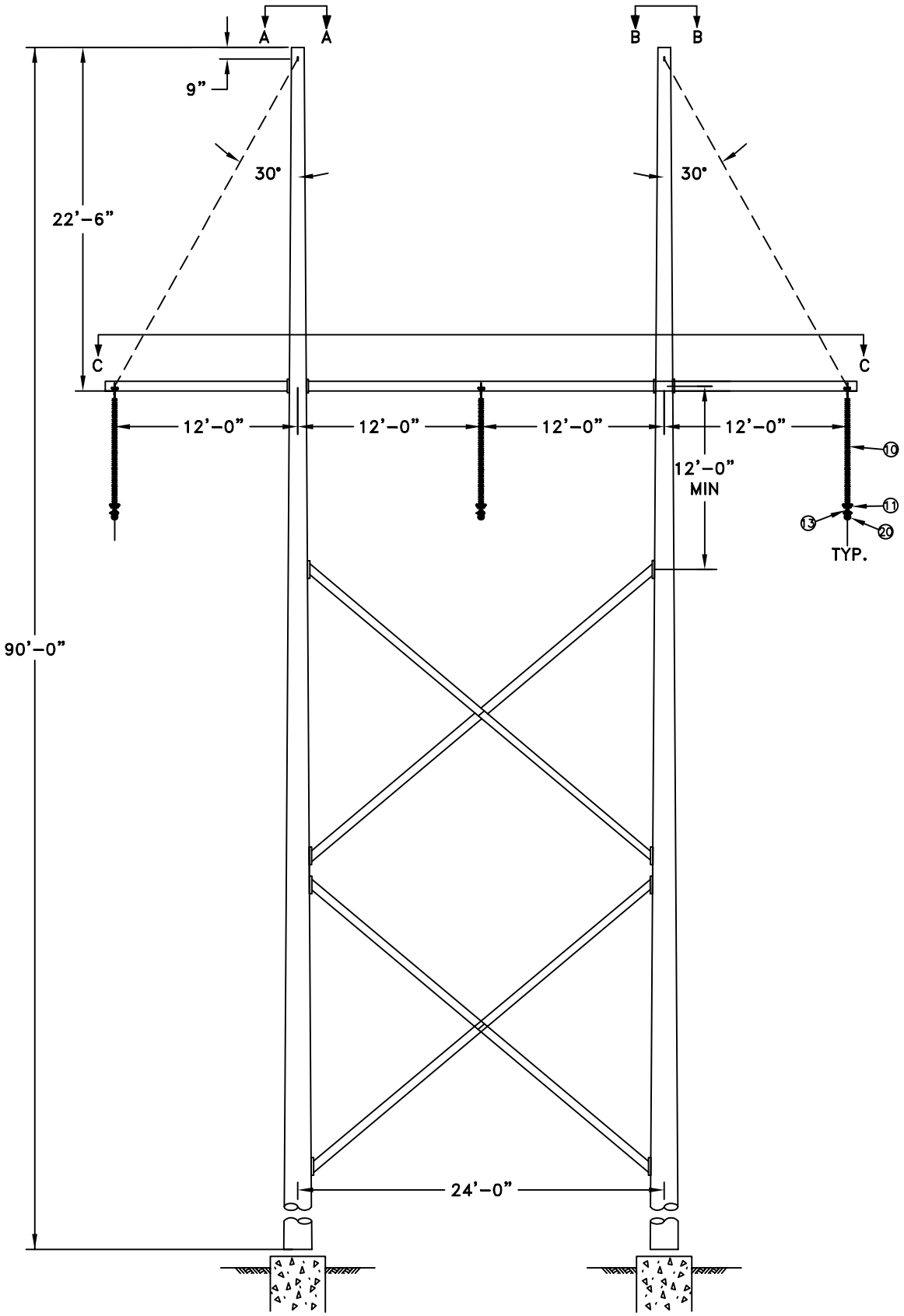
BILL OF MATERIAL

ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	4	Anchor Shackle
2	2	Dead End Bolted for OPGW
3	2	Dead End Bolted for 7/16" ST
4	2	Dead End Link Plate
8	6	Anchor Shackle
9	6	Suspension Insulator 230KV L=106" RTL=25 KIP
10	3	Suspension Insulator 230KV L=101" RTL=12.5 KIP
11	9	Corona Ring Dia=8"
13	3	Socket Eye
16	6	Socket Y-Clevis
17	6	Dead End Assembly for 1780 Chukar ACSS/TW
18	6	Terminal Connector (Included with D.E. Assy.)
20	3	AGS
		POLES AND FIXTURES
	* 2	Poles
	* 1	Crossarm Between Poles W/Mounting Hardware
	* 2	Crossarms Outside Poles W/Mounting Hardware
	* 2	X-Brace Assemblies W/Mounting Hardware

* Material included as part of structure assembly
Member Sizes and Mounting Hardware
Quantities and Dimensions to be
Determined by Structure Manufacturer

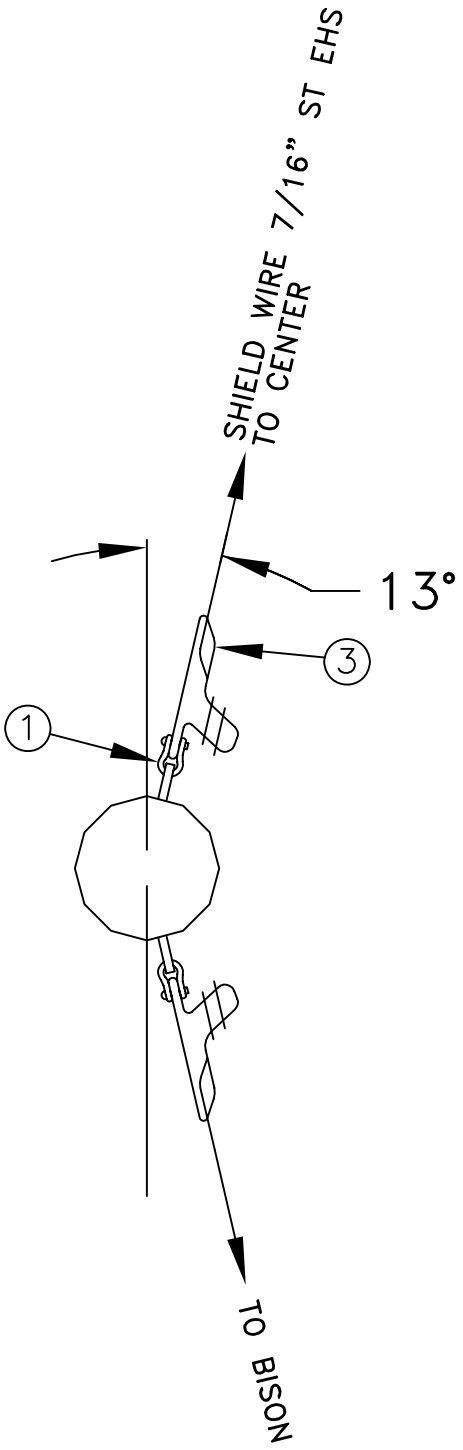
DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 121 TYPE HF-DE-0 DEG. STR. B.O.M.
		SHEET 4 OF 4 | DB-E444-P504

FILE:

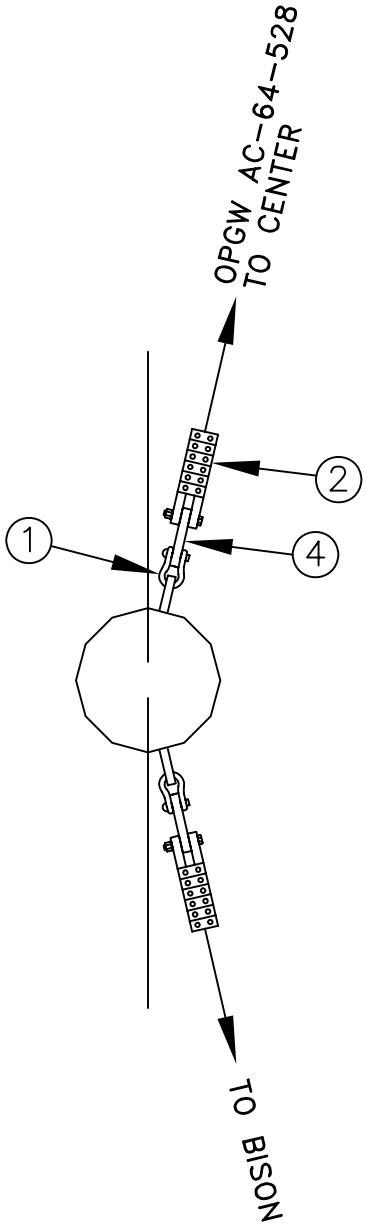


DRAWN: N.A.O./B&V CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 123 TYPE HF-DE-26 DEG. STR. ASSEMBLY	
		SHEET 1 OF 4	DB-E444-P505

FILE:



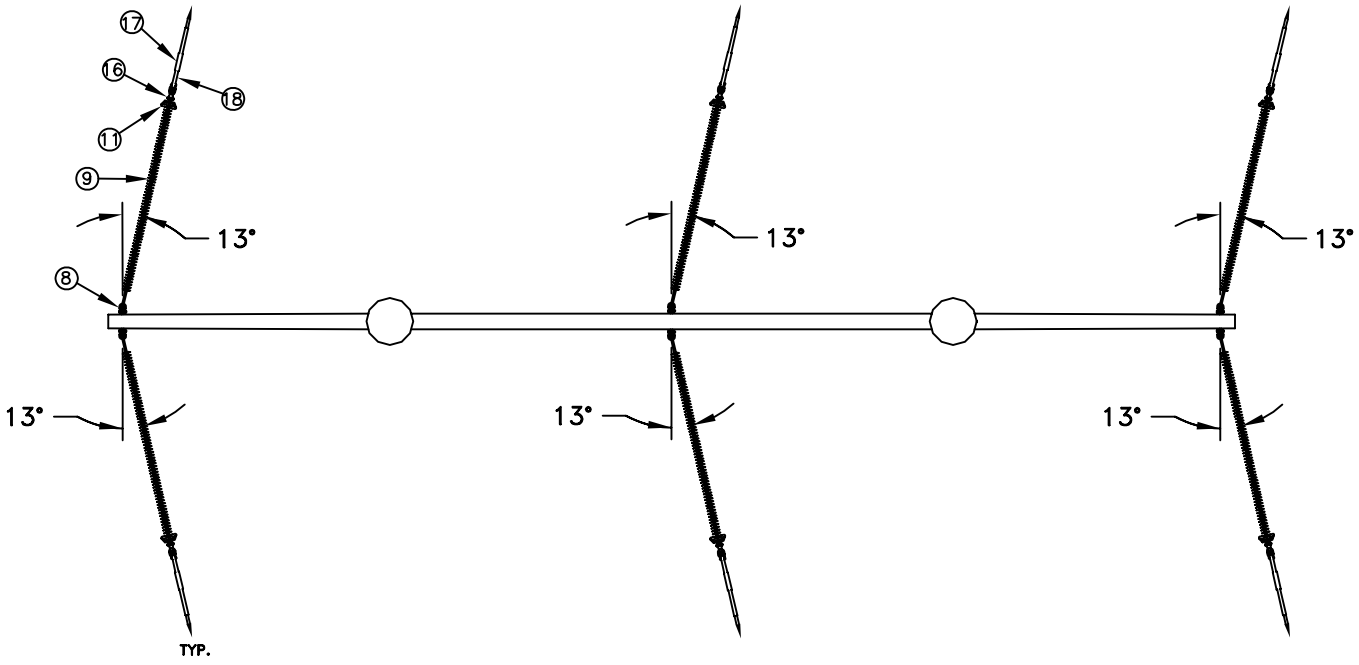
SECTION A–A



SECTION B–B

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 123 TYPE HF-DE-26 DEG. STR. ASSEMBLY	
		SHEET 2 OF 4	DB-E444-P505

FILE:



SECTION C–C

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 123 TYPE HF-DE-26 DEG. STR. ASSEMBLY	
		SHEET 3 OF 4	DB-E444-P505

FILE:

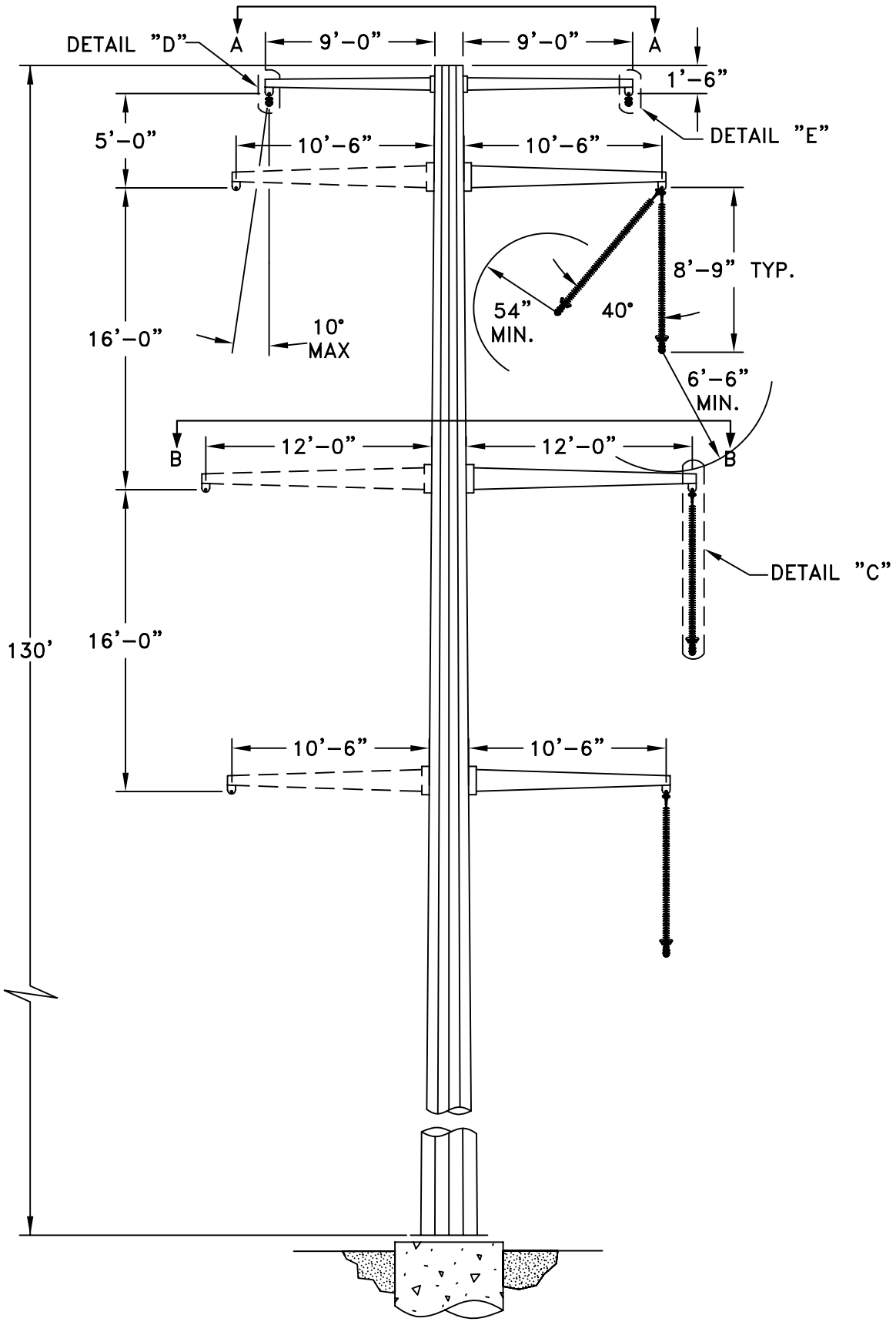
BILL OF MATERIAL

ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	4	Anchor Shackle
2	2	Dead End Bolted for OPGW
3	2	Dead End Bolted for 7/16" ST
4	2	Dead End Link Plate
8	6	Anchor Shackle
9	6	Suspension Insulator 230KV L=106" RTL=25 KIP
10	3	Suspension Insulator 230KV L=101" RTL=12.5 KIP
11	9	Corona Ring Dia=8"
13	3	Socket Eye
16	6	Socket Y-Clevis
17	6	Dead End Assembly for 1780 Chukar ACSS/TW
18	6	Terminal Connector (Included with D.E. Assy.)
20	3	AGS
		POLES AND FIXTURES
	* 2	Poles
	* 1	Crossarm Between Poles W/Mounting Hardware
	* 2	Crossarms Outside Poles W/Mounting Hardware
	* 2	X-Brace Assemblies W/Mounting Hardware

* Material included as part of structure assembly
Member Sizes and Mounting Hardware
Quantities and Dimensions to be
Determined by Structure Manufacturer

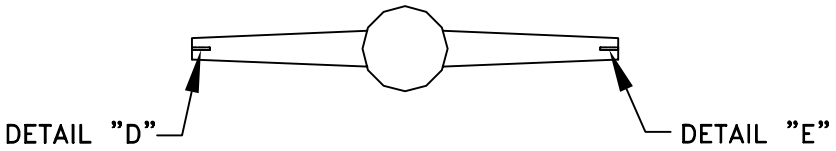
DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 123 TYPE HF-DE-26 DEG. STR. B.O.M. SHEET 4 OF 4 | DB-E444-P505

FILE:

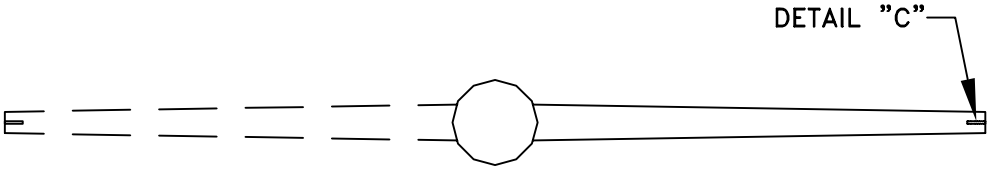


DRAWN: N.A.O./B&V CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 131 TYPE DC-TANG STRUCTURE ASSEMBLY	
		SHEET 1 OF 3	DB-E444-P506

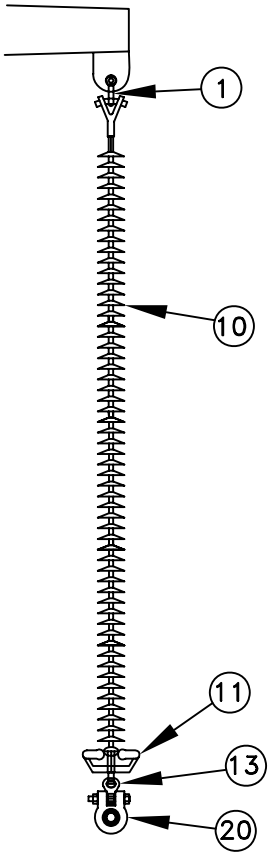
FILE:



SECTION A–A



SECTION B–B



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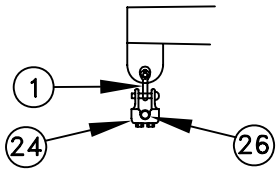

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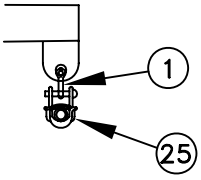


DETAIL "E"

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 131 TYPE DC-TANG STRUCTURE ASSEMBLY SHEET 2 OF 3 | DB-E444-P506

FILE:

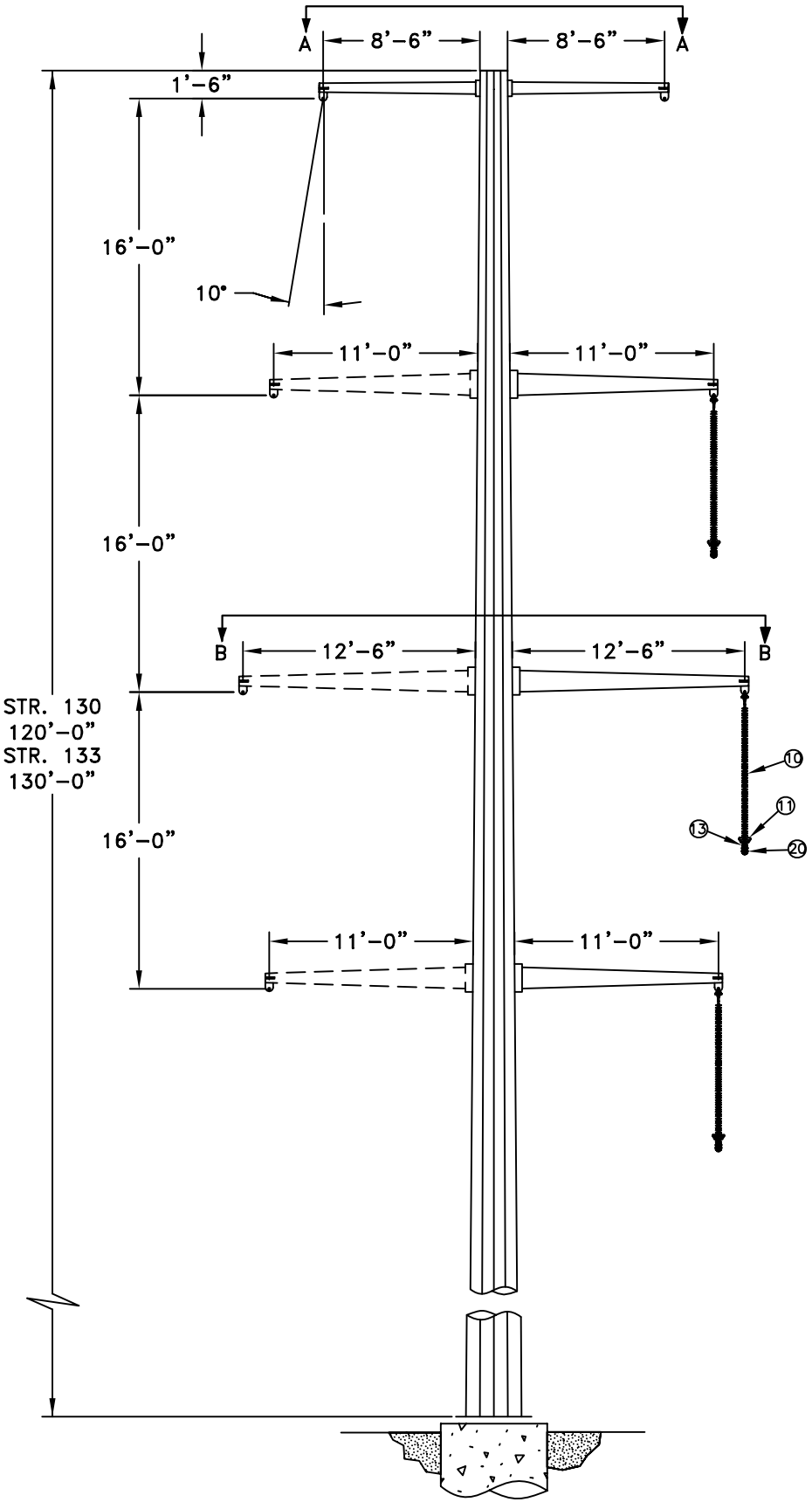
BILL OF MATERIAL

ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	6	Anchor Shackle
10	3	Suspension Insulator 230kV L=106" RTL=25KIP
11	3	Corona Ring DIA=8"
13	3	Socket Eye
20	3	AGS
24	1	Suspension Clamp for 7/16" ST
25	1	OPGW Suspension
26	1	Armor Rods for 7/16 ST

* Material included as part of structure assembly

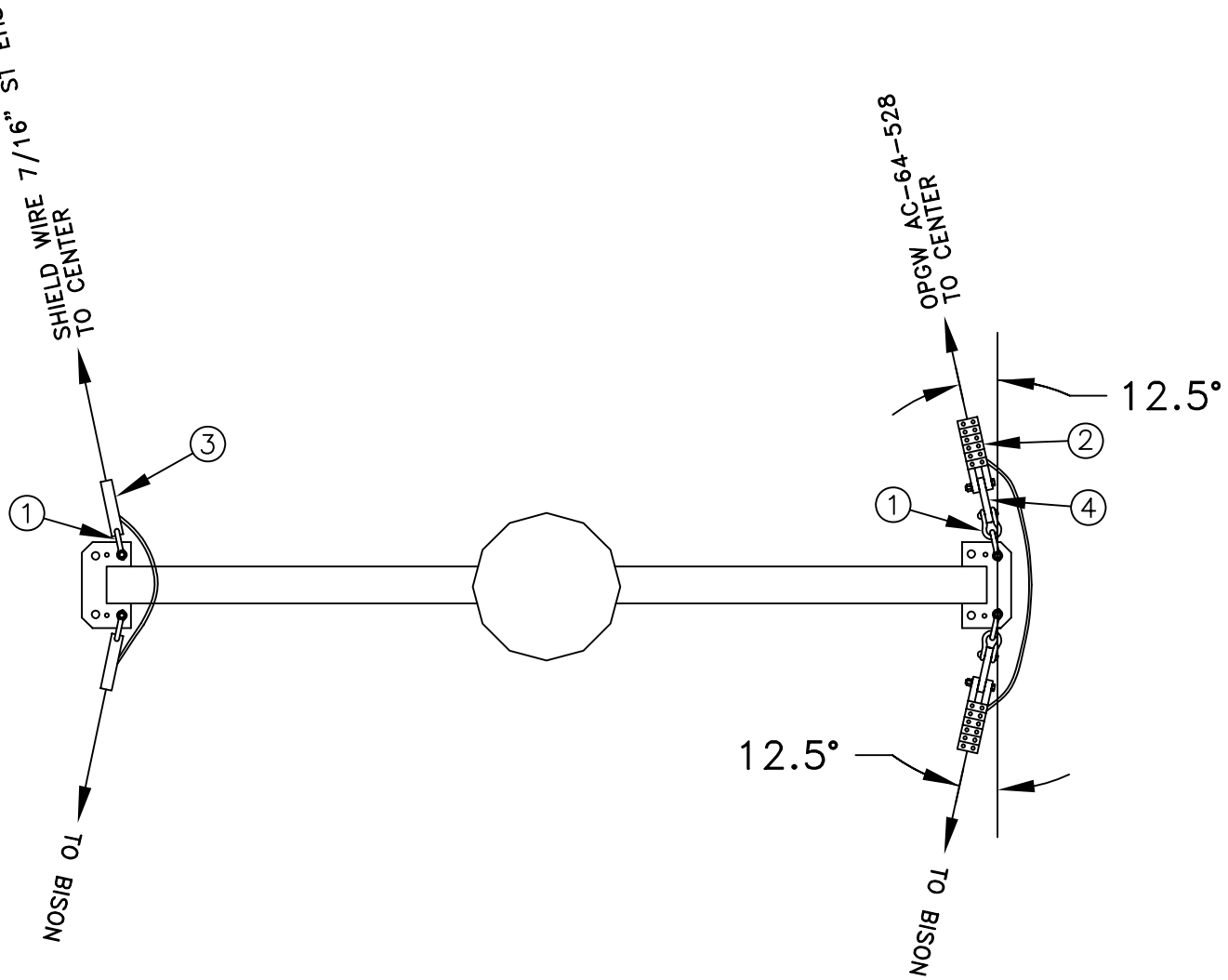
DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 131 TYPE DC-TANG STUCTURE B.O.M. SHEET 3 OF 3 | DB-E444-P506

FILE:



DRAWN: N.A.O./B&V CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 130,133 TYPE DC-DE-25 DEG. STR. ASSEMBLY SHEET 1 OF 4 | DB-E444-P507

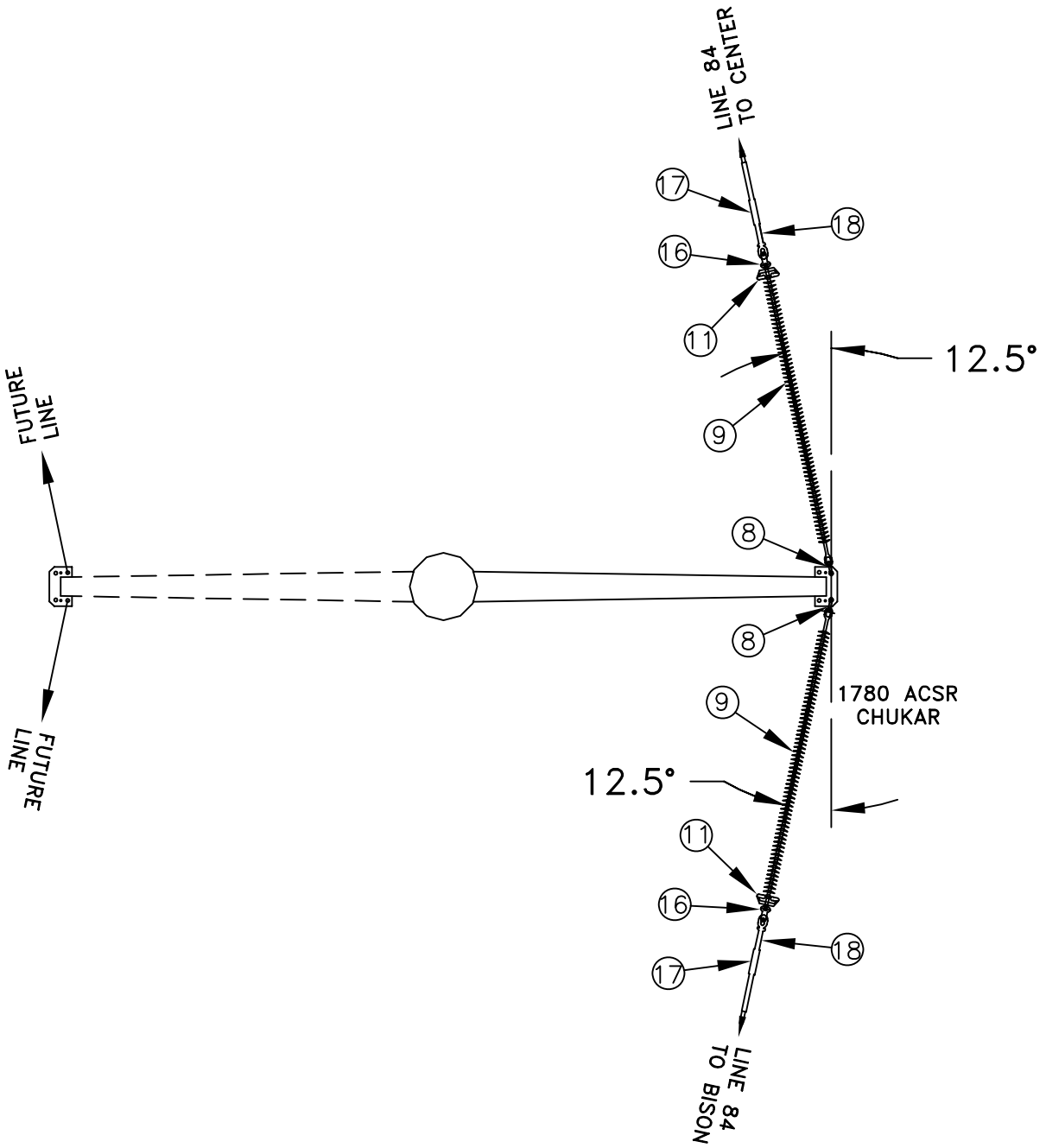
FILE:



SECTION A–A

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 130,133 TYPE DC-DE-25 DEG. STR. ASSEMBLY	
		SHEET 2 OF 4	DB-E444-P507

FILE:



SECTION B–B

This structure is for the double circuit Dead–Ends where the line approaches Square Butte sub.

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 130,133 TYPE DC-DE-25 DEG. STR. ASSEMBLY	
		SHEET 3 OF 4	DB-E444-P507

FILE:

BILL OF MATERIAL

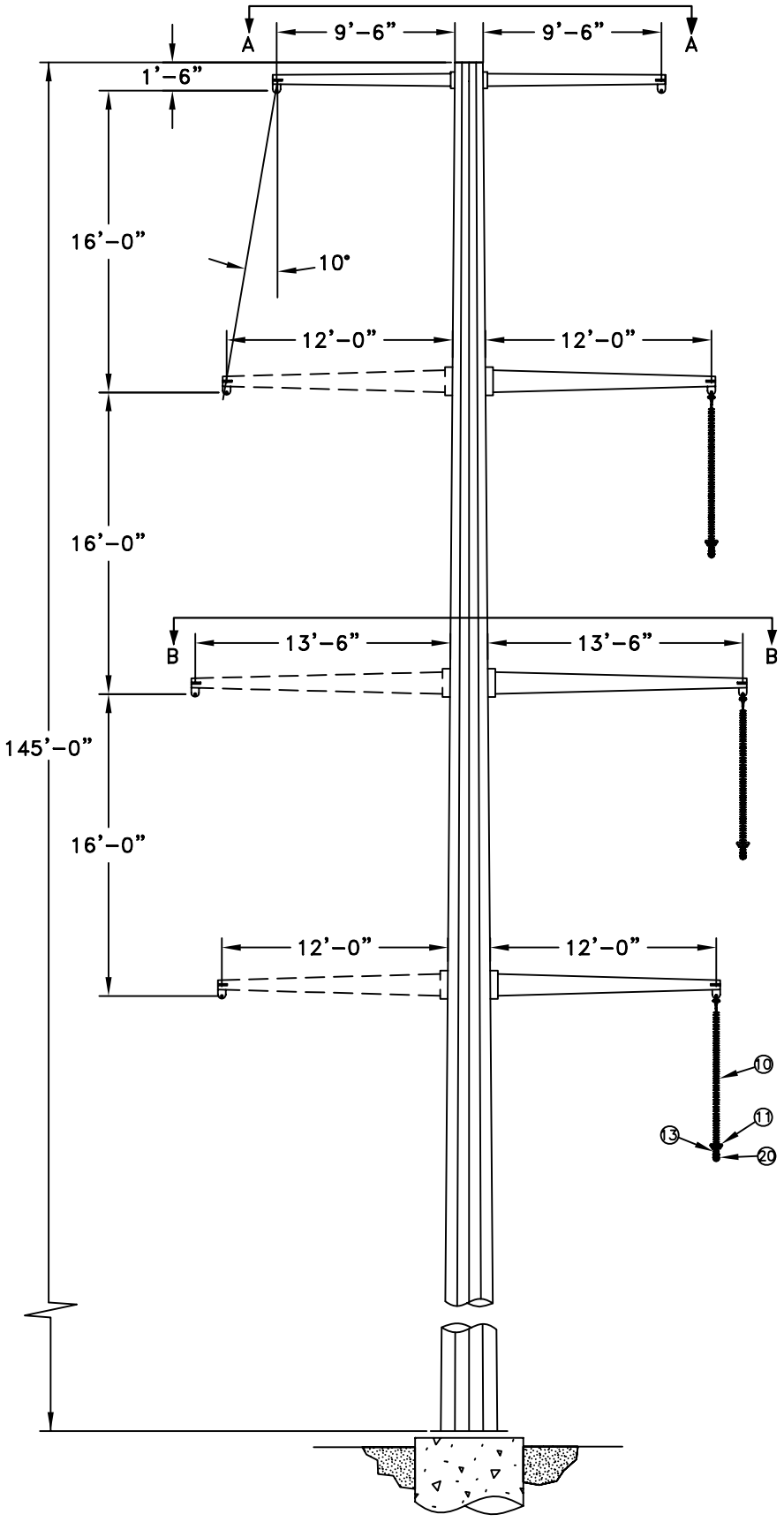
ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	6	Anchor Shackle
2	2	Dead End Bolted for OPGW
3	2	Dead End Bolted for 7/16" ST
4	2	Dead End Link Plate
8	6	Anchor Shackle
9	6	Suspension Insulator 230KV L=106" RTL=25 KIP
10	3	Suspension Insulator 230KV L=101" RTL=12.5 KIP
11	6	Corona Ring Dia=8"
13	3	Socket Eye
16	6	Socket Y-Clevis
17	6	Dead End Assembly for 1780 Chukar ACSS/TW
18	6	Terminal Connector (Included with D.E. Assy.)
20	3	AGS

* Material included as part of structure assembly

** Quanties shown are for one shield wire, one OPGW and one circuit.

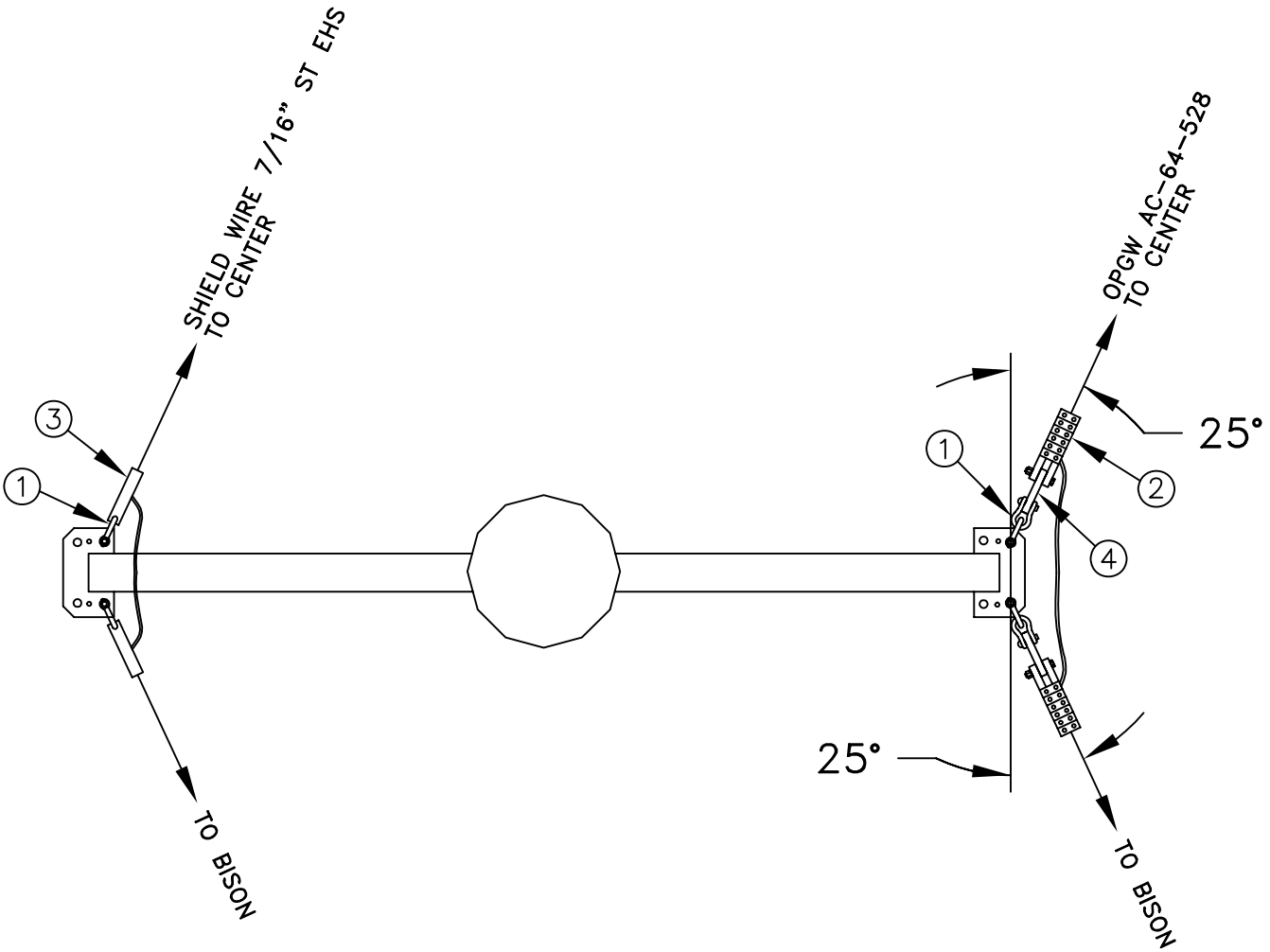
DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. #'s 130,133 TYPE DC-DE-25 DEG. STR. B.O.M.	
		SHEET 4 OF 4	DB-E444-P507

FILE:



DRAWN: N.A.O./B&V CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 129 TYPE DC-DE-50 DEG. STR. ASSEMBLY	
		SHEET 1 OF 4	DB-E444-P508

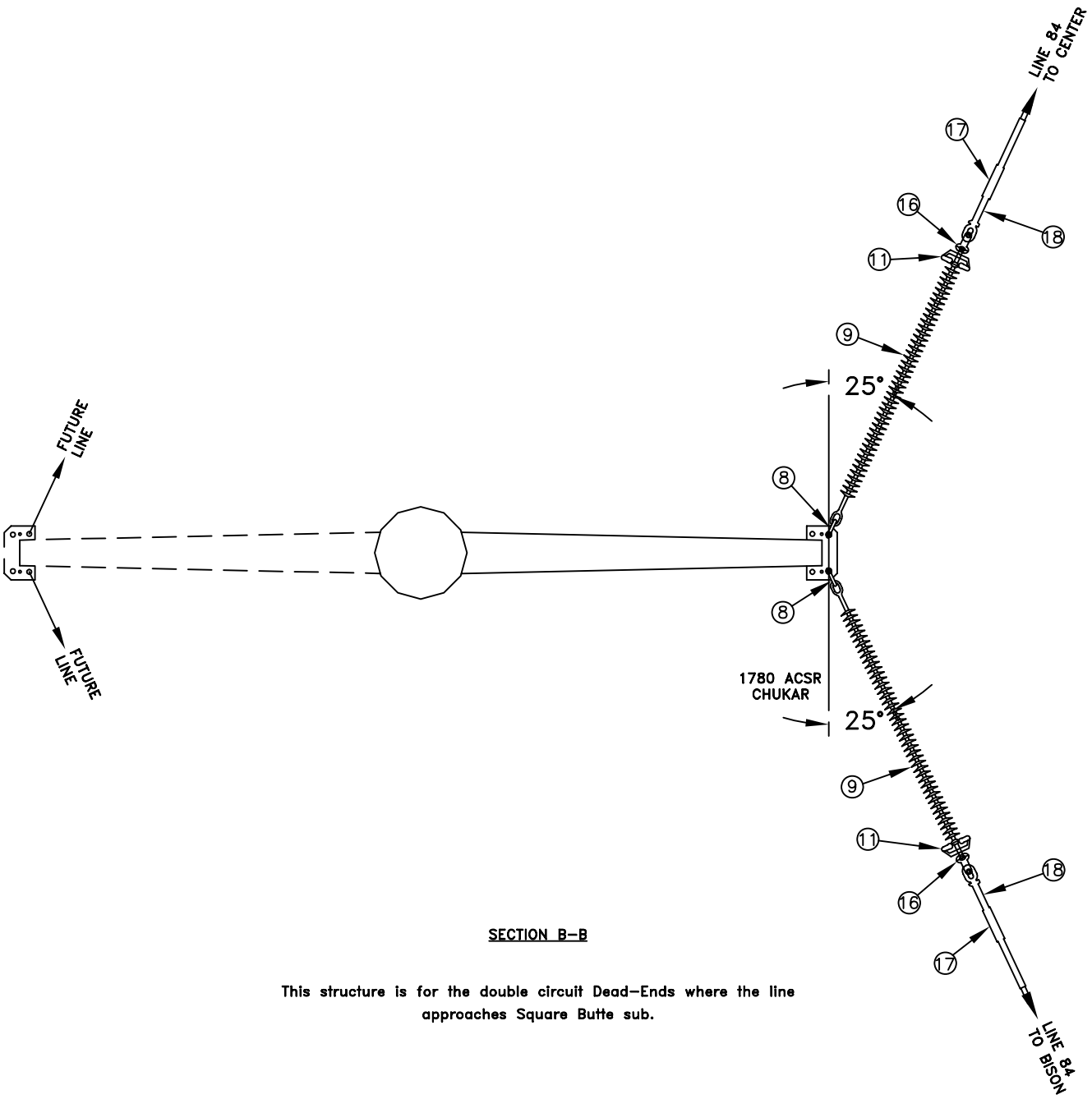
FILE:



SECTION A–A

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 129 TYPE DC-DE-50 DEG. STR. ASSEMBLY	
		SHEET 2 OF 4	DB-E444-P508

FILE:



SECTION B–B

This structure is for the double circuit Dead–Ends where the line approaches Square Butte sub.

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 129 TYPE DC-DE-50 DEG. STR. ASSEMBLY	
		SHEET 3 OF 4	DB-E444-P508

FILE:

BILL OF MATERIAL

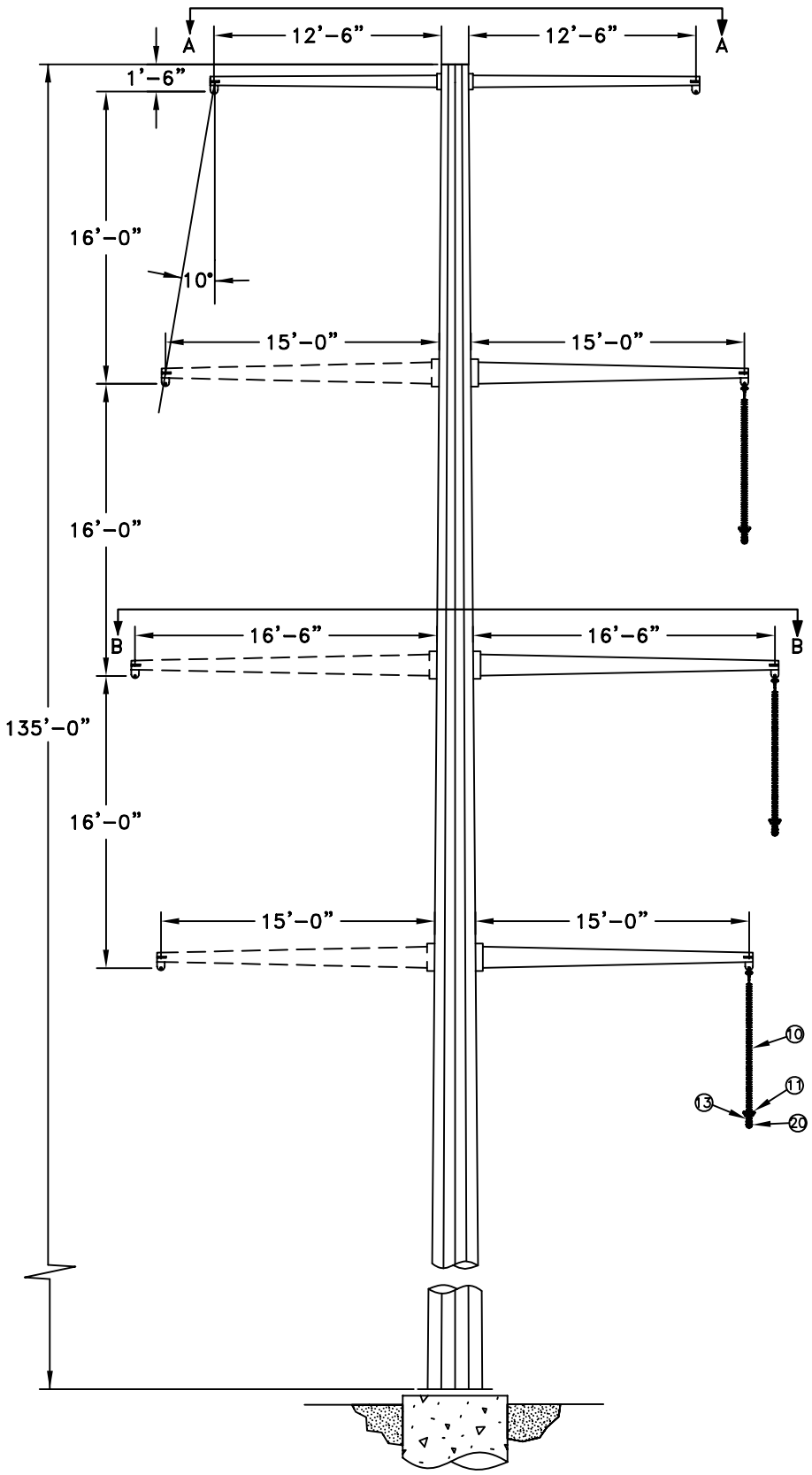
ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	6	Anchor Shackle
2	2	Dead End Bolted for OPGW
3	2	Dead End Bolted for 7/16" ST
4	2	Dead End Link Plate
8	6	Anchor Shackle
9	6	Suspension Insulator 230KV L=106" RTL=25 KIP
10	3	Suspension Insulator 230KV L=101" RTL=12.5 KIP
11	6	Corona Ring Dia=8"
13	3	Socket Eye
16	6	Socket Y-Clevis
17	6	Dead End Assembly for 1780 Chukar ACSS/TW
18	6	Terminal Connector (Included with D.E. Assy.)
20	3	AGS

* Material included as part of structure assembly

** Quanties shown are for one shield wire, one OPGW and one circuit.

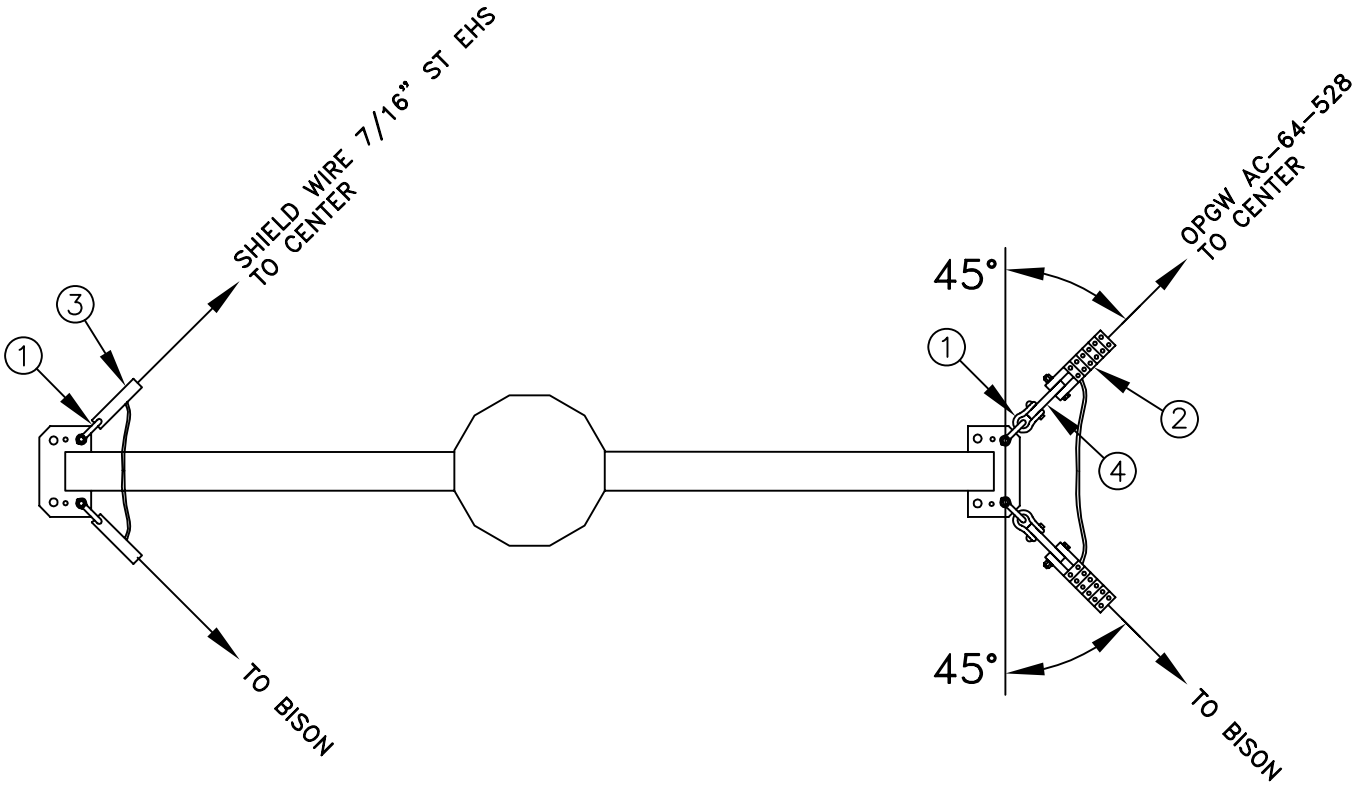
DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 129 TYPE DC-DE-50 DEG. STR. B.O.M.	
		SHEET 4 OF 4	DB-E444-P508

FILE:



DRAWN: N.A.O./B&V CHECKED: _____ APPROVED: _____ REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 132 TYPE DC-DE-90 DEG. STR. ASSEMBLY SHEET 1 OF 4 | DB-E444-P509

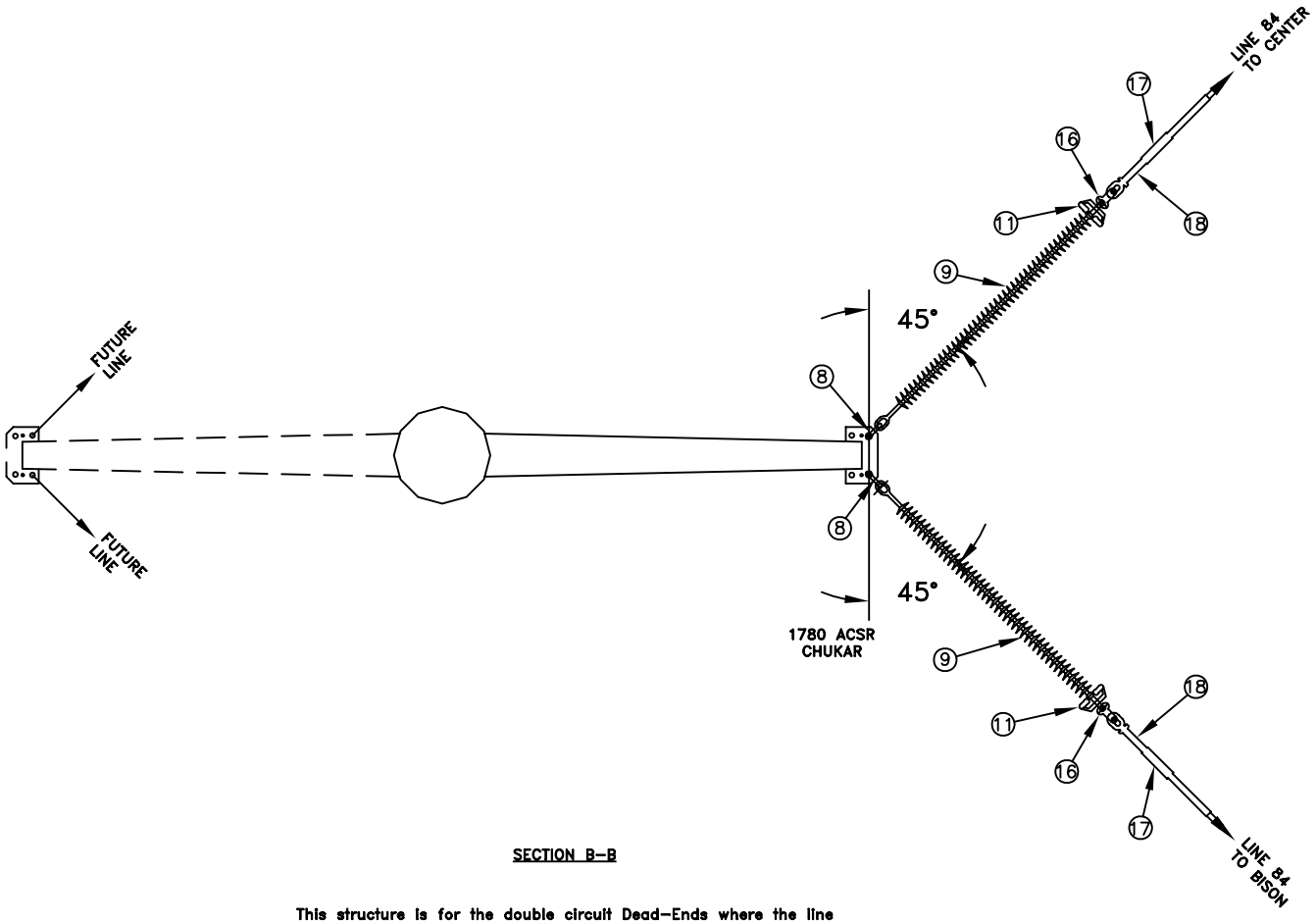
FILE:



SECTION A–A

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 132 TYPE DC-DE-90 DEG. STR. ASSEMBLY	
		SHEET 2 OF 4	DB-E444-P509

FILE:



SECTION B–B

This structure is for the double circuit Dead–Ends where the line approaches Square Butte sub.

DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12–9–09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 132 TYPE DC-DE-90 DEG. STR. ASSEMBLY	
		SHEET 3 OF 4	DB-E444-P509

FILE:

BILL OF MATERIAL

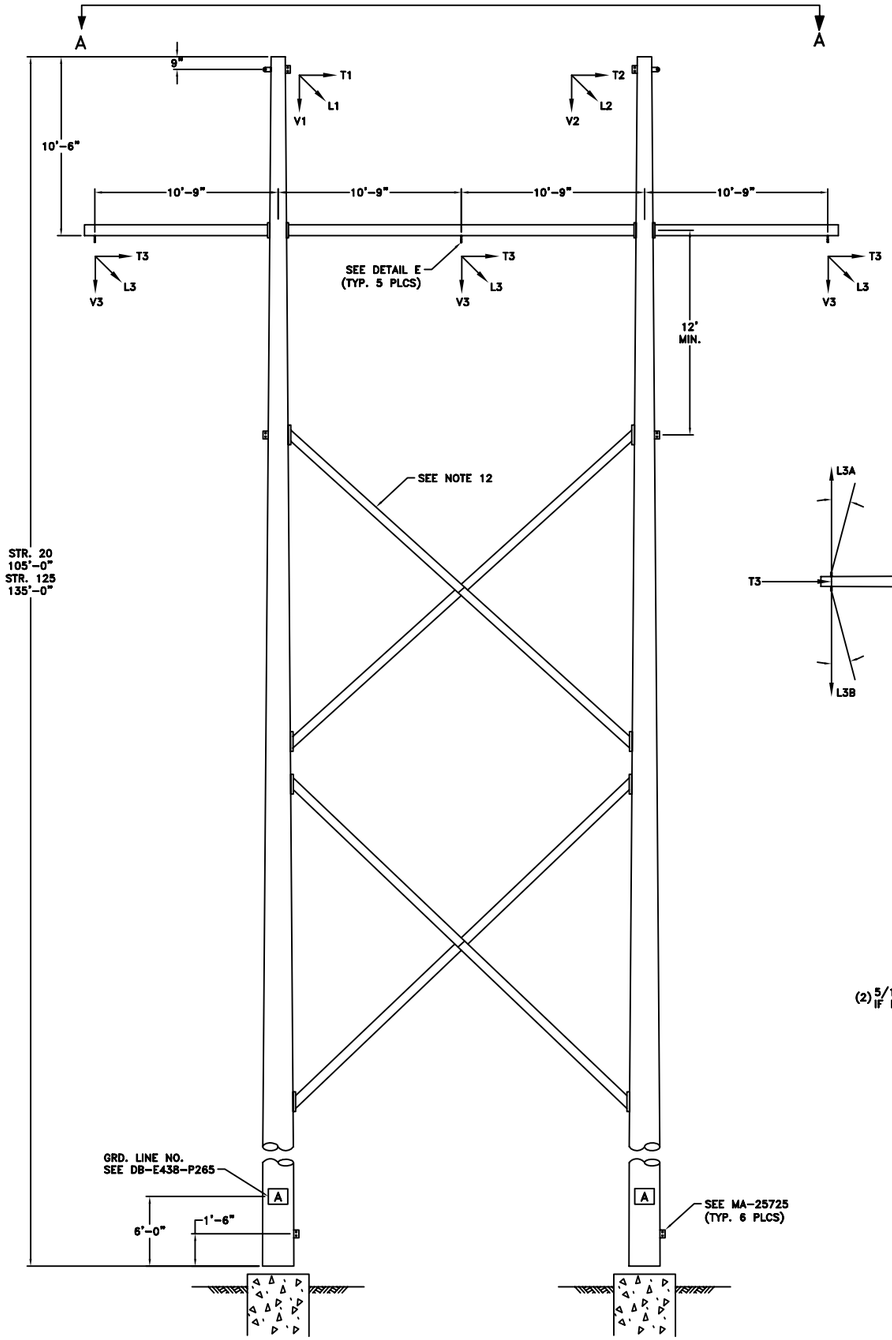
ITEM	QUANTITY	DESCRIPTION
		CONDUCTOR DEVICES
1	6	Anchor Shackle
2	2	Dead End Bolted for OPGW
3	2	Dead End Bolted for 7/16" ST
4	2	Dead End Link Plate
8	6	Anchor Shackle
9	6	Suspension Insulator 230KV L=106" RTL=25 KIP
10	3	Suspension Insulator 230KV L=101" RTL=12.5 KIP
11	6	Corona Ring Dia=8"
13	3	Socket Eye
16	6	Socket Y-Clevis
17	6	Dead End Assembly for 1780 Chukar ACSS/TW
18	6	Terminal Connector (Included with D.E. Assy.)
20	3	AGS

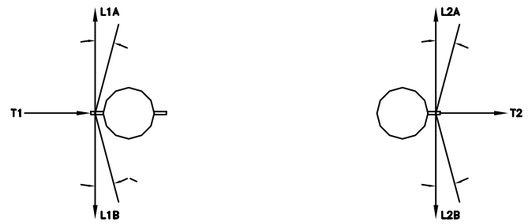
* Material included as part of structure assembly

** Quanties shown are for one shield wire, one OPGW and one circuit.

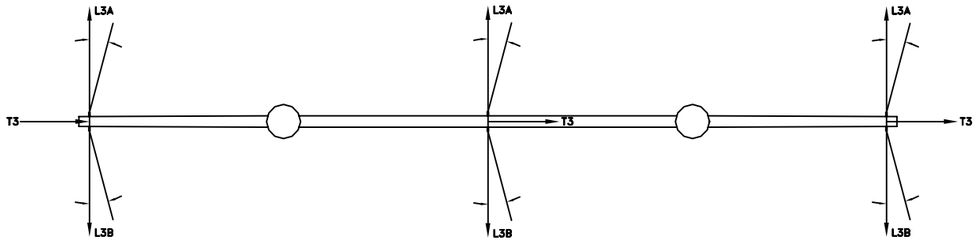
DRAWN: N.A.O. CHECKED: APPROVED: REV. 2 DATE: 12-9-09	minnesota power TRANSMISSION ENGINEERING	230 kV BISON-CENTER LINE NO. 84 STR. # 132 TYPE DC-DE-90 DEG. STR. B.O.M.	
		SHEET 4 OF 4	DB-E444-P509

FILE:





SECTION A-A
SW ORIENTATION PLAN VIEW



SECTION B-B
CONDUCTOR ORIENTATION PLAN VIEW

230KV 84L
BISON-CENTER LINE
SELF SUPPORTING STEEL POLE
SINGLE CIRCUIT H-FRAME
TANGENT STRUCTURE
ON DRILLED PIER

A IDENTIFICATION TAG-(FLAT 6)

STR. # (SEE TABLE)
LENGTH (FEET) (SEE TABLE)
STRUCTURE TYPE: STL-HF-TANG
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT-KIPS

STRUCTURE LENGTH TABLE

STR. #	LENGTH
19	105'
122	135'

WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0
7/16" EHS STEEL	T1	1,800	1,800	2,100	100
	V1	2,400	800	3,800	700
	L1A	8,700	4,900	9,000	1,800
	L1B	8,700	4,900	9,000	1,800
AC64-528 OPGW	T2	1,900	2,100	2,200	100
	V2	2,400	800	3,900	700
	L2A	8,900	5,600	9,100	1,600
	L2B	8,900	5,600	9,100	1,600
1780 ACSS CHUKAR	T3	3,300	5,800	3,200	200
	V3	7,900	3,800	8,800	3,400
	L3A	24,800	17,200	20,200	7,400
	L3B	24,800	17,200	20,200	7,400
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0

T, L AND V IN POUNDS, W IN PSF

GENERAL NOTES:

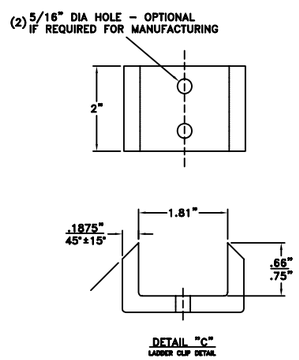
1. CONDUCTOR: 1780 KCMIL 84/19 ACSS-CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS-CADD GENERATED LOADS
   SHIELD WIRE: PLS-CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445-P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI-PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.
12. BRACING REQUIREMENTS TO BE DETERMINED BY STRUCTURE MANUFACTURER.

DEFLECTION:

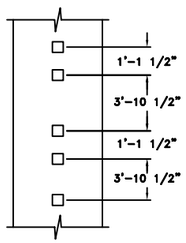
DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

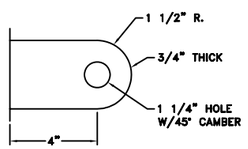
LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261-1A OF 2007 NESC.



DETAIL "C"
LADDER CLIP DETAIL



LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANG

NO.	DATE	BY	ENG.	REVISION DESCRIPTION	DWN. NAO	APP. RLO
.	.	.	.	.	SCALE	N.T.S.
.	.	.	.	.	DATE	10-20-09

minnesota power

230KV TRANSMISSION LINE
BISON-CENTER LINE NO. 84
TYPE HF-TANG STRUCTURE LOADING DIAGRAM

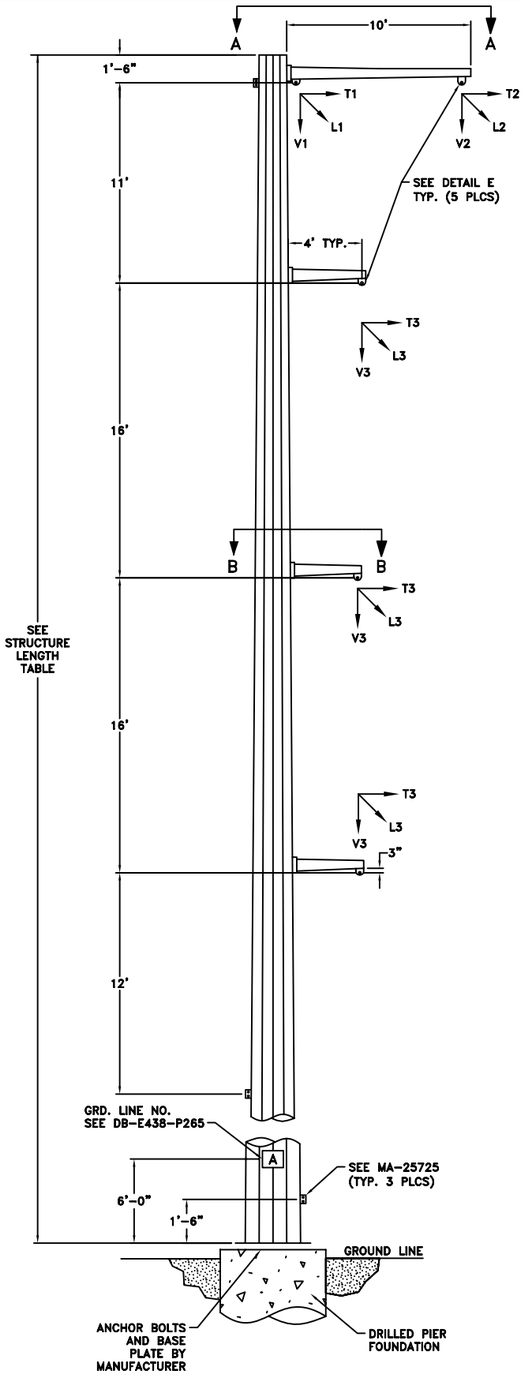
SH. 1 OF 1 | REV. 0

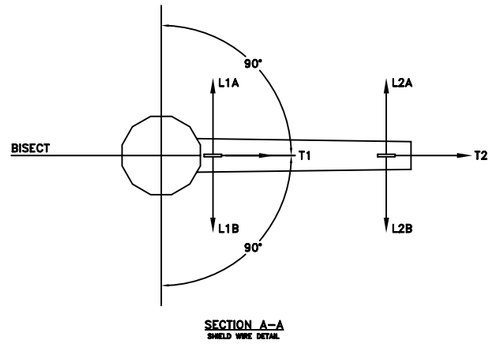
DB-E444-P510

CADD DRAWING
FOR REPRODUCTION ONLY

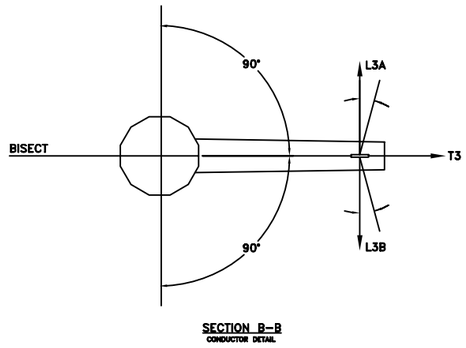
	CODE		
/ /	.	.	.

FILE: .

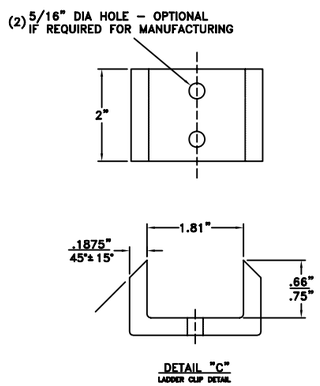




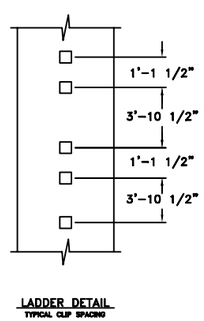
SECTION A-A
SHIELD WIRE DETAIL



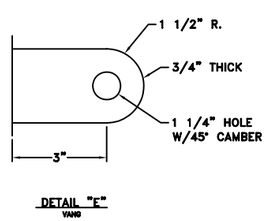
SECTION B-B
CONDUCTOR DETAIL



DETAIL "C"
LADDER CLIP DETAIL



LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANG

230KV 84L
BISON-CENTER LINE
SELF SUPPORTING STEEL POLE
SINGLE CIRCUIT MEDIUM ANGLE STRUCTURE
ON DRILLED PIER

A IDENTIFICATION TAG-(FLAT 6)

STR. # (SEE TABLE)
LENGTH (FEET) (SEE TABLE)
STRUCTURE TYPE: STL-SC-MA
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT-KIPS

STRUCTURE LENGTH TABLE

STR. #	LENGTH
67	110'
68	110'
128	120'

WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL	LOAD CASE 5A BROKEN WIRE (SHIELD WIRE) 1/2" ICE 4 PSF WIND 0° FINAL	LOAD CASE 5B BROKEN WIRE (CONDUCTOR) 1/2" ICE 4 PSF WIND 0° FINAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1
7/16" EHS STEEL	T1	4,100	2,800	4,400	700	2,500	2,500
	V1	1,800	600	2,800	600	1,300	1,300
	L1A	8,600	4,900	8,900	1,800	5,700	5,700
	L1B	8,600	4,900	8,900	1,800	5,700	5,700
AC64-528 OPGW	T2	4,200	3,300	4,500	600	1,300	2,600
	V2	1,800	600	2,900	500	800	1,400
	L2A	8,700	5,500	9,000	1,600	5,800	5,800
	L2B	8,700	5,500	9,000	1,600	–	5,800
1780 ACSS CHUKAR	T3	10,500	9,600	8,800	2,600	5,900	3,000
	V3	5,900	2,900	6,600	2,600	4,300	2,400
	L3A	24,400	16,900	19,900	7,300	14,500	14,500
	L3B	24,400	16,900	19,900	7,300	14,500	–
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0	4.4	4.4
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0	1.1	1.1

T, L AND V IN POUNDS, W IN PSF

GENERAL NOTES:

1. CONDUCTOR: 1780 KCMIL 84/19 ACSS-CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS-CADD GENERATED LOADS
   SHIELD WIRE: PLS-CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445-P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI-PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.

DEFLECTION:

DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261-1A OF 2007 NESC.

NO.	DATE	BY	ENG.	REVISION DESCRIPTION
.	.	.	.	.
.	.	.	.	.

DWN. NAO | APP. RLO
SCALE N.T.S.
DATE 10-20-09

minnesota power

230KV TRANSMISSION LINE
BISON-CENTER LINE NO. 84
TYPE SC-MA LOADING DIAGRAM

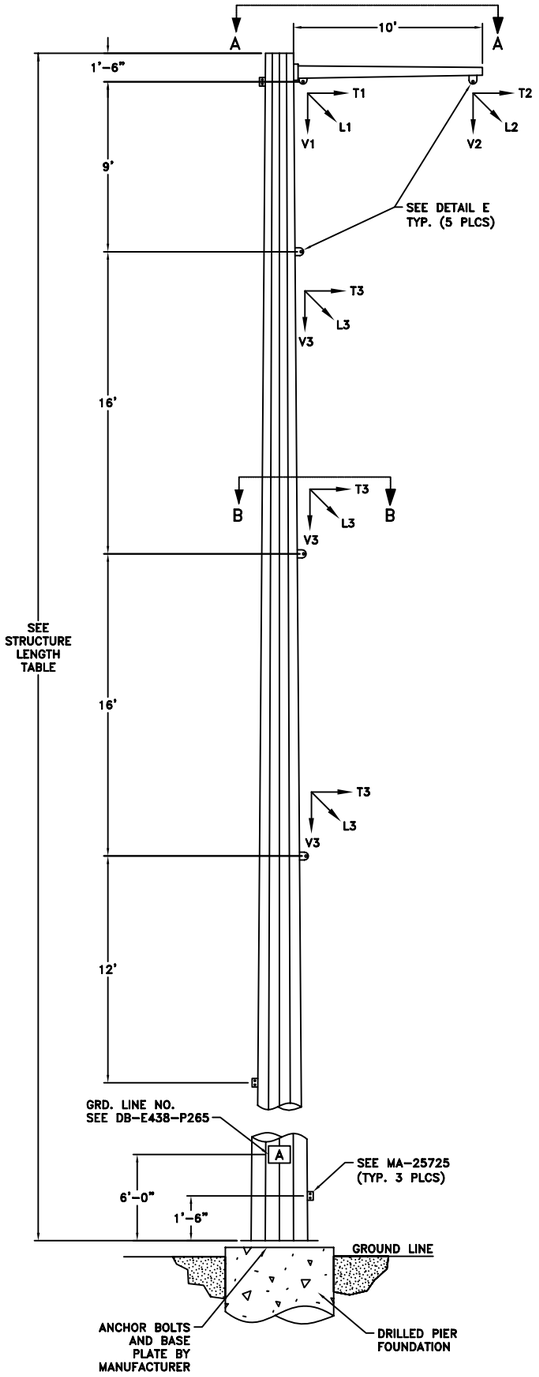
SH. 1 OF 1 | REV. 0

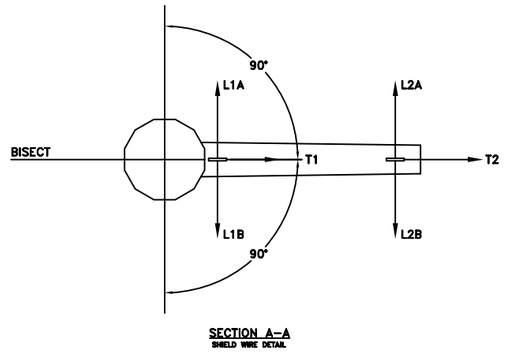
DB-E444-P511

CODE
/ / | . | . | .

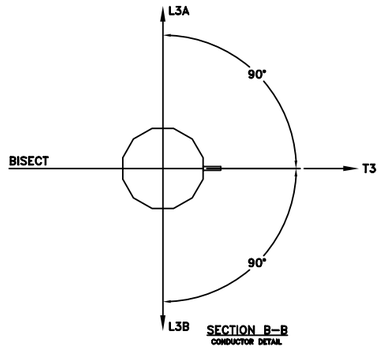
FILE: .

CADD DRAWING
FOR REPRODUCTION ONLY

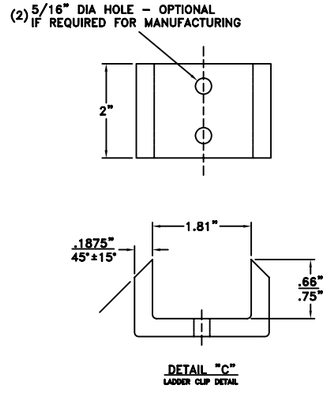




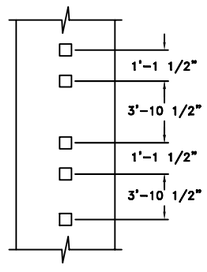
SECTION A-A
SHIELD WIRE DETAIL



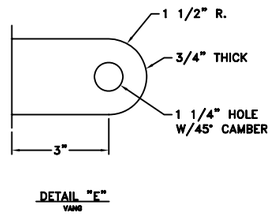
SECTION B-B
CONDUCTOR DETAIL



DETAIL "C"
LADDER CLIP DETAIL



LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANG

230KV 84L
BISON-CENTER LINE
SELF SUPPORTING STEEL POLE
SINGLE CIRCUIT HEAVY ANGLE STRUCTURE
ON DRILLED PIER

A IDENTIFICATION TAG-(FLAT 6)

STR. # (SEE TABLE)
LENGTH (FEET) (SEE TABLE)
STRUCTURE TYPE: STL-SC-HA
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT-KIPS

STRUCTURE LENGTH TABLE

STR. #	LENGTH
72	90'
77	140'
91	115'
106	90'
118	115'

WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL	LOAD CASE 5A BROKEN WIRE (SHIELD WIRE) 1/2" ICE 4 PSF WIND 0° FINAL	LOAD CASE 5B BROKEN WIRE (CONDUCTOR) 1/2" ICE 4 PSF WIND 0° FINAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1
7/16" EHS STEEL	T1	7,200	4,600	7,600	1,300	4,600	4,600
	V1	2,000	700	3,000	600	1,500	1,500
	L1A	8,200	4,600	8,500	1,700	5,500	5,500
	L1B	8,200	4,600	8,500	1,700	5,500	5,500
AC64-528 OPGW	T2	7,400	5,300	7,700	1,200	2,300	4,600
	V2	2,000	600	3,100	600	800	1,500
	L2A	8,300	5,200	8,500	1,500	5,500	5,500
	L2B	8,300	5,200	8,500	1,500	–	5,500
1780 ACSS CHUKAR	T3	19,200	15,700	16,000	5,200	11,100	5,600
	V3	6,400	3,100	7,100	2,800	4,700	2,300
	L3A	23,200	16,100	18,900	6,900	13,800	13,800
	L3B	23,200	16,100	18,900	6,900	13,800	–
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0	4.4	4.4
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0	1.1	1.1

T, L AND V IN POUNDS, W IN PSF

GENERAL NOTES:

1. CONDUCTOR: 1780 KCMIL 84/19 ACSS-CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS-CADD GENERATED LOADS
   SHIELD WIRE: PLS-CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445-P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI-PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.

DEFLECTION:

DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261-1A OF 2007 NESC.

NO.	DATE	BY	ENG.	REVISION DESCRIPTION	DWN. NAO	APP. RLO
.	.	.	.	.	SCALE	N.T.S.
.	.	.	.	.	DATE	10-20-09

minnesota power

230KV TRANSMISSION LINE
BISON-CENTER LINE NO. 84
TYPE SC-HA LOADING DIAGRAM

SH. 1 OF 1 | REV. 0

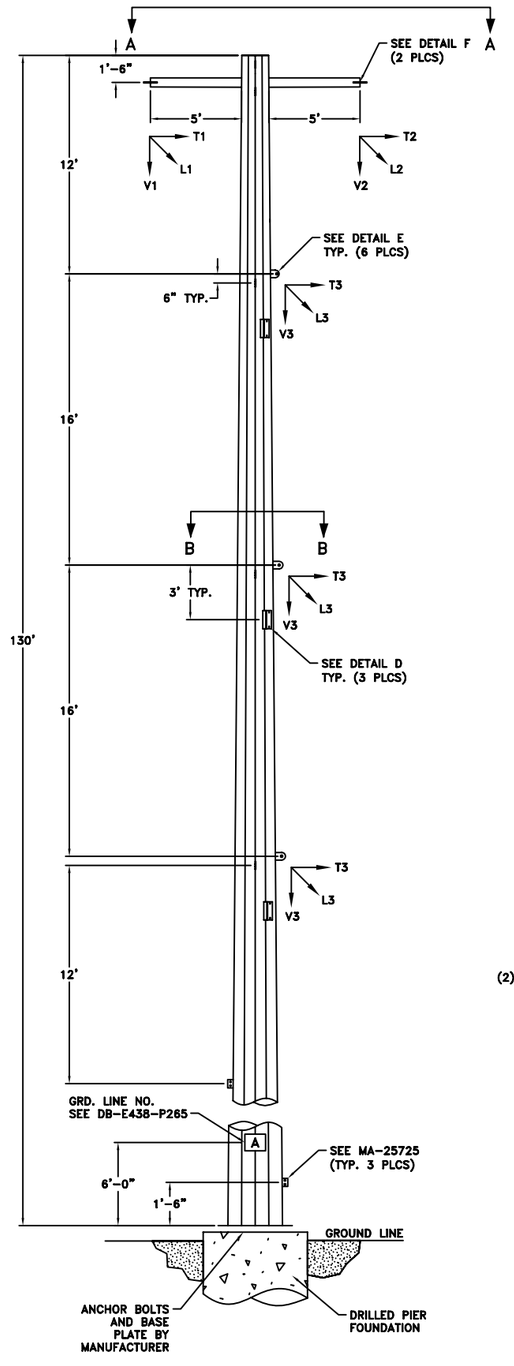
DB-E444-P512

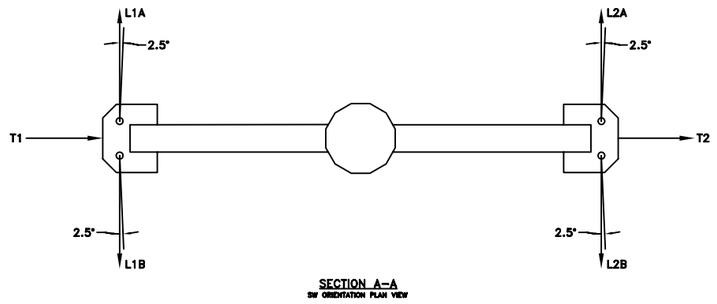
CODE

/ / | . | . | .

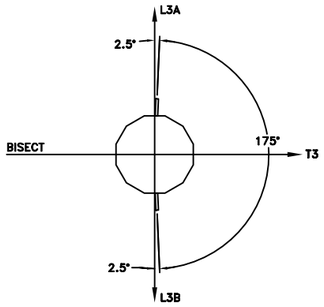
FILE: .

CADD DRAWING
FOR REPRODUCTION ONLY

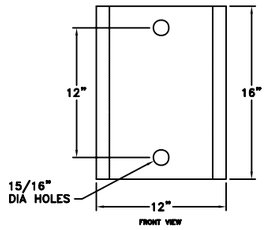




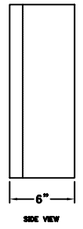
SECTION A-A
SW ORIENTATION PLAN VIEW



SECTION B-B
CONDUCTOR ORIENTATION PLAN VIEW

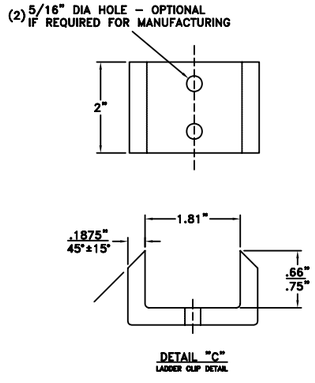


FRONT VIEW

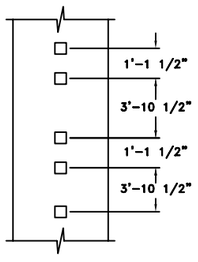


SIDE VIEW

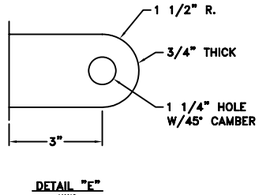
DETAIL "D"
HOR. POS INS. BRKT



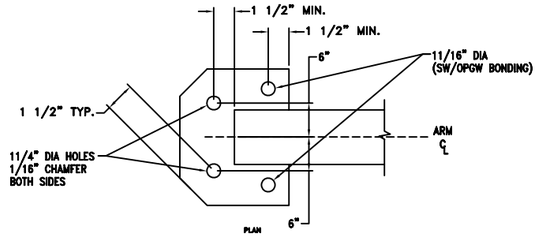
DETAIL "C"
LADDER CLIP DETAIL



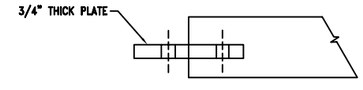
LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANG



PLAN



DETAIL "F"
ATTACHMENT PLATE

230KV 84L
BISON-CENTER LINE
SELF SUPPORTING STEEL POLE
SINGLE CIRCUIT DEADEND 5° STRUCTURE
ON DRILLED PIER

A IDENTIFICATION TAG-(FLAT 6)

STR. # 102
LENGTH (FEET) 130
STRUCTURE TYPE: STL-SC-DE 5°
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT-KIPS

WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ASCE I&W 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL	LOAD CASE 5 DEADEND 1/2" ICE 4 PSF WIND 0° INITIAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0	WIND=2.50 V=1.50 T=1.65 L=1.65
7/16" EHS STEEL	T1	1,800	1,500	2,000	200	900
	V1	1,800	600	2,800	600	1,000
	L1A	8,700	4,900	9,000	1,800	8,700
	L1B	8,700	4,900	9,000	1,800	–
AC64-528 OPGW	T2	1,900	1,800	2,100	200	1,000
	V2	1,800	600	2,900	500	1,000
	L2A	8,900	5,600	9,100	1,600	8,900
	L2B	8,900	5,600	9,100	1,600	–
1780 ACSS CHUKAR	T3	3,900	5,000	3,500	700	2,000
	V3	5,900	2,900	6,600	2,600	3,200
	L3A	24,800	17,200	20,200	7,400	24,800
	L3B	24,800	17,200	20,200	7,400	–
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0	10.0
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0	1.5

T, L AND V IN POUNDS, W IN PSF

GENERAL NOTES:

1. CONDUCTOR: 1780 KCMIL 84/19 ACSS-CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS-CADD GENERATED LOADS
   SHIELD WIRE: PLS-CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445-P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI-PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.

DEFLECTION:

DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261-1A OF 2007 NESC.

NO.	DATE	BY	ENG.	REVISION DESCRIPTION
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.	.	.	.	.

DWN. NAO APP. RLO
SCALE N.T.S.
DATE 10-20-09

minnesota power

230KV TRANSMISSION LINE
BISON-CENTER LINE NO. 84
TYPE SC-DE-5 DEG. LOADING DIAGRAM

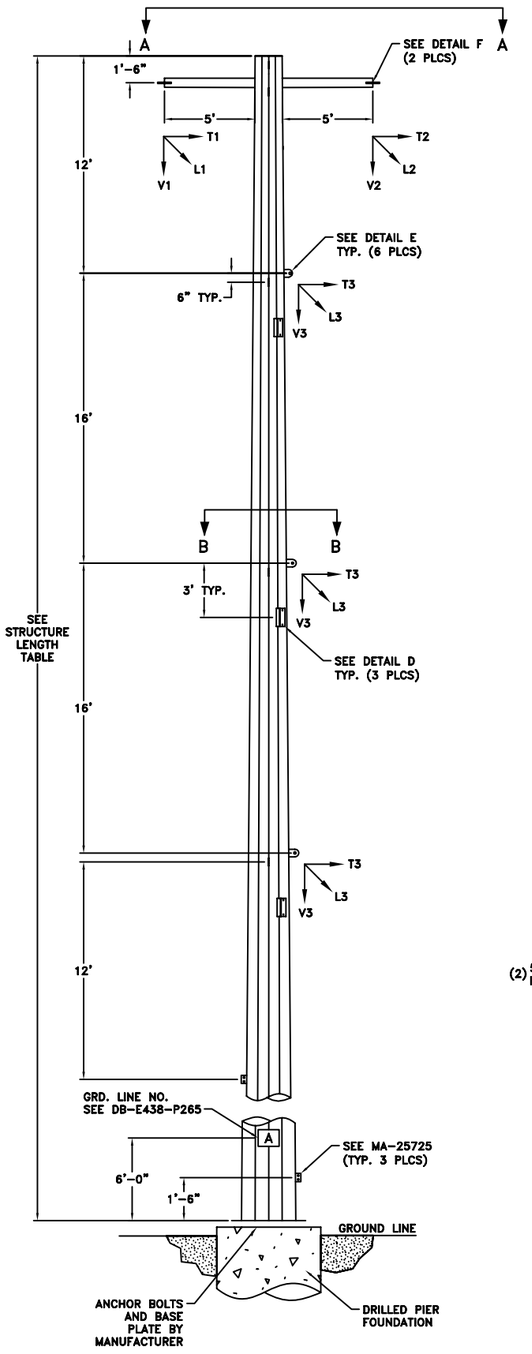
SH. 1 OF 1 REV. 0

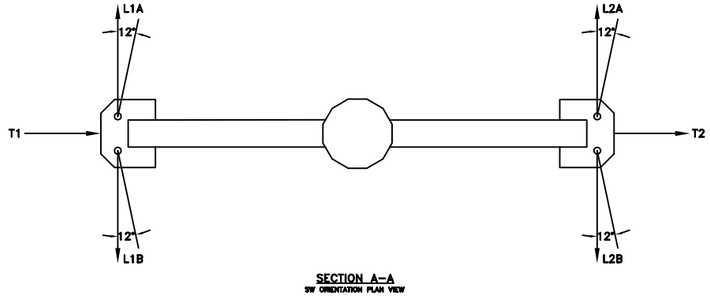
DB-E444-P513

CODE
/ / . . .

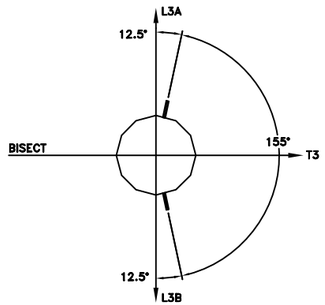
FILE: .

CADD DRAWING
FOR REPRODUCTION ONLY

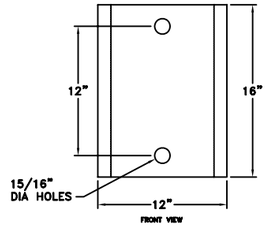




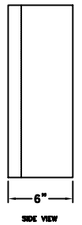
SECTION A-A
SW ORIENTATION PLAN VIEW



SECTION B-B
CONDUCTOR ORIENTATION PLAN VIEW

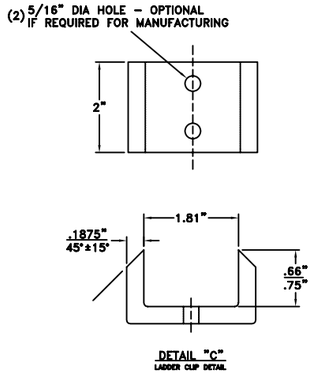


FRONT VIEW

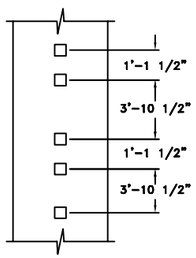


SIDE VIEW

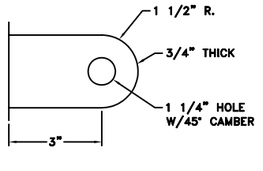
DETAIL "D"
HOR. POS INS. BRKT



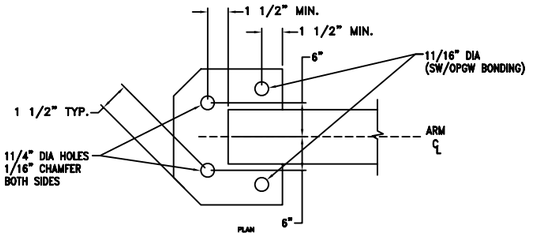
DETAIL "C"
LADDER CLIP DETAIL



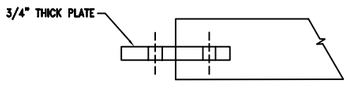
LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANG



PLAN



DETAIL "F"
ATTACHMENT PLATE

230KV 84L
BISON-CENTER LINE
SELF SUPPORTING STEEL POLE
SINGLE CIRCUIT DEADEND 25° STRUCTURE
ON DRILLED PIER

A IDENTIFICATION TAG-(FLAT 6)
STR. # (SEE TABLE)
LENGTH (FEET) (SEE TABLE)
STRUCTURE TYPE: STL-SC-DE 25°
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT-KIPS

STRUCTURE LENGTH TABLE

STR. #	LENGTH
9	105'
11	80'

WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL	LOAD CASE 5 DEADEND 1/2" ICE 4 PSF WIND 0° INITIAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0	WIND=2.50 V=1.50 T=1.65 L=1.65
7/16" EHS STEEL	T1	4,400	2,900	4,700	800	2,200
	V1	1,200	400	1,700	400	700
	L1A	8,500	4,800	8,900	1,800	8,500
	L1B	8,500	4,800	8,900	1,800	–
AC64-528 OPGW	T2	4,500	3,300	4,800	700	2,300
	V2	1,200	400	1,800	400	700
	L2A	8,700	5,500	8,900	1,600	8,700
	L2B	8,700	5,500	8,900	1,600	–
1780 ACSS CHUKAR	T3	11,600	9,800	9,700	3,100	5,800
	V3	3,700	1,900	4,000	1,700	2,100
	L3A	24,300	16,800	19,800	7,200	24,300
	L3B	24,300	16,800	19,800	7,200	–
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0	10.0
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0	1.5

T, L AND V IN POUNDS, W IN PSF

GENERAL NOTES:

1. CONDUCTOR: 1780 KCMIL 84/19 ACSS-CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS-CADD GENERATED LOADS
   SHIELD WIRE: PLS-CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445-P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI-PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.

DEFLECTION:

DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261-1A OF 2007 NESC.

NO.	DATE	BY	ENG.	REVISION DESCRIPTION
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.	.	.	.	.

DWN. NAO APP. RLO
SCALE N.T.S.
DATE 10-20-09

minnesota power

230KV TRANSMISSION LINE
BISON-CENTER LINE NO. 84
TYPE SC-DE-25 DEG. LOADING DIAGRAM

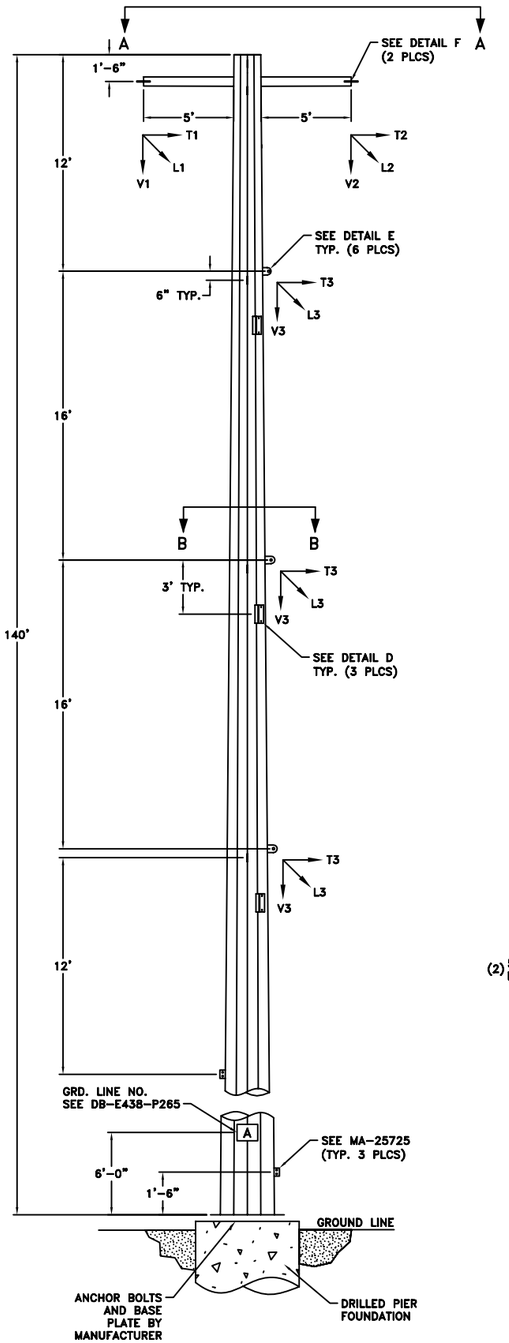
SH. 1 OF 1 REV. 0

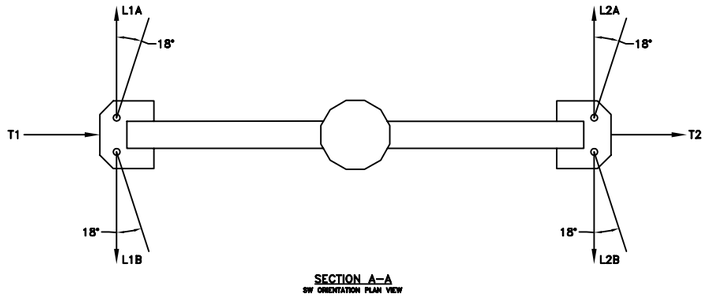
DB-E444-P514

CODE
/ / . . .

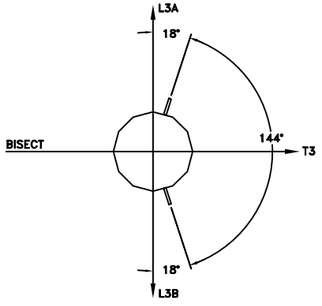
FILE: .

CADD DRAWING
FOR REPRODUCTION ONLY

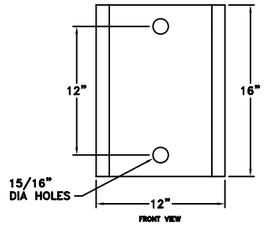




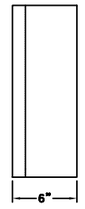
SECTION A–A
SW ORIENTATION PLAN VIEW



SECTION B–B
CONDUCTOR ORIENTATION PLAN VIEW

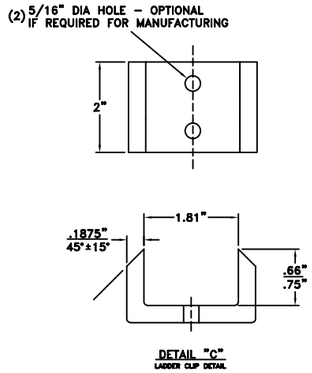


FRONT VIEW

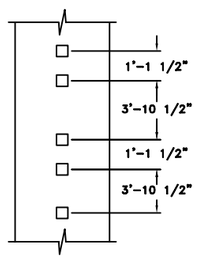


SIDE VIEW

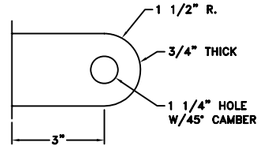
DETAIL "D"
HOR. POS INS. BRKT



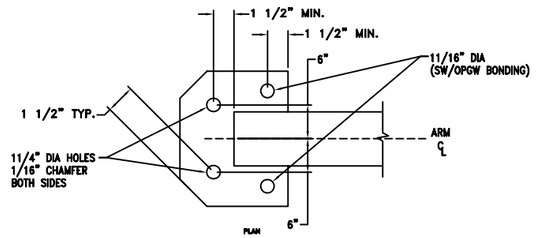
DETAIL "C"
LADDER CLIP DETAIL



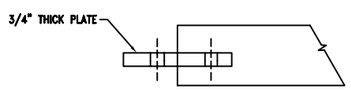
LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANG



PLAN



DETAIL "F"
ATTACHMENT PLATE

230KV 84L
BISON–CENTER LINE
SELF SUPPORTING STEEL POLE
SINGLE CIRCUIT DEADEND 36° STRUCTURE
ON DRILLED PIER

A IDENTIFICATION TAG–(FLAT 6)

STR. # 119
LENGTH (FEET) 140
STRUCTURE TYPE: STL–SC–DE 36°
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT–KIPS

WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL	LOAD CASE 5 DEADEND 1/2" ICE 4 PSF WIND 0° INITIAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0	WIND=2.50 V=1.50 T=1.65 L=1.65
7/16" EHS STEEL	T1	6,500	4,200	6,900	1,100	3,300
	V1	2,600	900	4,100	800	1,400
	L1A	8,300	4,700	8,600	1,700	8,300
	L1B	8,300	4,700	8,600	1,700	–
AC64–528 OPGW	T2	6,700	4,800	7,000	1,000	3,400
	V2	2,700	800	4,300	700	1,400
	L2A	8,500	5,300	8,700	1,600	8,500
	L2B	8,500	5,300	8,700	1,600	–
1780 ACSS CHUKAR	T3	17,200	14,400	14,300	4,600	8,600
	V3	8,600	4,100	9,600	3,800	4,500
	L3A	23,600	16,400	19,200	7,000	23,600
	L3B	23,600	16,400	19,200	7,000	–
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0	10.0
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0	1.5

T, L AND V IN POUNDS, W IN PSF

GENERAL NOTES:

1. CONDUCTOR: 1780 KCMIL 84/19 ACSS–CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS–CADD GENERATED LOADS
   SHIELD WIRE: PLS–CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445–P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI–PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.

DEFLECTION:

DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261–1A OF 2007 NESC.

NO.	DATE	BY	ENG.	REVISION DESCRIPTION
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.	.	.	.	.

DWN. NAO | APP. RLO
SCALE N.T.S.
DATE 10–20–09

minnesota power

230KV TRANSMISSION LINE
BISON–CENTER LINE NO. 84
TYPE SC–DE–36 DEG. LOADING DIAGRAM

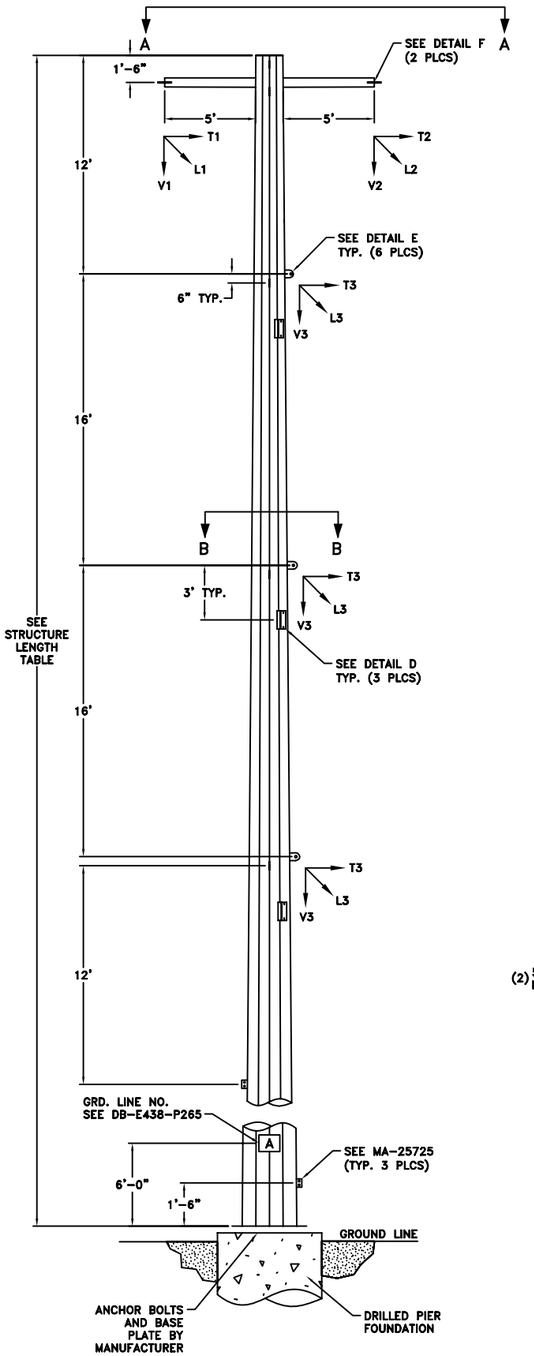
SH. 1 OF 1 | REV. 0

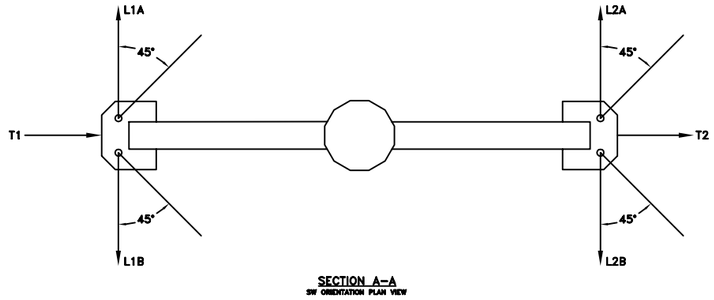
DB–E444–P515

CODE
/ / | . | . | .

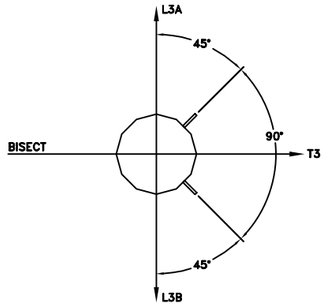
FILE: .

CADD DRAWING
FOR REPRODUCTION ONLY

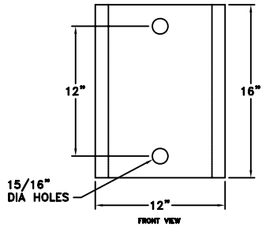




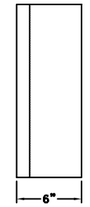
SECTION A-A
SW ORIENTATION PLAN VIEW



SECTION B-B
CONDUCTOR ORIENTATION PLAN VIEW

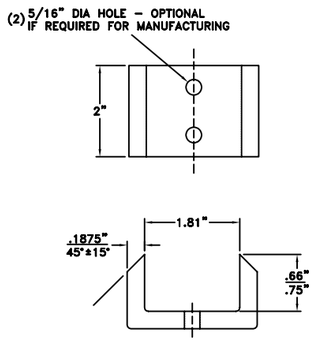


FRONT VIEW

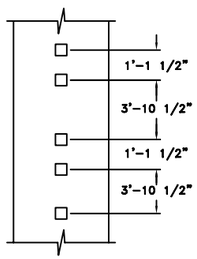


SIDE VIEW

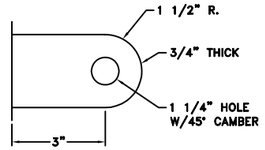
DETAIL "D"
HOR. POS INS. BRKT



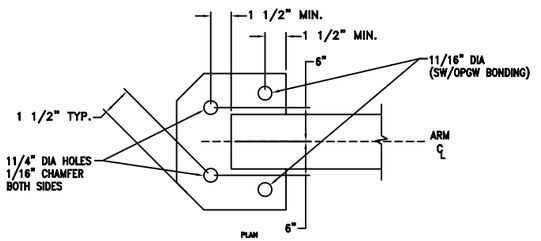
DETAIL "C"
LADDER CLIP DETAIL



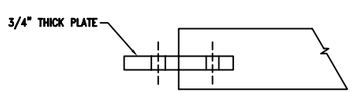
LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANG



PLAN



DETAIL "F"
ATTACHMENT PLATE

230KV 84L
BISON-CENTER LINE
SELF SUPPORTING STEEL POLE
SINGLE CIRCUIT DEADEND 90° STRUCTURE
ON DRILLED PIER

A IDENTIFICATION TAG-(FLAT 6)
STR. # (SEE TABLE)
LENGTH (FEET) (SEE TABLE)
STRUCTURE TYPE: STL-SC-DE 90°
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT-KIPS

STRUCTURE LENGTH TABLE

STR. #	LENGTH
1	80'
28	90'
34	90'
54	90'
82	105'

WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL	LOAD CASE 5 DEADEND 1/2" ICE 4 PSF WIND 0° INITIAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0	WIND=2.50 V=1.50 T=1.65 L=1.65
7/16" EHS STEEL	T1	13,000	7,700	13,600	2,600	6,500
	V1	1,800	600	2,800	600	1,000
	L1A	6,200	3,500	6,400	1,300	6,200
	L1B	6,200	3,500	6,400	1,300	–
AC64-528 OPGW	T2	13,300	8,800	13,800	2,300	6,700
	V2	1,800	600	2,900	500	1,000
	L2A	6,300	4,000	6,500	1,200	6,300
	L2B	6,300	4,000	6,500	1,200	–
1780 ACSS CHUKAR	T3	36,300	26,800	29,800	10,400	18,200
	V3	5,900	2,900	6,600	2,600	3,200
	L3A	17,600	12,200	14,300	5,200	17,600
	L3B	17,600	12,200	14,300	5,200	–
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0	10.0
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0	1.5

T, L AND V IN POUNDS, W IN PSF

GENERAL NOTES:

1. CONDUCTOR: 1780 KCMIL 84/19 ACSS-CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS-CADD GENERATED LOADS
   SHIELD WIRE: PLS-CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445-P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI-PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.

DEFLECTION:

DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261-1A OF 2007 NESC.

NO.	DATE	BY	ENG.	REVISION DESCRIPTION	DWN. NAO	APP. RLO
.	.	.	.	.	SCALE	N.T.S.
.	.	.	.	.	DATE	10-20-09

minnesota power

230KV TRANSMISSION LINE
BISON-CENTER LINE NO. 84
TYPE SC-DE-90 DEG. LOADING DIAGRAM

SH. 1 OF 1 | REV. 0

DB-E444-P516

CADD DRAWING
FOR REPRODUCTION ONLY

	CODE		
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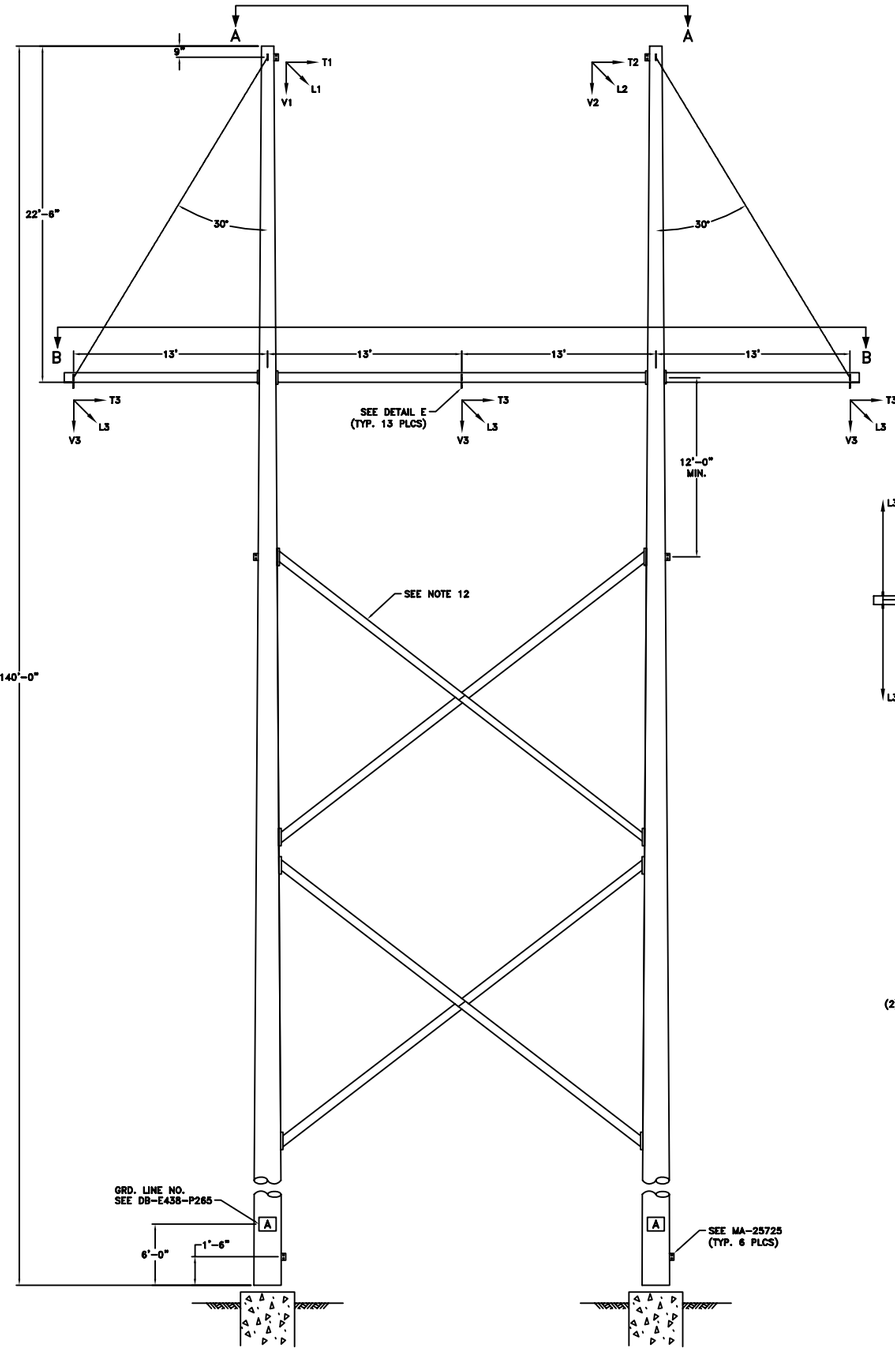
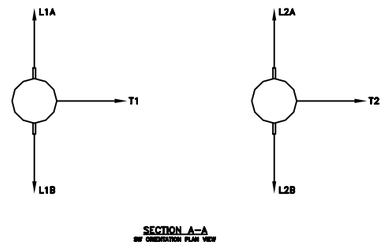
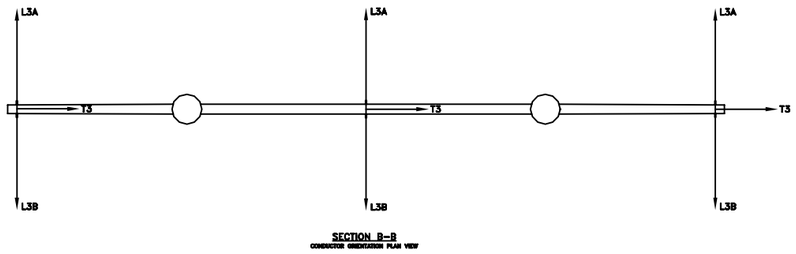




SECTION A-A
SW ORIENTATION PLAN VIEW



SECTION B-B
CONDUCTOR ORIENTATION PLAN VIEW

230KV 84L
BISON-CENTER LINE
SELF SUPPORTING STEEL POLE
SINGLE CIRCUIT H-FRAME
DEADEND 0° STRUCTURE
ON DRILLED PIER

A IDENTIFICATION TAG-(FLAT 6)

STR. # 121
LENGTH (FEET) 140
STRUCTURE TYPE: STL-HF-DE-0°
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT-KIPS

WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL	LOAD CASE 5 DEADEND 1/2" ICE 4 PSF WIND 0° INITIAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0	WIND=2.50 V=1.50 T=1.65 L=1.65
7/16" EHS STEEL	T1	1,600	1,700	1,900	–	800
	V1	2,000	700	3,200	600	1,100
	L1A	8,700	4,900	9,100	1,800	8,700
	L1B	8,700	4,900	9,100	1,800	–
AC64-528 OPGW	T2	1,700	2,000	2,000	–	900
	V2	2,100	700	3,300	600	1,100
	L2A	8,900	5,600	9,100	1,600	8,900
	L2B	8,900	5,600	9,100	1,600	–
1780 ACSS CHUKAR	T3	2,700	5,400	2,700	–	1,400
	V3	6,600	3,200	7,400	2,900	3,600
	L3A	24,800	17,200	20,200	7,400	24,800
	L3B	24,800	17,200	20,200	7,400	–
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0	10.0
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0	1.5

T, L AND V IN POUNDS, W IN PSF

GENERAL NOTES:

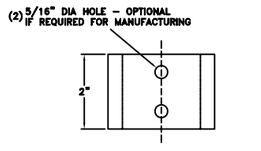
1. CONDUCTOR: 1780 KCMIL 84/19 ACSS-CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS-CADD GENERATED LOADS
   SHIELD WIRE: PLS-CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445-P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI-PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.
12. BRACING REQUIREMENTS TO BE DETERMINED BY STRUCTURE MANUFACTURER.

DEFLECTION:

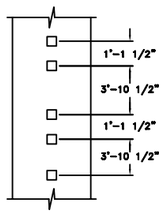
DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

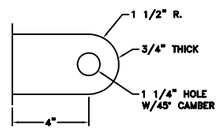
LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261-1A OF 2007 NESC.



DETAIL "C"
LADDER CLIP DETAIL



LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANG

NO.	DATE	BY	ENG.	REVISION DESCRIPTION
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.	.	.	.	.

DWN. NAO	APP. RLO		
SCALE	N.T.S.		
DATE	10-20-09		

minnesota power

230KV TRANSMISSION LINE
BISON-CENTER LINE NO. 84
TYPE HF-DE-0 DEG. STR. LOADING DIAGRAM

SH. 1 OF 1 | REV. 0

DB-E444-P517

CADD DRAWING
FOR REPRODUCTION ONLY

	CODE		
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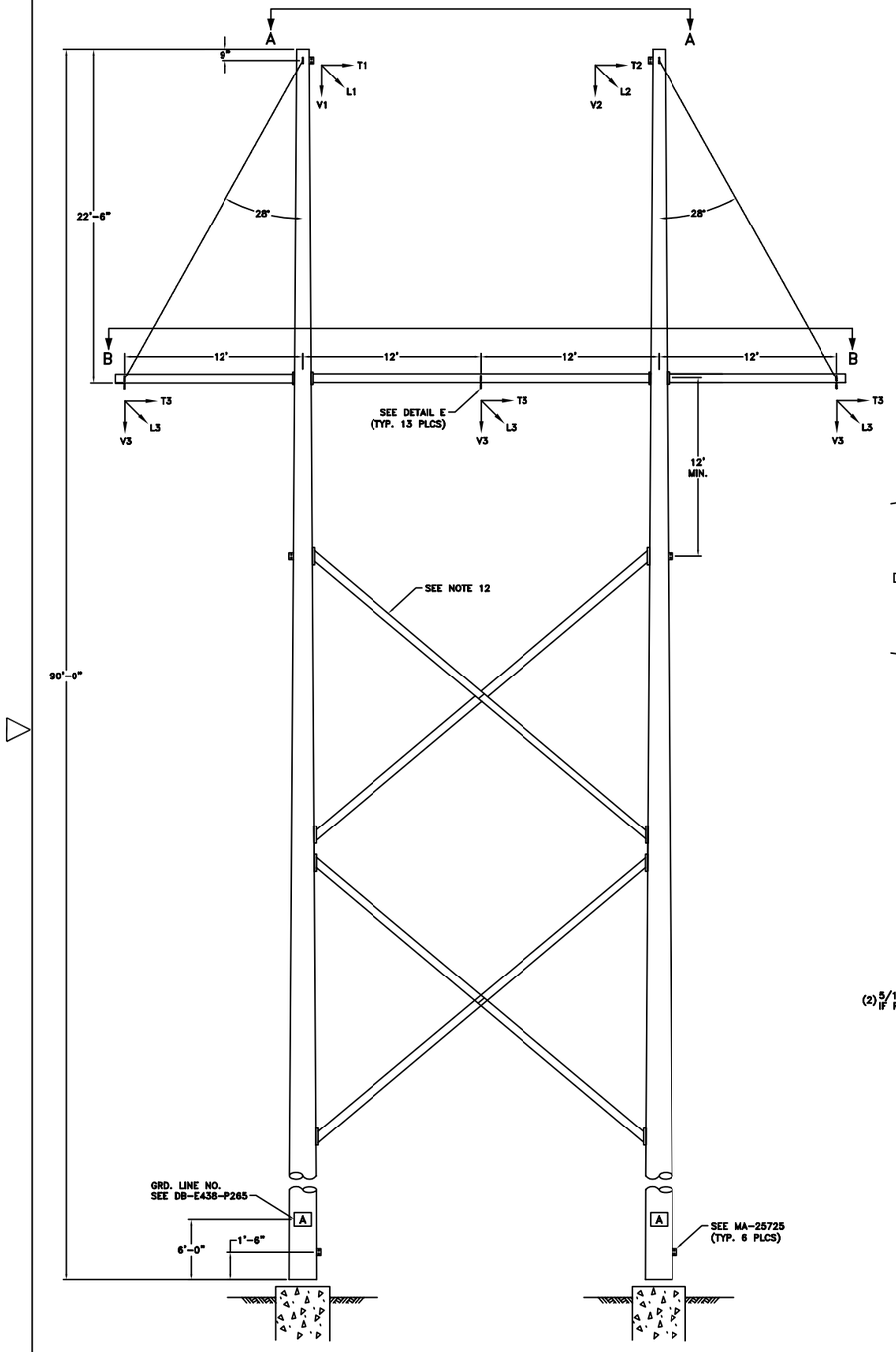
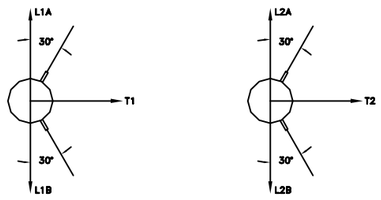
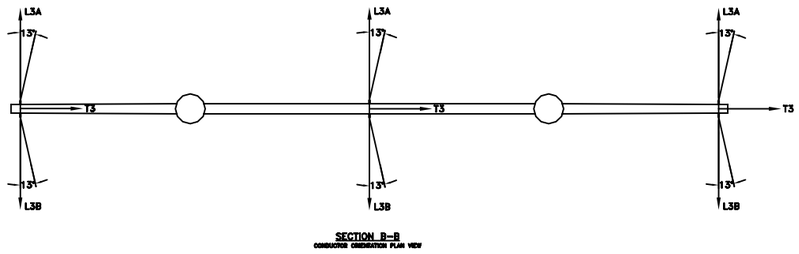




SECTION A-A
90° ORIENTATION PLAN VIEW



SECTION B-B
CONDUCTOR ORIENTATION PLAN VIEW

230KV 84L
BISON-CENTER LINE
SELF SUPPORTING STEEL POLE
SINGLE CIRCUIT H-FRAME
DEADEND 26° STRUCTURE
ON DRILLED PIER

A IDENTIFICATION TAG-(FLAT 6)

STR. # 123
LENGTH (FEET) 90
STRUCTURE TYPE: STL-HF-DE-26°
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT-KIPS

WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL	LOAD CASE 5 DEADEND 1/2" ICE 4 PSF WIND 0° INITIAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0	WIND=2.50 V=1.50 T=1.65 L=1.65
7/16" EHS STEEL	T1	5,100	3,500	5,500	800	2,600
	V1	2,000	700	3,200	600	1,100
	L1A	8,500	4,800	8,800	1,800	8,500
	L1B	8,500	4,800	8,800	1,800	–
AC64-528 OPGW	T2	5,300	4,000	5,600	800	2,700
	V2	2,100	700	3,300	600	1,100
	L2A	8,700	5,400	8,900	1,600	8,700
	L2B	8,700	5,400	8,900	1,600	–
1780 ACSS CHUKAR	T3	13,200	11,800	11,100	3,300	6,600
	V3	6,600	3,200	7,400	2,900	3,600
	L3A	24,200	16,700	19,700	7,200	24,200
	L3B	24,200	16,700	19,700	7,200	–
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0	10.0
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0	1.5

T, L AND V IN POUNDS, W IN PSF

GENERAL NOTES:

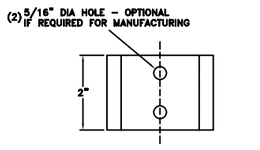
1. CONDUCTOR: 1780 KCMIL 84/19 ACSS-CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS-CADD GENERATED LOADS
   SHIELD WIRE: PLS-CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445-P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI-PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.
12. BRACING REQUIREMENTS TO BE DETERMINED BY STRUCTURE MANUFACTURER.

DEFLECTION:

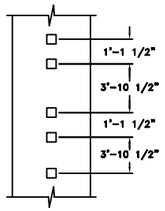
DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

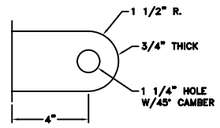
LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261-1A OF 2007 NESC.



DETAIL "C"
LADDER CLIP DETAIL



LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANG

NO.	DATE	BY	ENG.	REVISION DESCRIPTION
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.	.	.	.	.

DWN. NAO | APP. RLO
SCALE N.T.S.
DATE 10-20-09

minnesota power

230KV TRANSMISSION LINE
BISON-CENTER LINE NO. 84
TYPE HF-DE-26 DEG. STR. LOADING DIAGRAM

SH. 1 OF 1 | REV. 0

DB-E444-P518

FILE: .

CADD DRAWING
FOR REPRODUCTION ONLY

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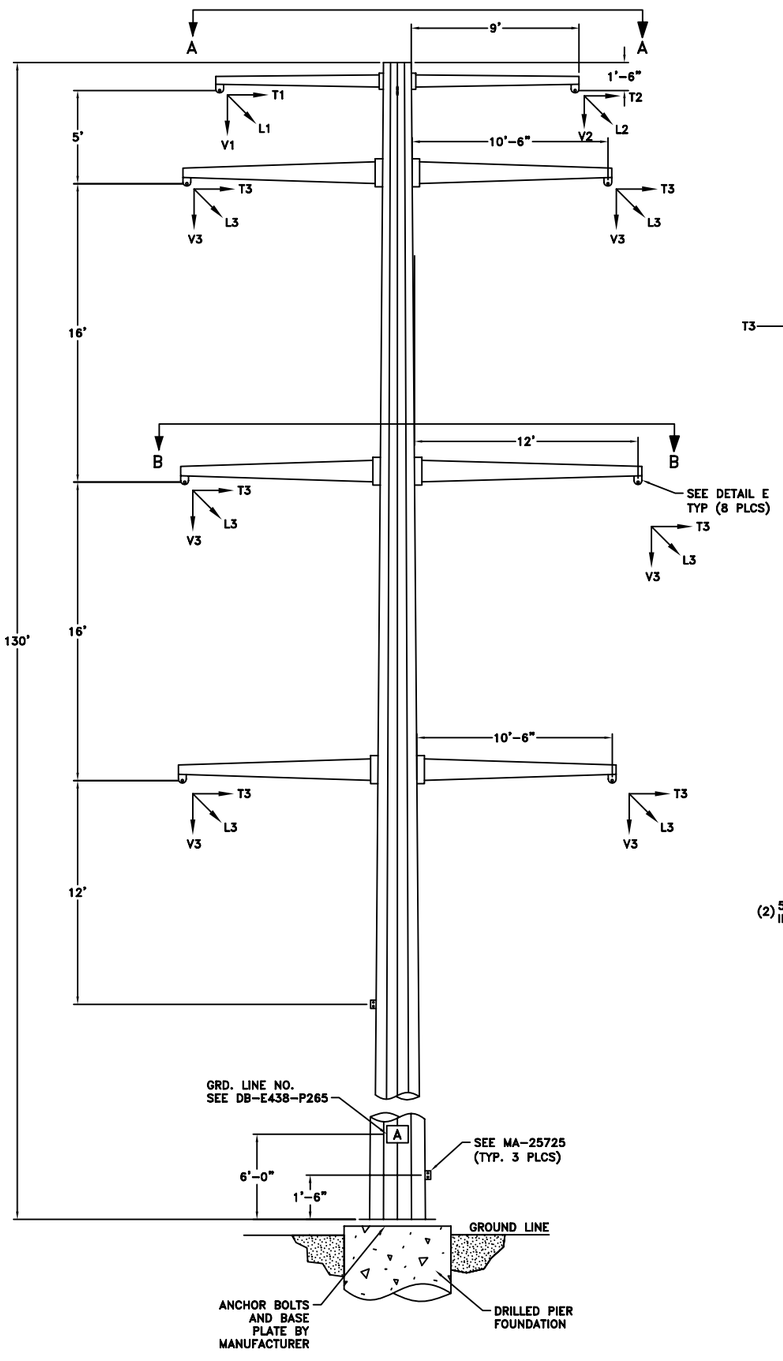
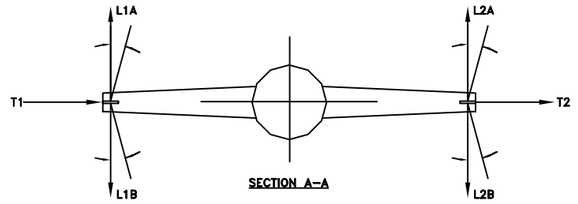
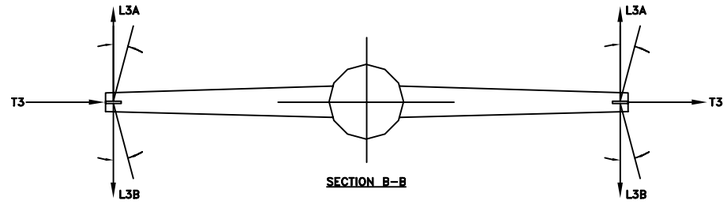




SECTION A–A



SECTION B–B

230KV 84L
BISON–CENTER LINE
SELF SUPPORTING STEEL POLE
DOUBLE CIRCUIT TANGENT STRUCTURE
ON DRILLED PIER

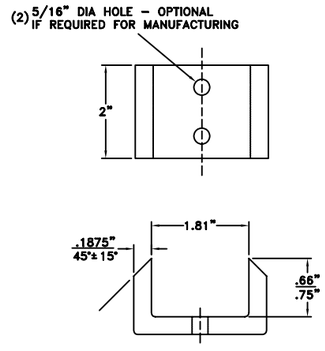
A IDENTIFICATION TAG–(FLAT 6)

STR. # 131
LENGTH (FEET) 130
STRUCTURE TYPE: STL–DC–TANG
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT–KIPS

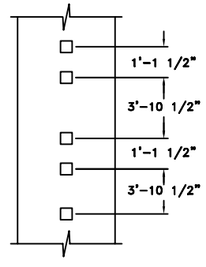
WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0
7/16" EHS STEEL	T1	1,200	1,100	1,400	100
	V1	1,200	400	1,700	400
	L1A	8,700	4,900	9,000	1,800
	L1B	8,700	4,900	9,000	1,800
AC64–528 OPGW	T2	1,200	1,300	1,400	100
	V2	1,200	400	1,800	400
	L2A	8,900	5,600	9,100	1,600
	L2B	8,900	5,600	9,100	1,600
1780 ACSS CHUKAR	T3	2,200	3,600	2,100	200
	V3	3,700	1,900	4,000	1,700
	L3A	24,800	17,200	20,200	7,400
	L3B	24,800	17,200	20,200	7,400
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0

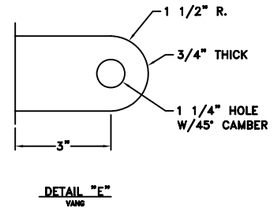
T, L AND V IN POUNDS, W IN PSF



DETAIL "C"
LADDER CLIP DETAIL



LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANG

GENERAL NOTES:

1. CONDUCTOR: 1780 KCMIL 84/19 ACSS–CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS–CADD GENERATED LOADS
   SHIELD WIRE: PLS–CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445–P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI–PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.

DEFLECTION:

DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261–1A OF 2007 NESC.

NO.	DATE	BY	ENG.	REVISION DESCRIPTION
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DWN. NAO APP. RLO
SCALE N.T.S.
DATE 10–20–09

minnesota power

230KV TRANSMISSION LINE
BISON–CENTER LINE NO. 84
TYPE DC–TANG LOADING DIAGRAM

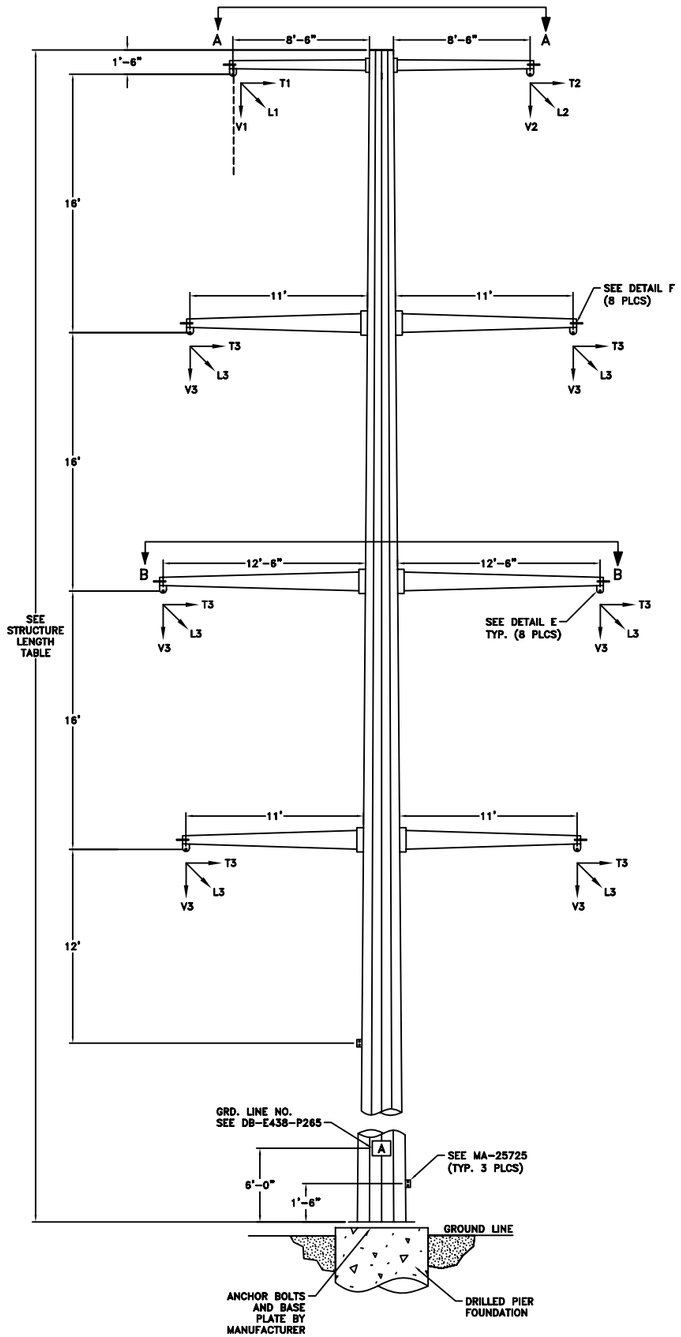
SH. 1 OF 1 REV. 0

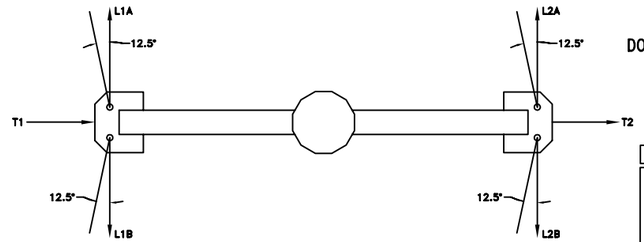
DB–E444–P519

CODE
/ / . . .

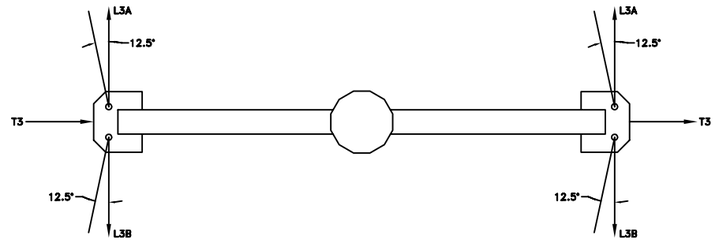
FILE: .

CADD DRAWING
FOR REPRODUCTION ONLY





SECTION A-A
SW ORIENTATION PLAN VIEW



SECTION B-B
CONDUCTOR ORIENTATION PLAN VIEW

230KV 84L
BISON-CENTER LINE
SELF SUPPORTING STEEL POLE
DOUBLE CIRCUIT DEADEND 25° STRUCTURE
ON DRILLED PIER

A IDENTIFICATION TAG-(FLAT 6)

STR. # (SEE TABLE)
LENGTH (FEET) (SEE TABLE)
STRUCTURE TYPE: STL-DC-DE 25°
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT-KIPS

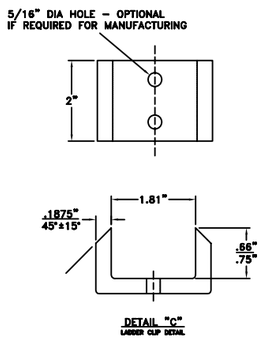
STRUCTURE LENGTH TABLE

STR. #	LENGTH
130	120'
133	130'

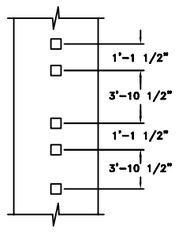
WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL	LOAD CASE 5 DEADEND 1/2" ICE 4 PSF WIND 0° INITIAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0	WIND=2.50 V=1.50 T=1.65 L=1.65
7/16" EHS STEEL	T1	5,000	3,400	5,300	800	2,500
	V1	1,400	500	2,100	500	800
	L1A	8,500	4,800	8,800	1,800	8,500
	L1B	8,500	4,800	8,800	1,800	–
AC64-528 OPGW	T2	5,100	3,900	5,400	700	2,600
	V2	1,400	500	2,100	400	800
	L2A	8,700	5,500	8,900	1,600	8,700
	L2B	8,700	5,500	8,900	1,600	–
1780 ACSS CHUKAR	T3	12,800	11,500	10,700	3,200	6,400
	V3	4,400	2,200	4,900	2,000	2,500
	L3A	24,200	16,800	19,700	7,200	24,200
	L3B	24,200	16,800	19,700	7,200	–
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0	10.0
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0	1.5

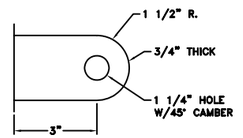
T, L AND V IN POUNDS, W IN PSF



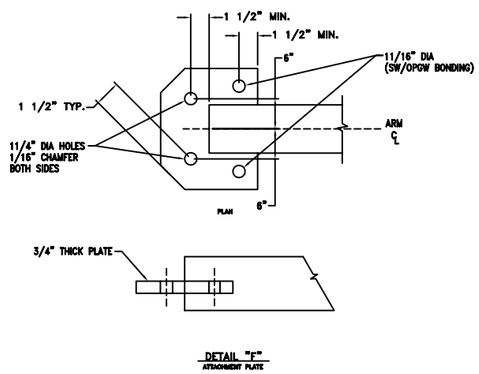
DETAIL "C"
LADDER CLIP DETAIL



LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANE



DETAIL "F"
ATTACHMENT PLATE

GENERAL NOTES:

1. CONDUCTOR: 1780 KCMIL 84/19 ACSS-CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS-CADD GENERATED LOADS
   SHIELD WIRE: PLS-CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445-P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI-PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.

DEFLECTION:

DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261-1A OF 2007 NESC.

NO.	DATE	BY	ENG.	REVISION DESCRIPTION	DWN. NAO	APP. RLO
.	.	.	.	.	SCALE	N.T.S.
.	.	.	.	.	DATE	10-20-09

minnesota power

230KV TRANSMISSION LINE
BISON-CENTER LINE NO. 84
TYPE DC-DE-25 DEG. LOADING DIAGRAM

SH. 3 OF 4 | REV. 0

DB-E444-P520

FILE: .

CADD DRAWING
FOR REPRODUCTION ONLY

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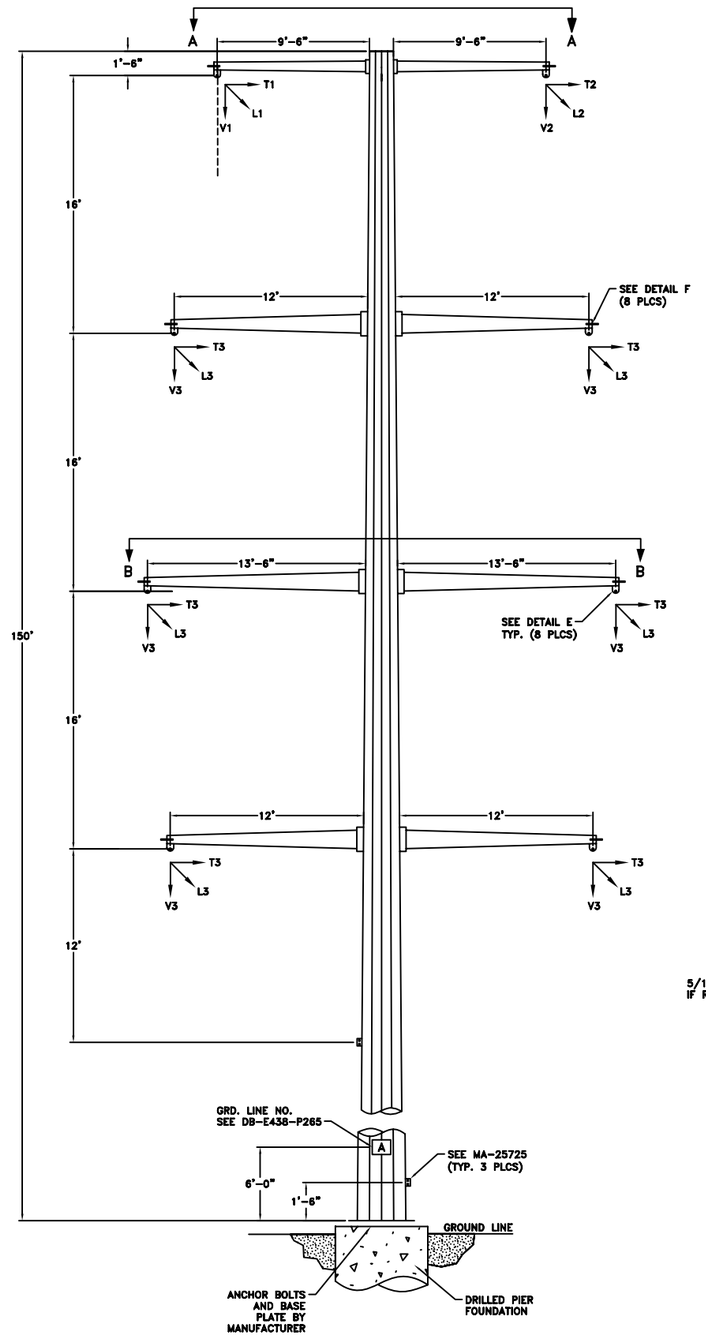
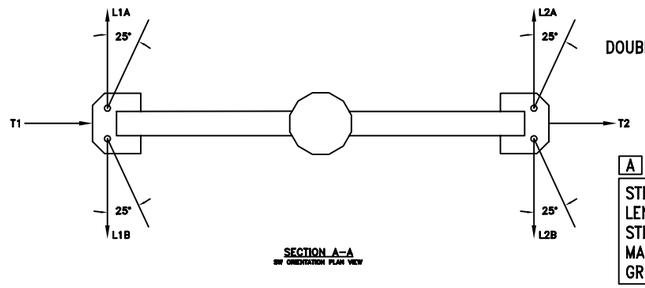
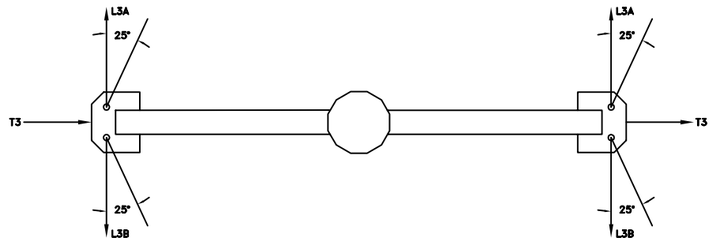




SECTION A-A
SW ORIENTATION PLAN VIEW



SECTION B-B
CONDUCTOR ORIENTATION PLAN VIEW

230KV 84L
BISON-CENTER LINE
SELF SUPPORTING STEEL POLE
DOUBLE CIRCUIT DEADEND 50° STRUCTURE
ON DRILLED PIER

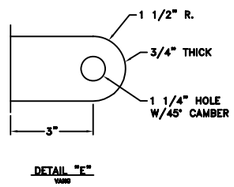
A IDENTIFICATION TAG-(FLAT 6)

STR. # 129
LENGTH (FEET) 145
STRUCTURE TYPE: STL-DC-DE 50°
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT-KIPS

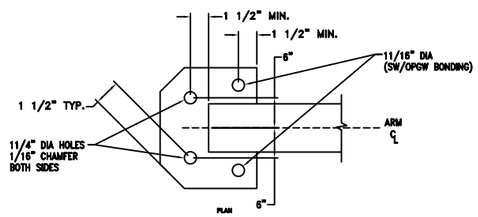
WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL	LOAD CASE 5 DEADEND 1/2" ICE 4 PSF WIND 0° INITIAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0	WIND=2.50 V=1.50 T=1.65 L=1.65
7/16" EHS STEEL	T1	8,300	5,100	8,800	1,500	4,200
	V1	2,300	800	3,500	700	1,200
	L1A	7,900	4,500	8,200	1,700	7,900
	L1B	7,900	4,500	8,200	1,700	–
AC64-528 OPGW	T2	8,500	5,900	8,900	1,400	4,300
	V2	2,300	700	3,600	700	1,200
	L2A	8,100	5,100	8,300	1,500	8,100
	L2B	8,100	5,100	8,300	1,500	–
1780 ACSS CHUKAR	T3	22,500	17,700	18,600	6,200	11,300
	V3	7,400	3,600	8,200	3,200	3,900
	L3A	22,500	15,600	18,300	6,700	22,500
	L3B	22,500	15,600	18,300	6,700	–
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0	10.0
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0	1.5

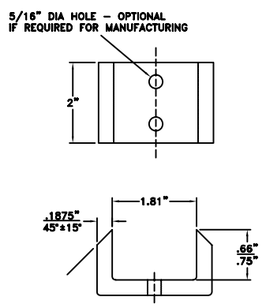
T, L AND V IN POUNDS, W IN PSF



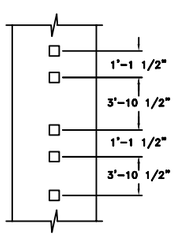
DETAIL "E"
YANG



DETAIL "F"
ATTACHMENT PLATE



DETAIL "C"
LADDER CLIP DETAIL



LADDER DETAIL
TYPICAL CLIP SPACING

GENERAL NOTES:

1. CONDUCTOR: 1780 KCMIL 84/19 ACSS-CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS-CADD GENERATED LOADS
   SHIELD WIRE: PLS-CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445-P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI-PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.

DEFLECTION:

DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261-1A OF 2007 NESC.

NO.	DATE	BY	ENG.	REVISION DESCRIPTION	DWN. NAO	APP. RLO
.	.	.	.	.	SCALE	N.T.S.
.	.	.	.	.	DATE	10-20-09

minnesota power

230KV TRANSMISSION LINE
BISON-CENTER LINE NO. 84
TYPE DC-DE-50 DEG. LOADING DIAGRAM

SH. 2 OF 4 | REV. 0

DB-E444-P521

CADD DRAWING
FOR REPRODUCTION ONLY

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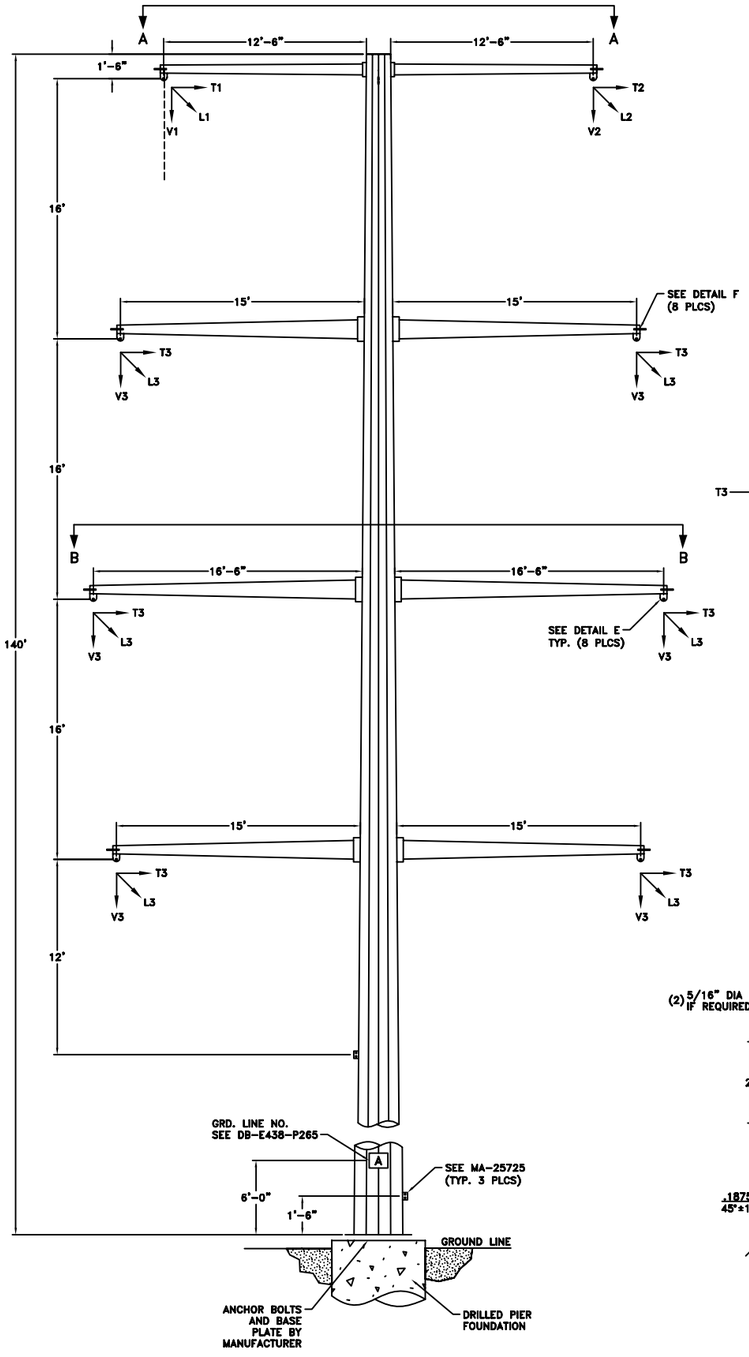
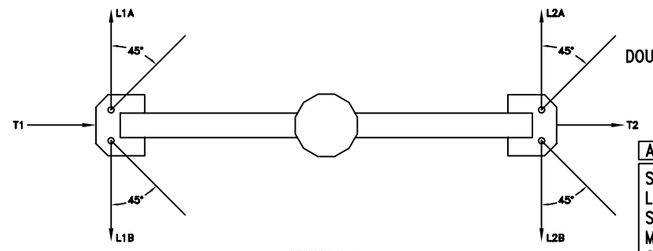
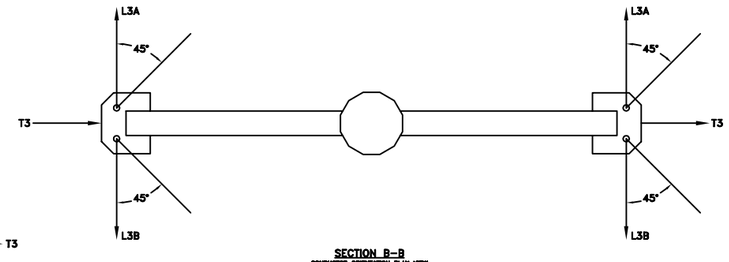
FILE: .





SECTION A–A
SW ORIENTATION PLAN VIEW



SECTION B–B
CONDUCTOR ORIENTATION PLAN VIEW

230KV 84L
BISON–CENTER LINE
SELF SUPPORTING STEEL POLE
DOUBLE CIRCUIT DEADEND 90° STRUCTURE
ON DRILLED PIER

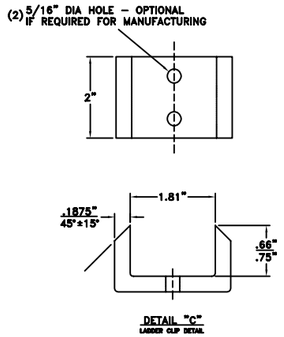
A IDENTIFICATION TAG–(FLAT 6)

STR. # 132
LENGTH (FEET) 135
STRUCTURE TYPE: STL–DC–DE 90°
MANUFACTURED DATE: (DATE)
GRD. LINE MOM. IN FT–KIPS

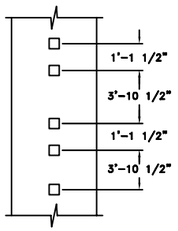
WIND LOAD ON POLE NOT INCLUDED
STRUCTURE LOADS(LBS)

		LOAD CASE 1 NESC HEAVY 1/2" ICE 4 PSF WIND 0° INITIAL	LOAD CASE 2 EXT. WIND NO ICE 31 PSF WIND 60° INITIAL	LOAD CASE 3 ICE & WIND 1" ICE 6.4 PSF WIND 15° INITIAL	LOAD CASE 4 DEFLECTION NO ICE NO WIND 60° FINAL	LOAD CASE 5 DEADEND 1/2" ICE 4 PSF WIND 0° INITIAL
CONDUCTOR	LOAD FACTORS	WIND=2.50 V=1.50 T=1.65 L=1.65	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.1 V=1.1 T=1.1 L=1.1	WIND=1.0 V=1.0 T=1.0 L=1.0	WIND=2.50 V=1.50 T=1.65 L=1.65
7/16" EHS STEEL	T1	12,600	7,300	13,100	2,600	6,300
	V1	1,200	400	1,700	400	700
	L1A	6,200	3,500	6,400	1,300	6,200
	L1B	6,200	3,500	6,400	1,300	–
AC64–528 OPGW	T2	12,900	8,200	13,200	2,300	6,500
	V2	1,200	400	1,800	400	700
	L2A	6,300	4,000	6,500	1,200	6,300
	L2B	6,300	4,000	6,500	1,200	–
1780 ACSS CHUKAR	T3	35,600	25,300	29,000	10,400	17,800
	V3	3,700	1,900	4,000	1,700	2,100
	L3A	17,600	12,200	14,300	5,200	17,600
	L3B	17,600	12,200	14,300	5,200	–
WIND ON STRUCTURE	W	10.0	34.1	7.1	0.0	10.0
DEAD LOAD OLF	DL	1.5	1.1	1.1	1.0	1.5

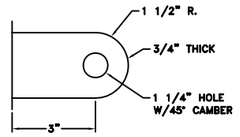
T, L AND V IN POUNDS, W IN PSF



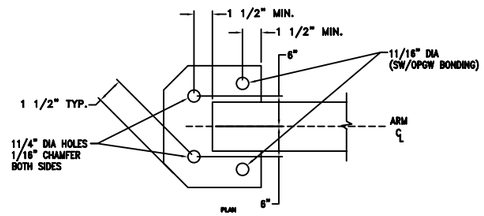
DETAIL "C"
LADDER CLIP DETAIL



LADDER DETAIL
TYPICAL CLIP SPACING



DETAIL "E"
VANG



DETAIL "F"
ATTACHMENT PLATE

GENERAL NOTES:

1. CONDUCTOR: 1780 KCMIL 84/19 ACSS–CHUKAR
   SHIELD WIRE: 64/528 OPGW
   DIA.=0.528" WT.=0.359 LB/FT
   7/16" EHS STEEL
2. DESIGN: CONDUCTOR: PLS–CADD GENERATED LOADS
   SHIELD WIRE: PLS–CADD GENERATED LOADS
3. FINISH: CORTEN
4. THE POLE SHALL BE DESIGNED AND MANUFACTURED PER STEEL POLE SPECIFICATIONS.
5. MAX. SINGLE HOLE VANG THICKNESS = 3/4 INCH
6. STRUCTURE TO BE FURNISHED COMPLETE WITH STANDARD POLE SHAFT, CONDUCTOR AND SHIELD WIRE VANGS, GROUNDING NUTS AND ALL NECESSARY HARDWARE TO COMPLETELY ASSEMBLE THE STRUCTURE.
7. LADDER CLIPS TO BE INSTALLED FROM POLE TOP TO APPROXIMATELY 3' ABOVE BASEPLATE.
   PROVIDE 3 SETS OF WORKING LADDER CLIPS BELOW ALL CONDUCTOR LOCATIONS. SEE "DETAIL C" FOR CLIP DETAIL.
8. FURNISH 1 RUN OF OPGW ATTACHMENT CLIPS PER DBE445–P271.
9. THE WEIGHT OF THE STRUCTURE, WITH VERTICAL OVERLOAD FACTOR, SHALL BE INCLUDED FOR EACH LOAD CASE.
10. STRUCTURE TO BE DESIGNED AS FULL TENSION DEADEND IN ONE DIRECTION, SEE LOAD CASE V.
11. MULTI–PIECE POLES SHALL BE DESIGNED AS BOLTED CONNECTIONS. ALL REQUIRED HARDWARE FOR BOLTED CONNECTIONS SHALL BE PROVIDED BY STRUCTURE MANUFACTURER.

DEFLECTION:

DEFLECTION SHALL BE LIMITED TO 1% OF STRUCTURE HEIGHT TO SW FROM BASE, UNDER LOAD CASE IV.

LOADING:

LOADS SHOWN PICTORIALLY ARE ULTIMATE, INCLUDING OVERLOAD FACTORS, AND SHALL BE USED WITH STRENGTH FACTORS ON TABLE 261–1A OF 2007 NESC.

NO.	DATE	BY	ENG.	REVISION DESCRIPTION	DWN. NAO	APP. RLO
.	.	.	.	.	SCALE	N.T.S.
.	.	.	.	.	DATE	10–20–09

minnesota power

230KV TRANSMISSION LINE
BISON–CENTER LINE NO. 84
TYPE DC–DE–90 DEG. LOADING DIAGRAM

SH. 1 OF 4 | REV. 0

DB–E444–P522

CODE: / / | . | . | .

FILE: .

CADD DRAWING
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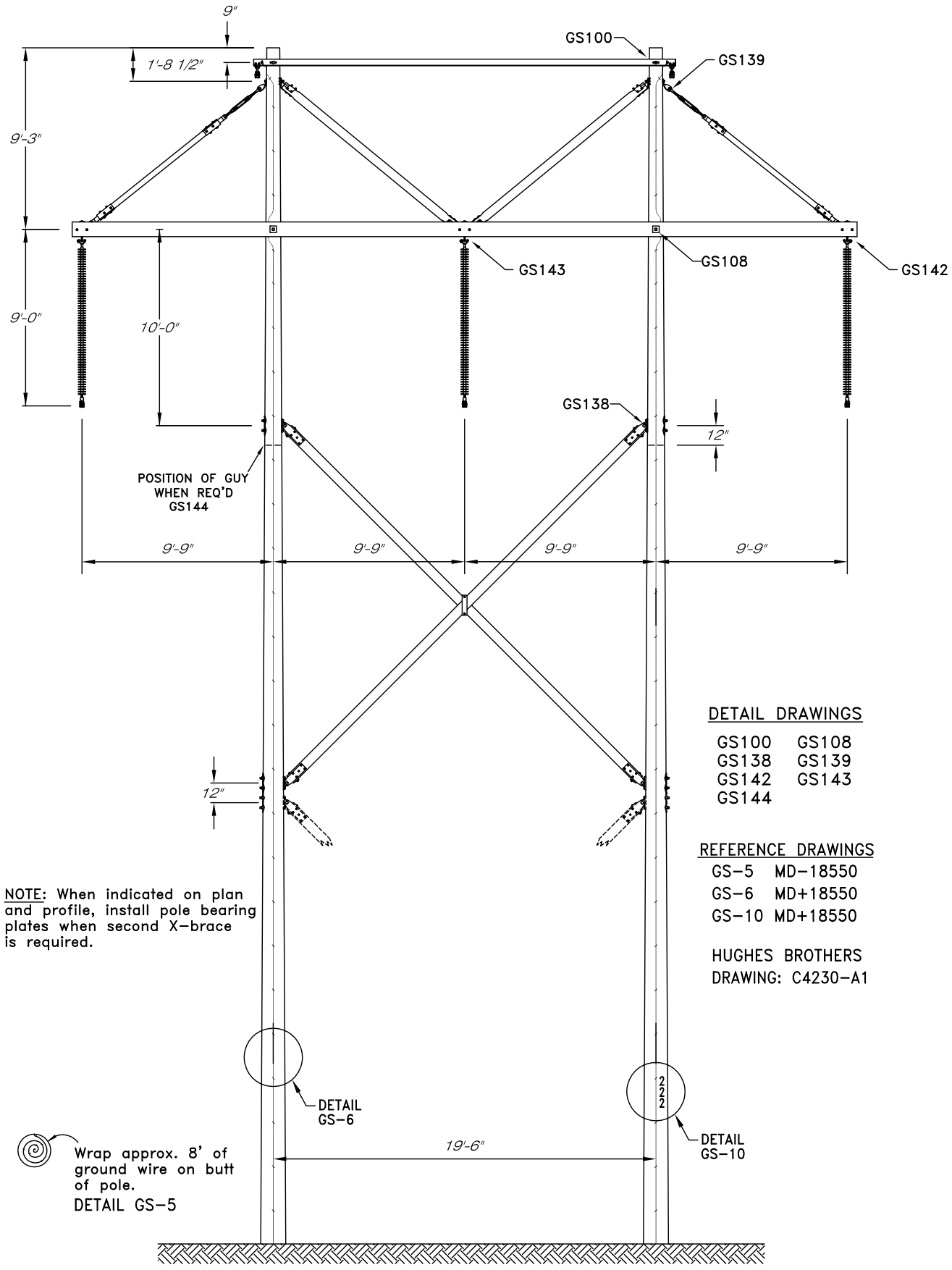

DETAIL DRAWINGS

GS100	GS108
GS138	GS139
GS142	GS143
GS144	

REFERENCE DRAWINGS

GS-5	MD-18550
GS-6	MD+18550
GS-10	MD+18550

HUGHES BROTHERS
DRAWING: C4230-A1

NOTE: When indicated on plan and profile, install pole bearing plates when second X-brace is required.

Wrap approx. 8' of ground wire on butt of pole.
DETAIL GS-5

DRAWN: D.J.L.
CHECKED:
APPROVED:
REV. 0 DATE: 11-19-09

minnesota power
TRANSMISSION ENGINEERING

230 kV TRANSMISSION TYPE TH2 STRUCTURE ASSEMBLY WITH POLYMER INSULATORS

SHEET 1 OF 3

MA-32904

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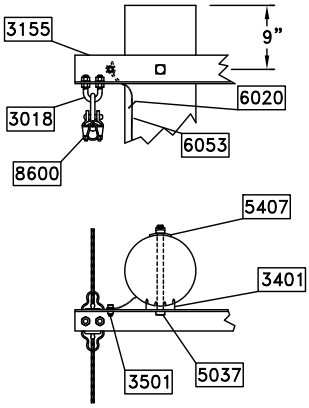
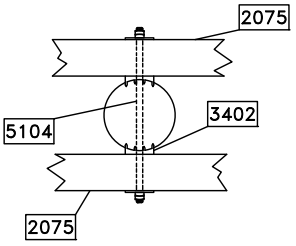
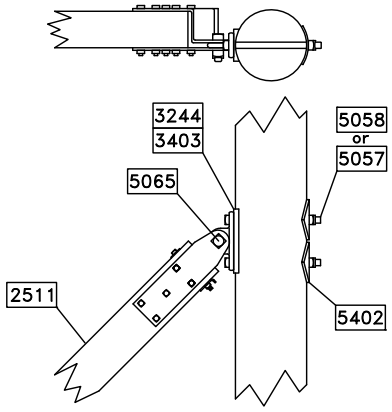


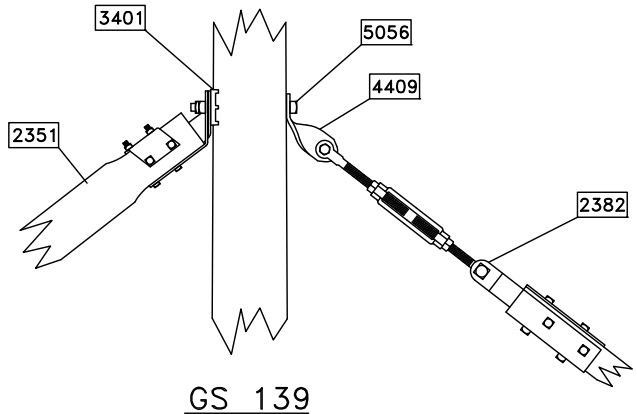
GS 100



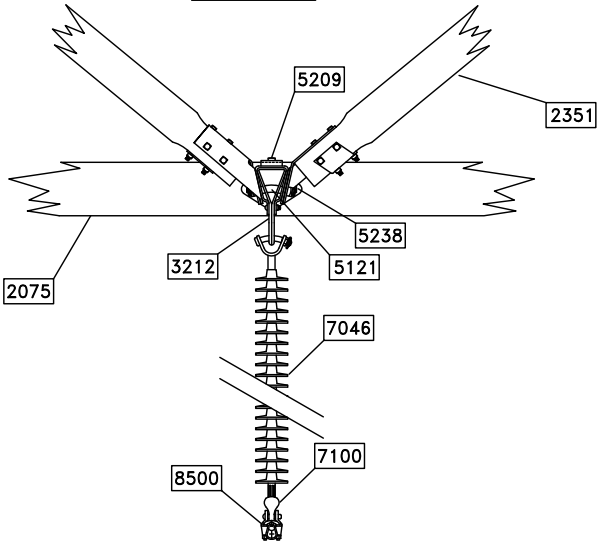
GS 108



GS 138



GS 139



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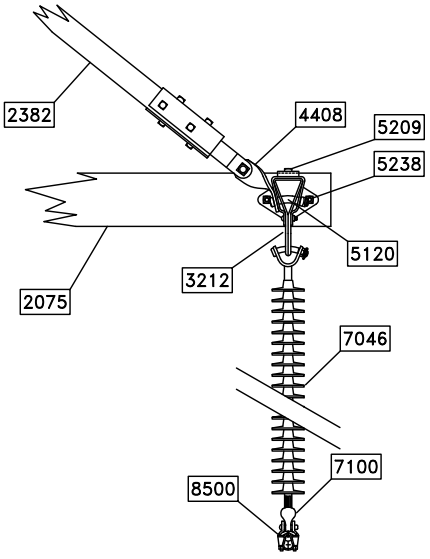
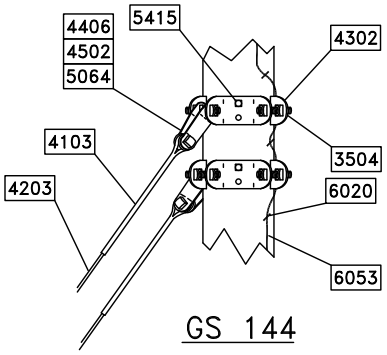


GS 142



GS 144

DRAWN: D.J.L. CHECKED: APPROVED: REV. 0 DATE: 11-19-09	minnesota power TRANSMISSION ENGINEERING	230 kV TRANSMISSION TYPE TH2 STRUCTURE ASSEMBLY DETAILS SHEET 2 OF 3 | MA-32904

FILE: \\P\private\CADD\private\files2\XMSN\MA-\MA-32904.dwg

ITEM	QUANTITY		DESCRIPTION
			POLES AND FIXTURES
	2		Poles
2075	* 2		Crossarm, 5–1/8" x 7–1/2" x 40'–0" Laminated Fir
2351	* 2		Vee Brace, 3–3/8" x 4–3/8" x 11'–7", 37–1/2° & 52–1/2° Fitg.
2382	* 2		Brace, Adj. Tension Assembly, 3–3/8" x 4–3/8" Fir, 10'–6" length, with 7/8" x 12" turnbuckle
2511	* 1 set		X–Brace Assembly, 5–1/8" x 6" Fir, for 19'–6" Pole Spacing with Center Clamp
3018	* 2		5/8" U–Bolt, 1/2" Chain Link
3155	* 1		Tie Angle, 4" x 3" x 1/4" x 21'–6"
3212	* 3		Adjustable Spacer Fitting
3244	* 4		Dead End Tee, 7/8" mounting bolts, 6" bolt spacing
3401	* 4		Grid Gain, 4" x 4" with 15/16" hole
3402	* 4		Grid Gain, 4" x 6–3/4" with 15/16" hole
3403	* 4		Grid Gain, 4–1/2" x 9" with 15/16" hole
3501	* 2		Ground Wire Bonding Bolt, 1/2" x 1–1/2"
3504	4	+	Bonding Clip Assembly, 7/8" with extra nut (2727.8 & N80)
4103	4	+	7/16" Preformed Guy Grip, 7–Strand Steel U.G.
4203	AR	+	7/16" U.G. 7–Strand Steel Guy Wire
4302	4	+	Pole Band Assembly, 4–Way (Hughes #3105.6)
4406	4 pr.	+	Connecting Link (Hughes #3169)
4408	* 2		Twisted Clip, 35° Bend
4409	* 2		Twisted Clip, 55° Bend
4502	4	+	Guy Roller, (Hughes #28083)
5037	* 2		3/4" x 14" Machine Bolt, w/SN & MF
5056	* 2		7/8" x 14" Machine Bolt, w/SN & MF
5057	* 4		7/8" x 16" Machine Bolt, w/SN & MF
5058	* 4		7/8" x 18" Machine Bolt, w/SN & MF
5064	4	+	1" x 4" Machine Bolt, w/SN & MF
5065	* 4		1" x 3" Machine Bolt, w/SN & MF
5104	* 2		7/8" x 28" Full Length Threaded Rod, w/2 WN & SN
5120	* 2		7/8" x 6" Bent Bolt, w/Nut & Locknut
5121	* 1		7/8" x 6" Bent Stud, w/2 Nuts & Locknuts
5209	* 6		1/2" x 8–1/2" Washer head bolt w/washer nut
5238	* 12		5/8" x 6–1/2" Washer head bolt w/washer nut
5402	* 8		4" x 4" x 1/4" Square Curved Washer, 15/16" hole
5407	* 2		3" x 3" x 1/4" Square Curved Washer, 13/16" hole
5415	16	+	1/2" x 4" Lag Screw (Hughes #LS54)
5540	2		Dating Nails, Aluminum, 1/4" dia. x 1–1/2" length
5560	AR		Pole Number, Aluminum, 3" high
			CONDUCTOR DEVICES
6020	AR		Staples, Square Shank Barbed, 2" x 3/8" x .131
6053	AR ft.		#2 Dead Soft Annealed Copperweld Ground Wire
7046	3		230kV Suspension Insulator, Polymer, 25k
7100	3		Socket Eye
8500	3		Suspension Clamp, Conductor
8600	2		Suspension Clamp, Shield Wire

* Material included as part of structure assembly

\+ Material used when installing diagonal guys

DRAWN: D.J.L. CHECKED: APPROVED: REV. 0 DATE: 11–19–09	minnesota power TRANSMISSION ENGINEERING	230 kV TRANSMISSION TYPE TH2 STRUCTURE ASSEMBLY BILL OF MATERIALS SHEET 3 OF 3 | MA-32904

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NO.	DATE	REVISION DESCRIPTION	BY	APPROVED

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED

DRAWN BY	D.J.L.
APPROVED	
DATE	12/10/09
SCALE	N.T.S.

minnesota power

230kV BISON - CENTER LINE NO. 84

SHEET 1 OF 22 | REV. 0

MD+32900

FILE:

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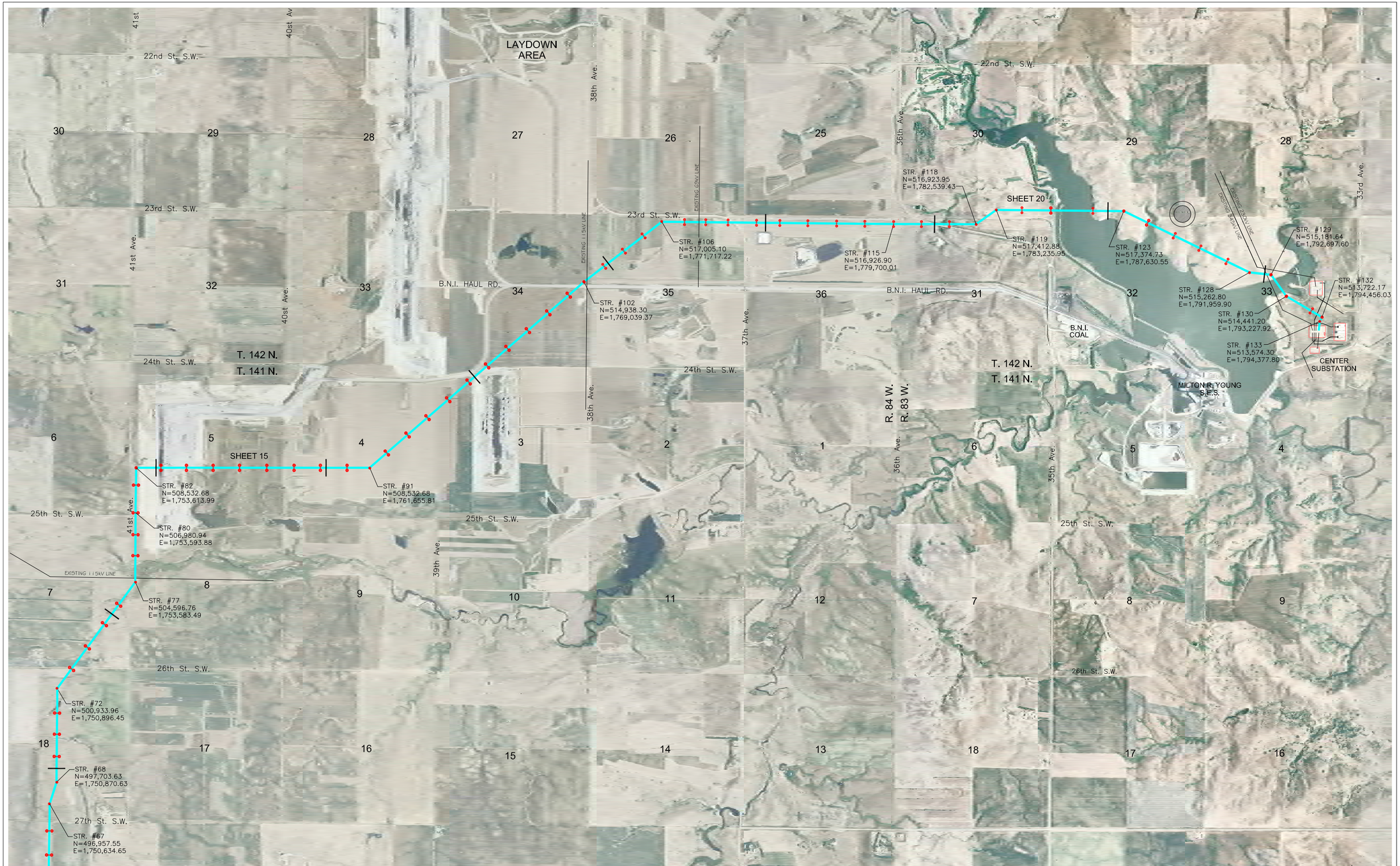

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED

DRAWN BY	D.J.L.
APPROVED	
DATE	12/10/09
SCALE	N.T.S.

minnesota power

230kV BISON - CENTER LINE NO. 84

SHEET 2 OF 22 | REV. 0

MD+32900

FILE:

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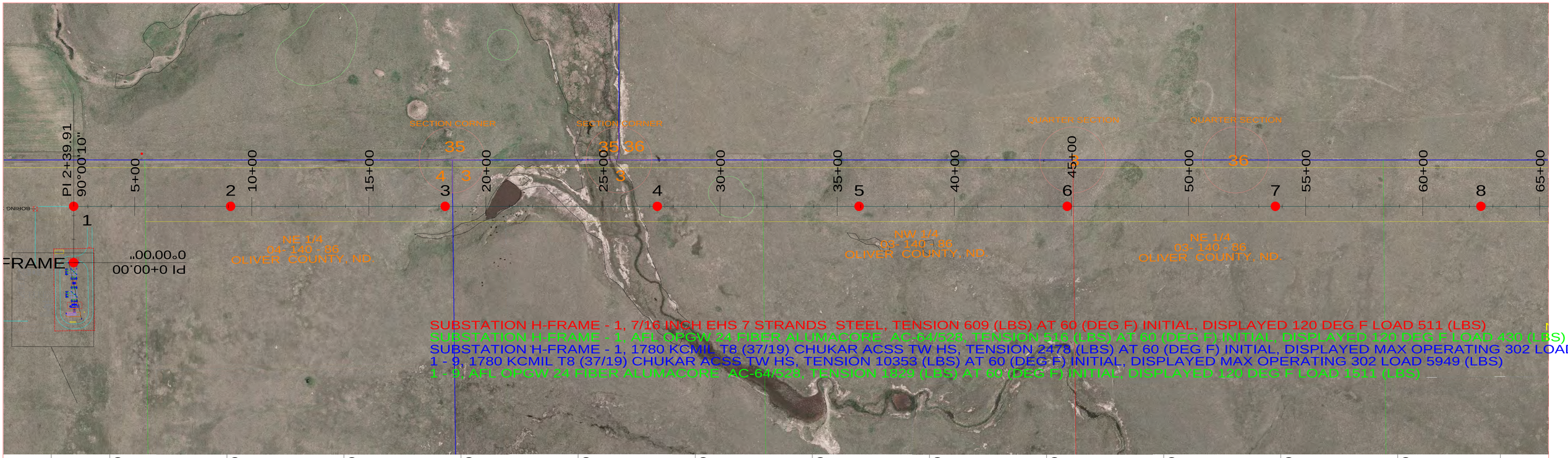

0+00 5+00 10+00 15+00 20+00 25+00 30+00 35+00 40+00 45+00 50+00 55+00

1
230S1DJV5
STA=2+39.91
X=1708633.39
Y=480927.50
HT=81.00 ELE=2166.66
HT ADJUST=1.00
POLE LENGTH = 80FT

2
230W1TNH3
STA=9+10.12
X=1709303.53
Y=480918.31
HT=78.50 ELE=2165.28
EMBED LEN=16.50
95 FT DF CLASS H1

3
230W1TNH3
STA=18+26.17
X=1710219.50
Y=480905.74
HT=87.50 ELE=2150.94
EMBED LEN=17.50
105 FT DF CLASS H1

4
230W1TNH3
STA=27+32.73
X=1711125.97
Y=480893.30
HT=87.50 ELE=2128.20
EMBED LEN=17.50
105 FT DF CLASS H1

5
230W1TNH3
STA=35+94.03
X=1711987.19
Y=480881.49
HT=78.50 ELE=2154.00
EMBED LEN=16.50
95 FT DF CLASS H1

6
230W1TNH3
STA=44+82.69
X=1712875.77
Y=480869.30
HT=69.50 ELE=2183.48
EMBED LEN=15.50
85 FT DF CLASS H1

7
230W1TNH3
STA=53+71.51
X=1713764.50
Y=480857.11
HT=74.00 ELE=2158.67
EMBED LEN=16.00
90 FT DF CLASS H1

SUBSTATION H-FRAME
SUBSTATION TAKE OFF STRUCTURE
STA=0+00.00
X=1708630.11
Y=480687.61
HT=60.00 ELE=2169.20
EMBED LEN=5.00

2360 2340 2320 2300 2280 2260 2240 2220 2200 2180 2160 2140 2120 2100

239.9 79.50 59.50 69.00 49.75 53.00 37.00 670.2 77.75 60.82 60.77 916.0 86.75 69.77 906.6 861.3 86.75 69.77 888.7 77.75 60.77 68.75 51.77 888.8 73.25 56.27 877.3

PI 0°00'00"
PI 90°00'10"

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 3 OF 22 REV. C

MD+32900

IMAGESITE PROJECT_NAME

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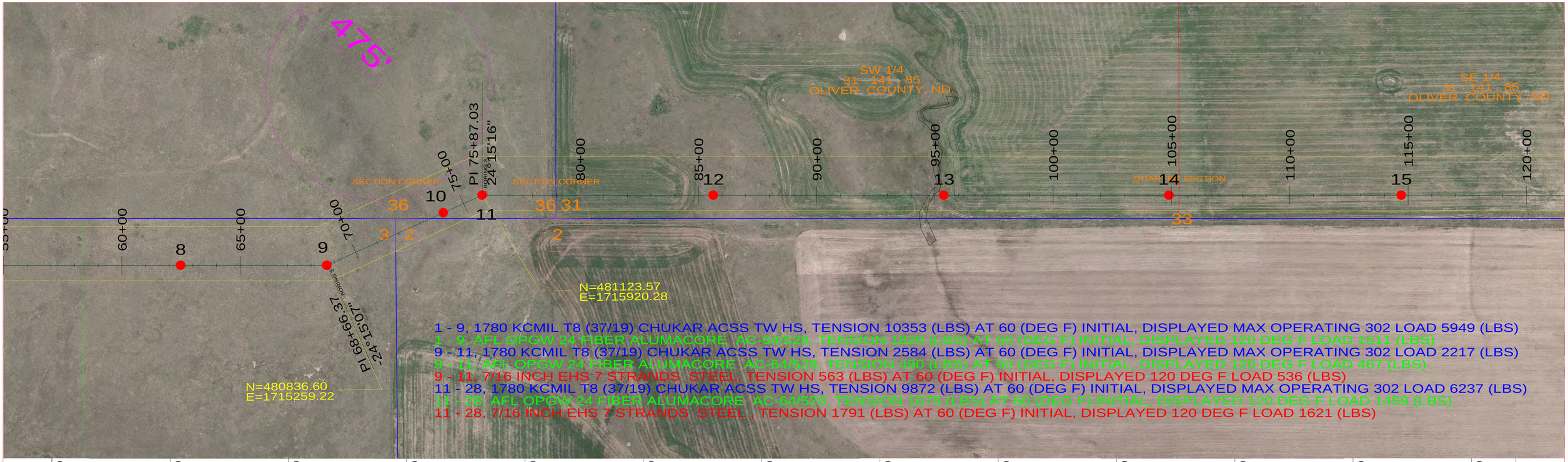
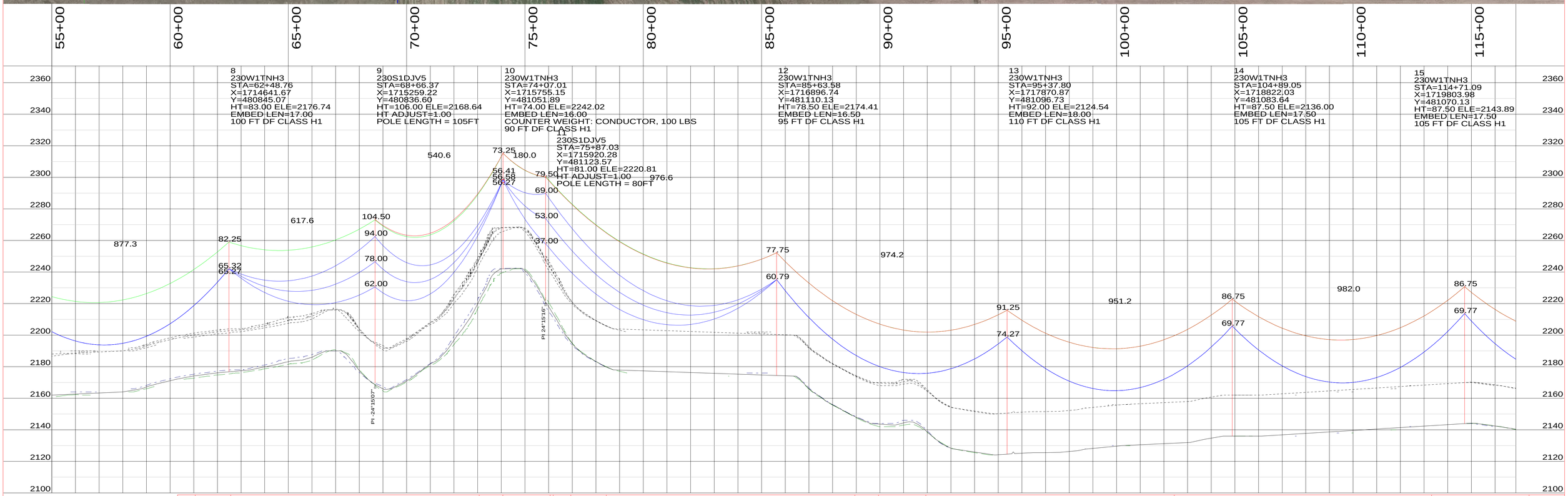
SCALE:

MICROFILMED / /

CODE ALPHA BROAD FINE





NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
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NO.	DATE	REVISION DESCRIPTION	BY	APPROVED

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 4 OF 22 REV. C

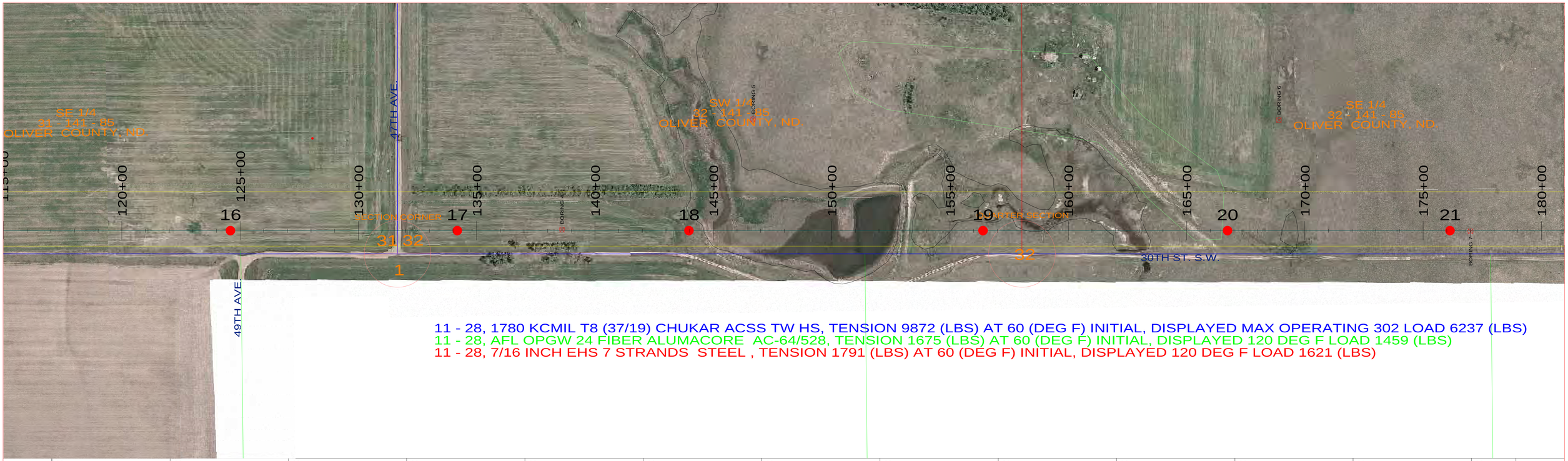
MD+32900

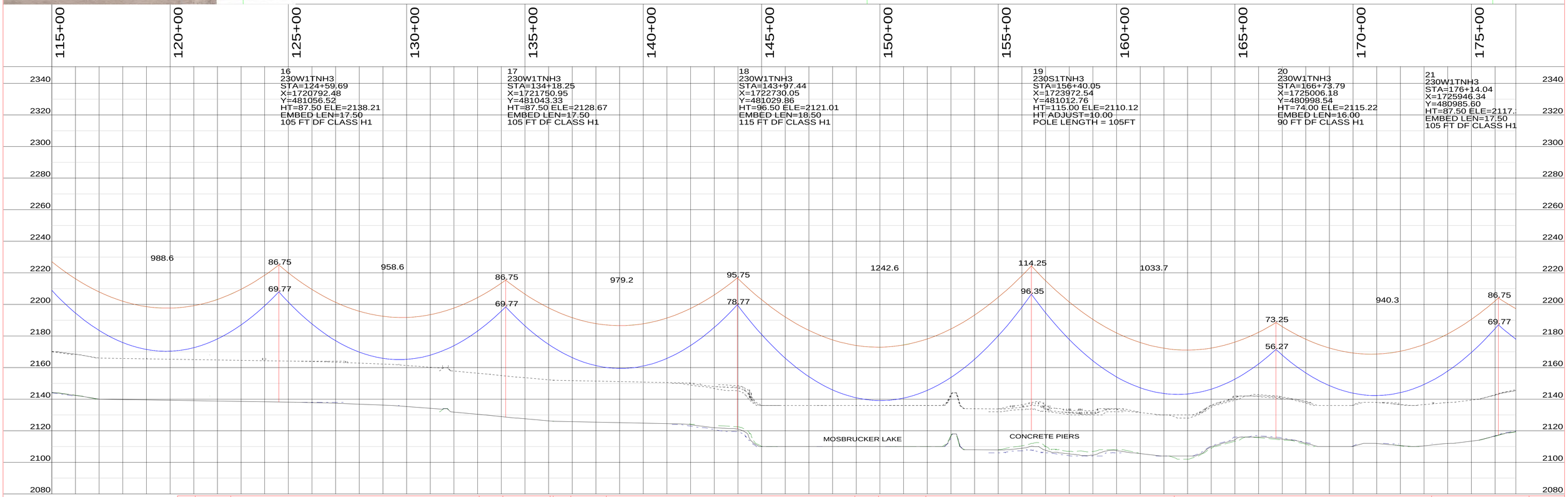
IMAGESITE PROJECT_NAME

CADD DRAWING - FOR REPRODUCTION ONLY

SCALE:

MICROFILMED	CODE		
/ /	ALPHA	BROAD	FINE





NORTH

200.0 FT. HORIZ. SCALE

30.0 FT. VERT. SCALE

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A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
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C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED

MINNESOTA POWER

230 KV BISON - CENTER LINE N0. 84

SHEET 5 OF 22 REV. C

MD+32900

IMAGESITE PROJECT_NAME

SCALE:

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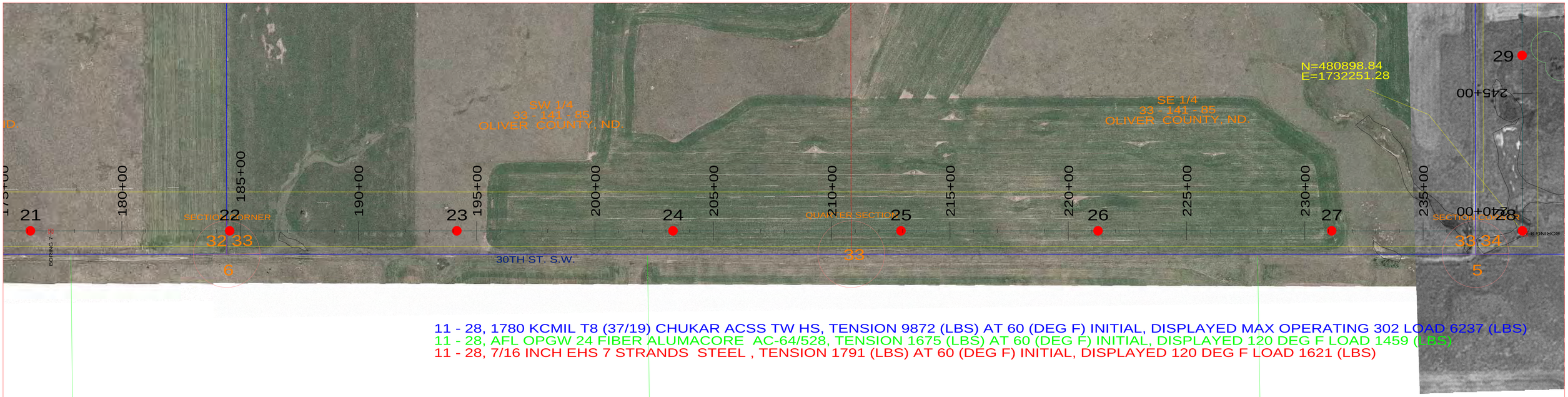
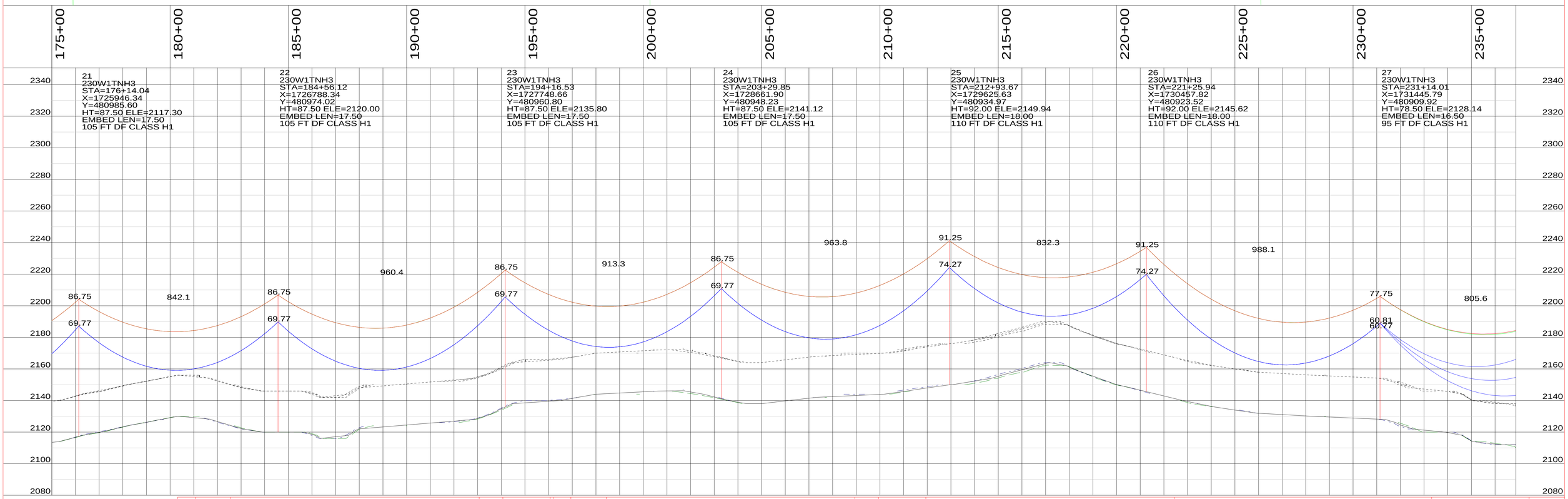
/	/	ALPHA	BROAD	FINE



11 - 28, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 9872 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 6237 (LBS)
11 - 28, AFL OPGW 24 FIBER ALUMACORE AC-64/528, TENSION 1675 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1459 (LBS)
11 - 28, 7/16 INCH EHS 7 STRANDS STEEL , TENSION 1791 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1621 (LBS)



NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

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MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 6 OF 22 REV. C

MD+32900

IMAGESITE PROJECT_NAME

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SCALE:

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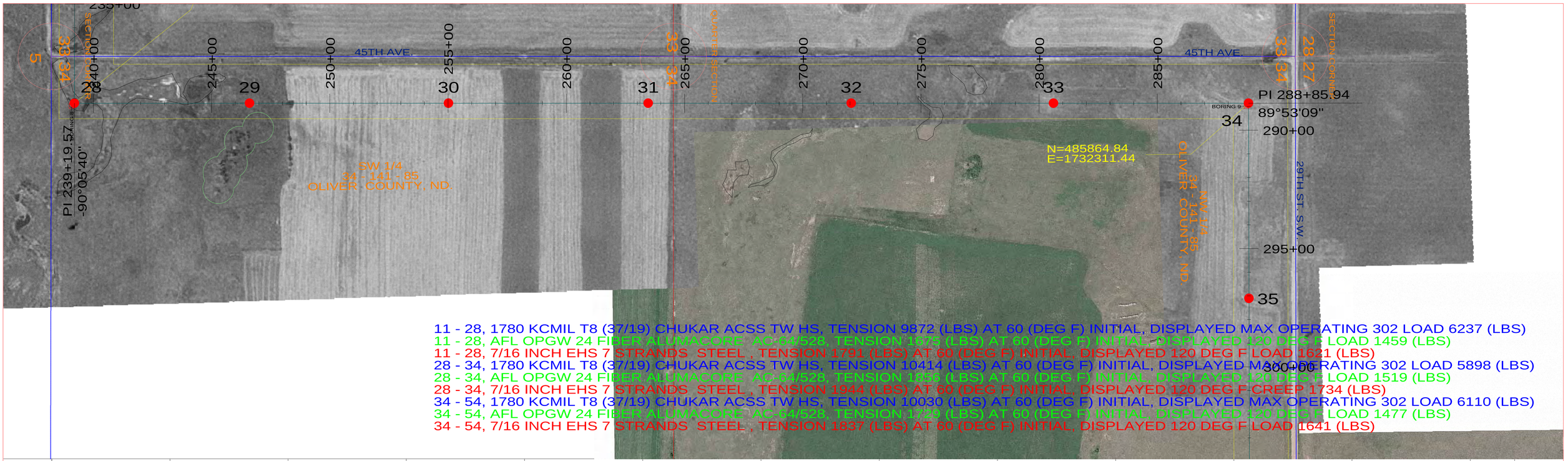
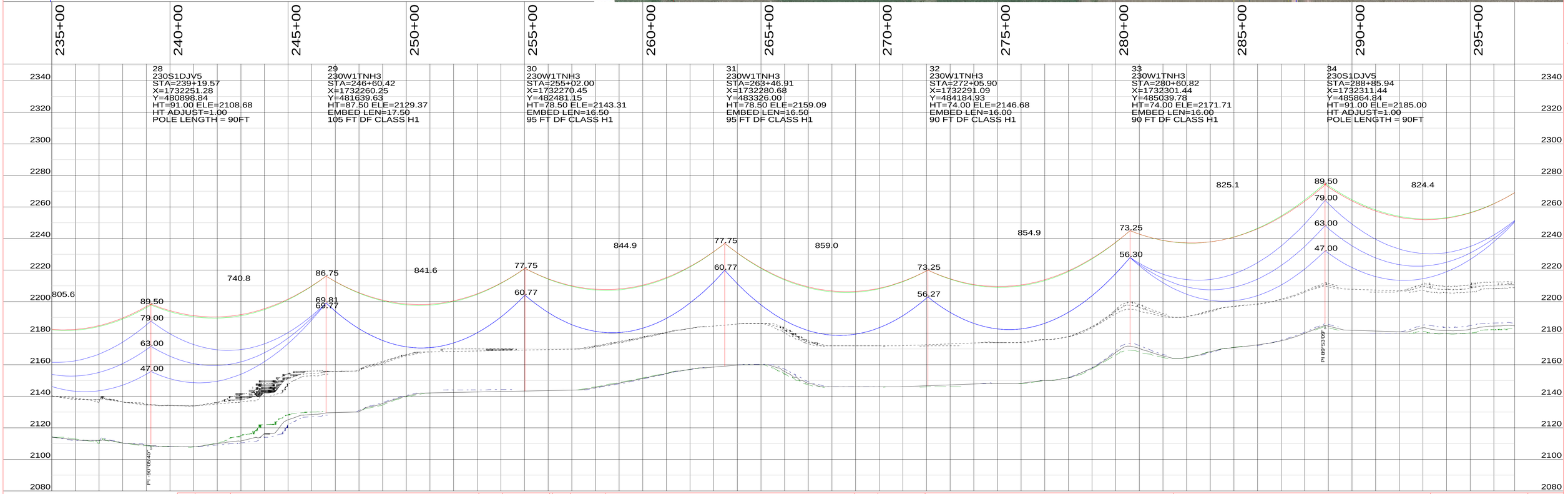
CODE ALPHA BROAD FINE

PLS-CADD DRAWIN



11 - 28, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 9872 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 6237 (LBS)
11 - 28, AFL OPGW 24 FIBER ALUMACORE, AC-64/528, TENSION 1675 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1459 (LBS)
11 - 28, 7/16 INCH EHS 7 STRANDS STEEL , TENSION 1791 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1621 (LBS)
28 - 34, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 10414 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 5898 (LBS)
28 - 34, AFL OPGW 24 FIBER ALUMACORE, AC-64/528, TENSION 1856 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1519 (LBS)
28 - 34, 7/16 INCH EHS 7 STRANDS STEEL , TENSION 1944 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F CREEP 1734 (LBS)
34 - 54, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 10030 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 6110 (LBS)
34 - 54, AFL OPGW 24 FIBER ALUMACORE, AC-64/528, TENSION 1729 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1477 (LBS)
34 - 54, 7/16 INCH EHS 7 STRANDS STEEL , TENSION 1837 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1641 (LBS)



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A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 7 OF 22 REV. C

MD+32900

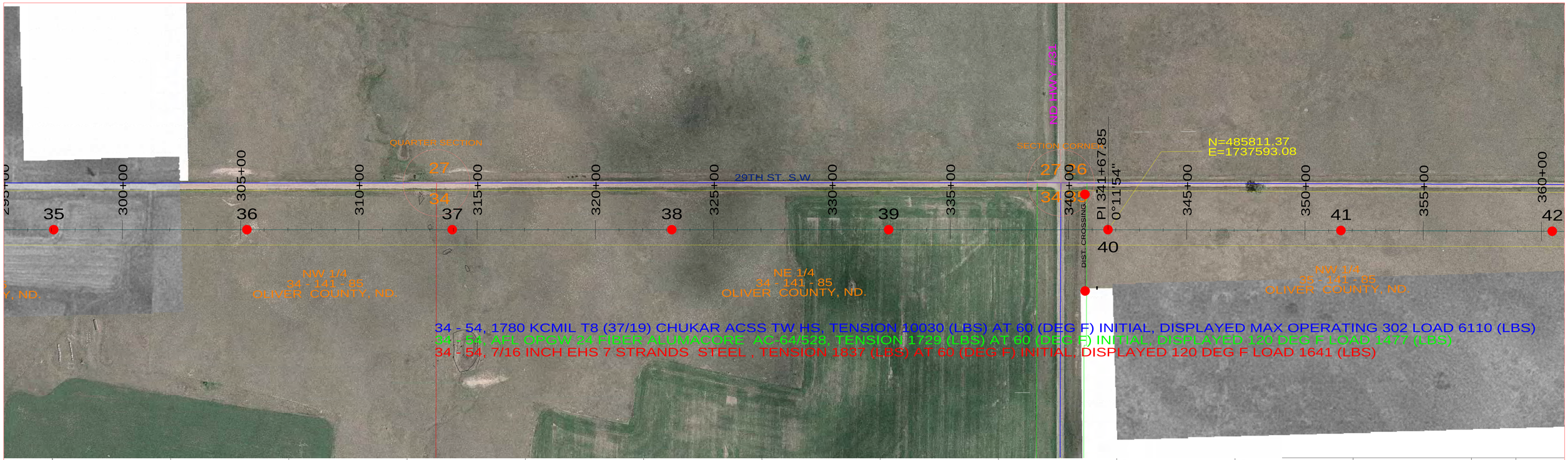
IMAGESITE2PROJECT_NAME

CADD DRAWING - FOR REPRODUCTION ONLY

SCALE:

MICROFILMED / /

CODE: ALPHA BROAD FINE



295+00 300+00 305+00 310+00 315+00 320+00 325+00 330+00 335+00 340+00 345+00 350+00 355+00

35
230W1TNH3
STA=297+10.30
X=1733135.76
Y=485856.49
HT=87.50 ELE=2184.45
EMBED LEN=17.50
105 FT DF CLASS H1

36
230W1TNH3
STA=305+26.73
X=1733952.15
Y=485848.23
HT=69.50 ELE=2195.67
EMBED LEN=15.50
85 FT DF CLASS H1

37
230W1TNH3
STA=313+95.01
X=1734820.38
Y=485839.44
HT=83.00 ELE=2156.74
EMBED LEN=17.00
100 FT DF CLASS H1

38
230W1TNH3
STA=323+23.48
X=1735748.81
Y=485830.04
HT=87.50 ELE=2170.80
EMBED LEN=17.50
105 FT DF CLASS H1

39
230W1TNH3
STA=332+40.20
X=1736665.48
Y=485820.76
HT=87.50 ELE=2137.46
EMBED LEN=17.50
105 FT DF CLASS H1

40
230W1TNH3
STA=341+67.85
X=1737593.08
Y=485811.37
HT=87.50 ELE=2144.13
EMBED LEN=17.50
105 FT DF CLASS H1

41
230W1TNH3
STA=351+52.59
X=1738577.73
Y=485797.99
HT=92.00 ELE=2143.10
EMBED LEN=18.00
110 FT DF CLASS H1

2360 2340 2320 2300 2280 2260 2240 2220 2200 2180 2160 2140 2120 2100

86.75 816.4 68.75 868.3 928.5 86.75 916.7 927.6 86.75 984.7 91.25 893.5
69.80 51.77 82.25 65.27 69.77 69.77 69.77 74.27
DIST. CROSSING
PI 0°11'54"

NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
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MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 8 OF 22 REV. C

MD+32900

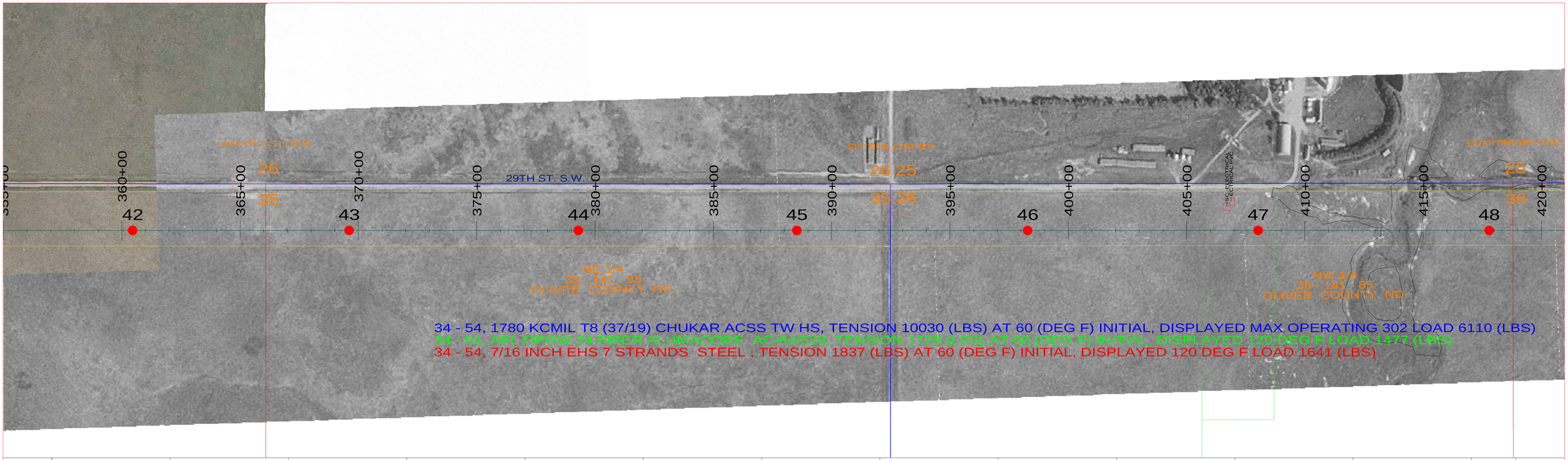
IMAGESITE2PROJECT_NAME

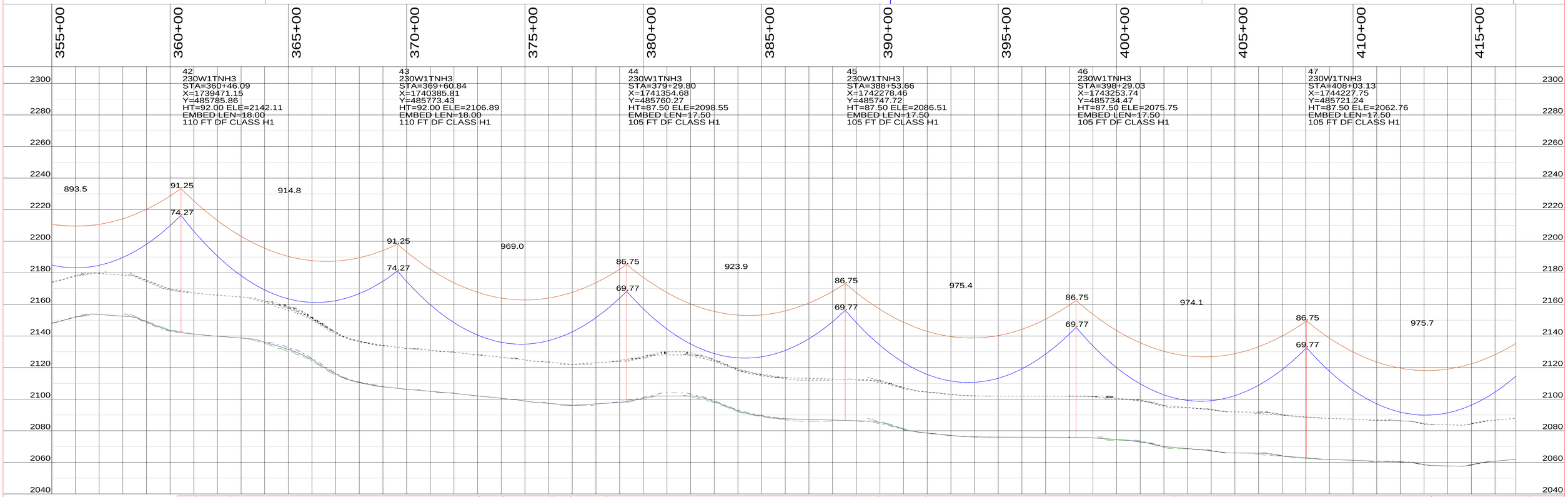
CADD DRAWING - FOR REPRODUCTION ONLY

SCALE:

MICROFILMED / /

CODE ALPHA BROAD FINE





NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
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NO.	DATE	REVISION DESCRIPTION	BY	APPROVED

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 9 OF 22 REV. C

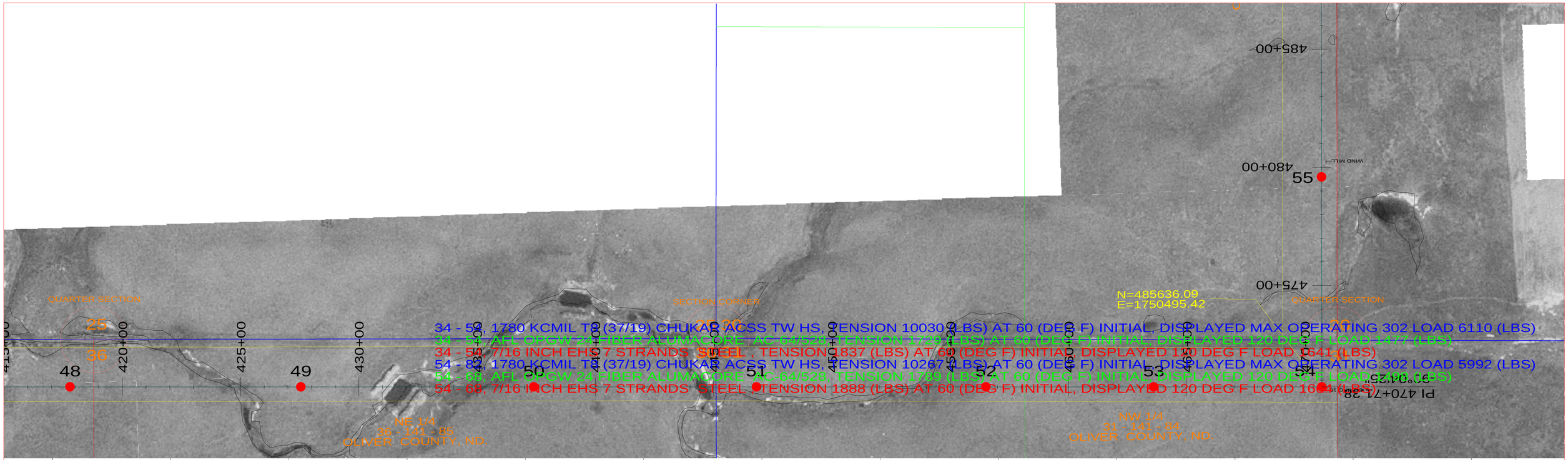
MD+32900

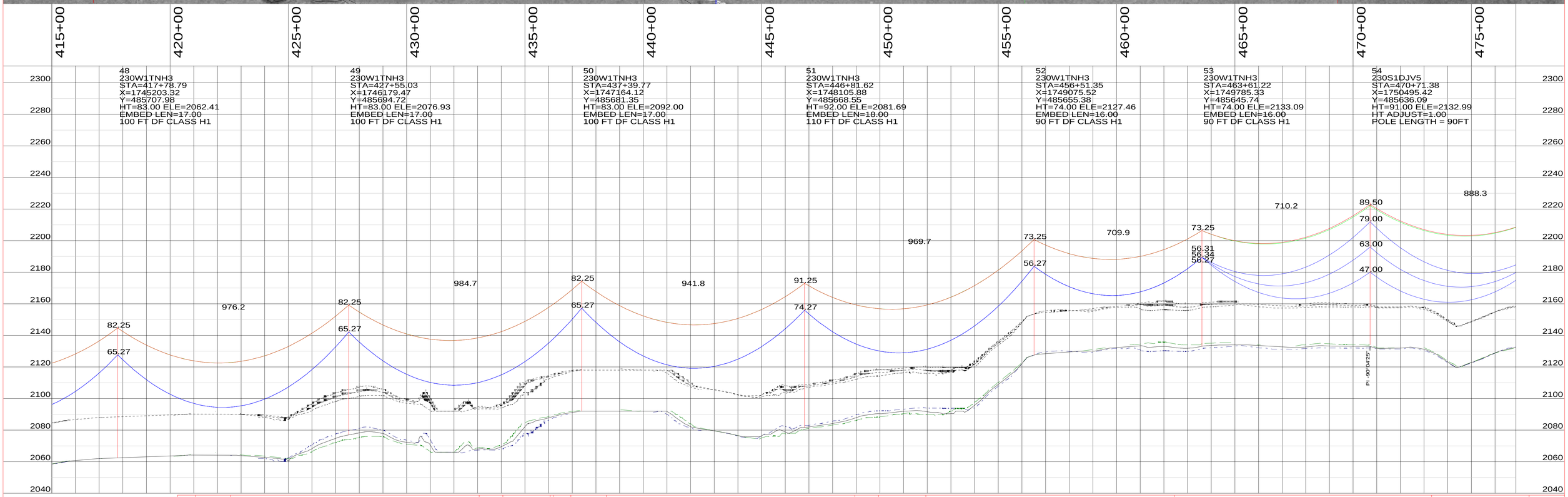
IMAGESITE PROJECT_NAME

SCALE:

MICROFILMED / /

CODE ALPHA BROAD FINE





NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 10 OF 22 | REV. C

MD+32900

SCALE:

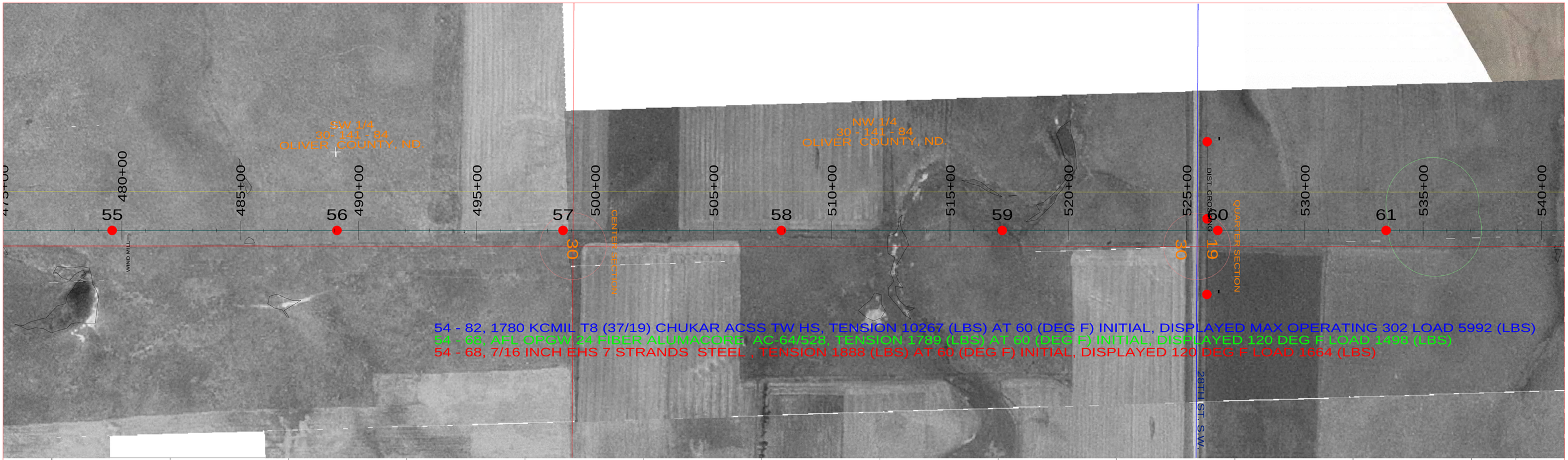
MICROFILMED / /

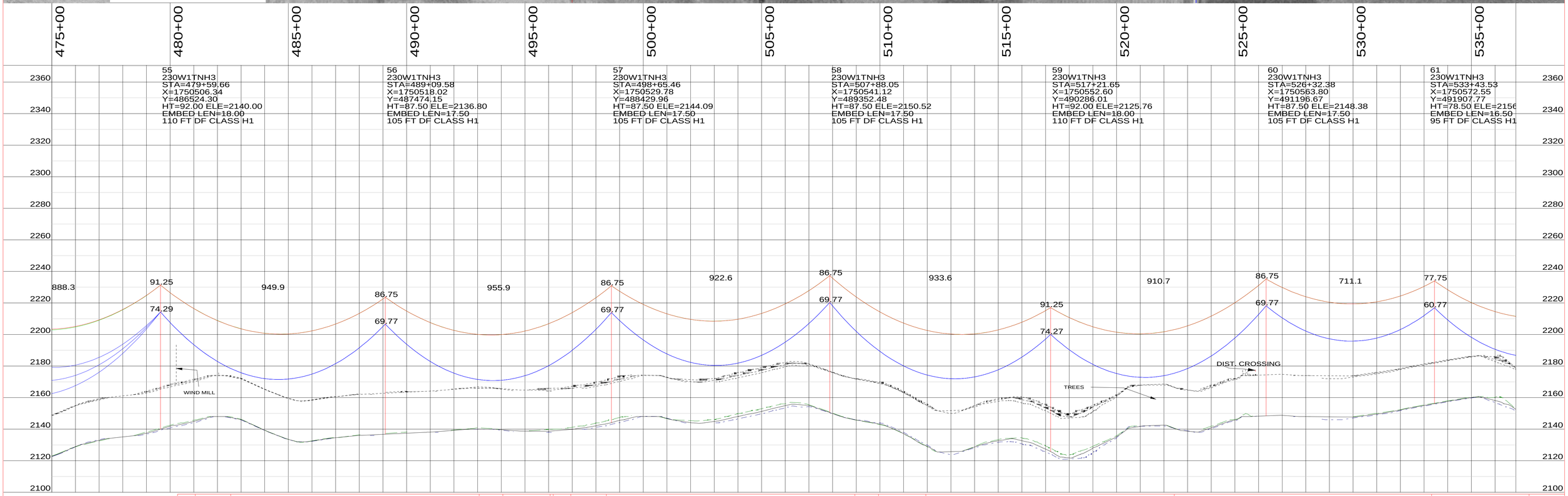
CODE: ALPHA | BROAD | FINE

IMAGESITE PROJECT_NAME

CADD DRAWING - FOR REPRODUCTION ONLY

PLS-CADD DRAWIN





NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 11 OF 22 REV. C

MD+32900

SCALE:

MICROFILMED / /

CODE: ALPHA BROAD FINE

IMAGESITE2PROJECT_NAME

CADD DRAWING - FOR REPRODUCTION ONLY

PLS-CADD DRAWIN

SW 1/4
19 - 141 - 84
OLIVER COUNTY, ND.

NW 1/4
19 - 141 - 84
OLIVER COUNTY, ND.

SW 1/4
18 - 141 - 84
OLIVER COUNTY, ND.

N=496957.55
E=1750634.65

N=497703.63
E=1750870.63

CENTER SECTION

54 - 82, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 10267 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 5992 (LBS)
54 - 68, AFL OPGW 24 FIBER ALUMACORE, AC-84/528, TENSION 1789 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1498 (LBS)
54 - 68, 7/16 INCH EHS 7 STRANDS STEEL , TENSION 1888 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1664 (LBS)
68 - 82, AFL OPGW 24 FIBER ALUMACORE, AC-84/528, TENSION 1789 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1491 (LBS)
68 - 82, 7/16 INCH EHS 7 STRANDS STEEL , TENSION 1888 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1658 (LBS)

62
230W1TNH3
STA=541+15.88
X=1750582.05
Y=492680.06
HT=92.00 ELE=2132.00
EMBED LEN=18.00
110 FT DF CLASS H1

63
230W1TNH3
STA=548+93.33
X=1750591.61
Y=493457.45
HT=87.50 ELE=2153.92
EMBED LEN=17.50
105 FT DF CLASS H1

64
230W1TNH3
STA=558+04.14
X=1750602.81
Y=494368.19
HT=83.00 ELE=2164.00
EMBED LEN=17.00
100 FT DF CLASS H1

65
230W1TNH3
STA=566+32.96
X=1750613.00
Y=495196.95
HT=83.00 ELE=2138.25
EMBED LEN=17.00
100 FT DF CLASS H1

66
230W1TNH3
STA=574+61.84
X=1750623.19
Y=496025.77
HT=78.50 ELE=2125.94
EMBED LEN=16.50
95 FT DF CLASS H1

67
230S1MAV5
STA=583+93.69
X=1750622.80
Y=496959.45
HT=111.00 ELE=2127.72
HT ADJUST=1.00
OFFSET ADJUST=-12.00
POLE LENGTH = 110FT

68
230S1MAV5
STA=591+76.20
X=1750882.48
Y=497701.75
HT=111.00 ELE=2124.71
HT ADJUST=1.00
OFFSET ADJUST=12.00
POLE LENGTH = 110FT

772.4 777.5 910.8 828.8 828.9 933.7 786.4 889.0

91.25 74.27 86.75 69.77 82.25 65.27 82.25 65.27 77.75 60.78 109.70 109.44 92.62 76.94 61.28 109.70 109.44 93.62 77.58 61.54

PI 16°50'50"
PI 17°05'38"

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

MINNESOTA POWER

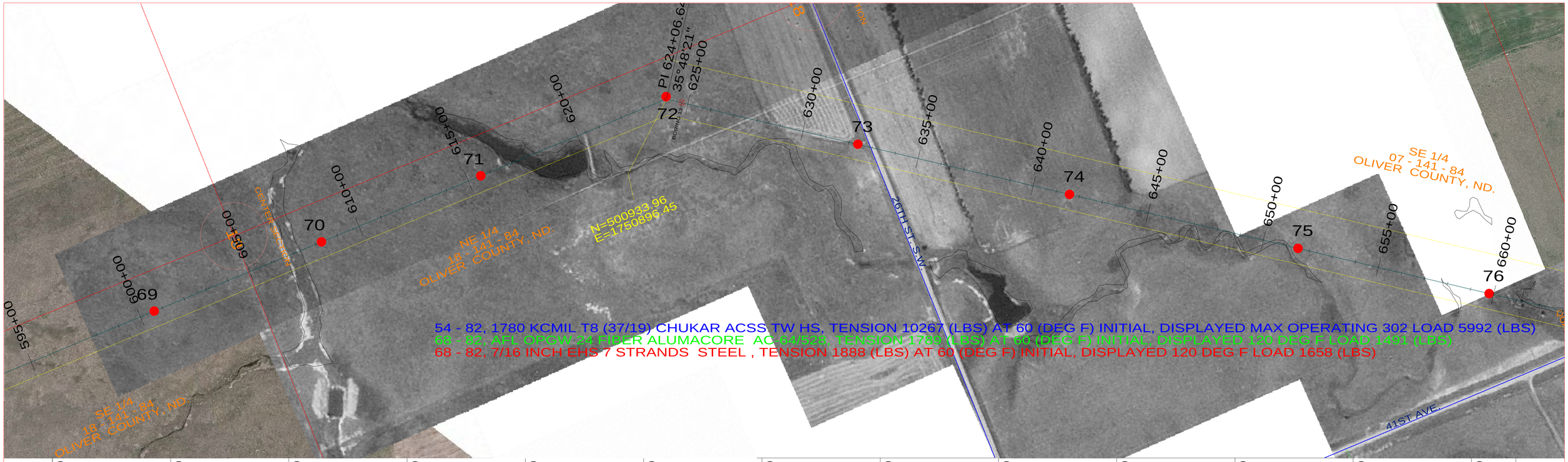
230 KV BISON - CENTER
LINE N0. 84

SHEET 12 OF 22
REV. C
MD+32900

IMAGESITE PROJECT_NAME

CADD DRAWING - FOR REPRODUCTION ONLY

SCALE:
MICROFILMED
CODE: ALPHA BROAD FINE



595+00 600+00 605+00 610+00 615+00 620+00 625+00 630+00 635+00 640+00 645+00 650+00 655+00

69
230W1TNH3
STA=600+63.32
X=1750877.72
Y=498590.72
HT=74.00 ELE=2109.11
EMBED LEN=16.00
90 FT DF CLASS H1

70
230W1TNH3
STA=608+28.72
X=1750883.84
Y=499356.09
HT=74.00 ELE=2091.05
EMBED LEN=16.00
90 FT DF CLASS H1

71
230W1TNH3
STA=615+57.57
X=1750889.66
Y=500084.92
HT=83.00 ELE=2088.91
EMBED LEN=17.00
100 FT DF CLASS H1

72
230S1HAV5
STA=624+06.64
X=1750886.96
Y=500937.11
HT=91.00 ELE=2090.04
HT ADJUST=1.00
OFFSET ADJUST=-10.00
POLE LENGTH = 90FT

73
230W1TNH3
STA=632+38.52
X=1751388.51
Y=501604.71
HT=83.00 ELE=2090.86
EMBED LEN=17.00
100 FT DF CLASS H1

74
230W1TNH3
STA=641+58.45
X=1751932.66
Y=502346.45
HT=83.00 ELE=2091.43
EMBED LEN=17.00
100 FT DF CLASS H1

75
230W1TNH3
STA=651+51.25
X=1752519.90
Y=503146.94
HT=92.00 ELE=2060.92
EMBED LEN=18.00
110 FT DF CLASS H1

2280 2260 2240 2220 2200 2180 2160 2140 2120 2100 2080 2060 2040 2020

889.0
73.25
765.4
56.32
56.27
73.25
728.9
56.27
82.25
852.2
65.28
89.70
89.44
77.27
835.0
61.84
46.38
82.25
919.9
65.28
82.25
992.8
65.27
91.25
830.0
74.27
PI 35°48'21"

NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 13 OF 22 REV. C

MD+32900

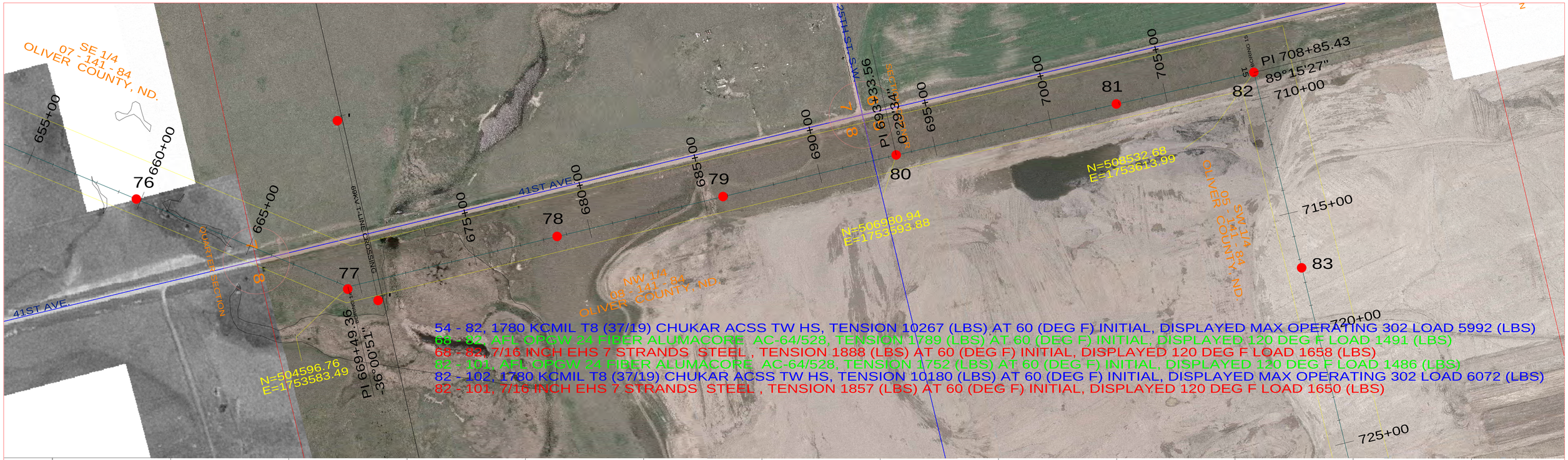
IMAGESITE PROJECT_NAME

CADD DRAWING - FOR REPRODUCTION ONLY

SCALE:

MICROFILMED / /

CODE ALPHA BROAD FINE



76
230W1TNH3
STA=659+81.27
X=1753010.86
Y=503816.19
HT=83.00 ELE=2069.91
EMBED LEN=17.00
100 FT DF CLASS H1

77
230S1HAV5
STA=669+49.36
X=1753592.99
Y=504593.63
HT=141.00 ELE=2048.00
HT ADJUST=1.00
OFFSET ADJUST=10.00
POLE LENGTH = 140FT

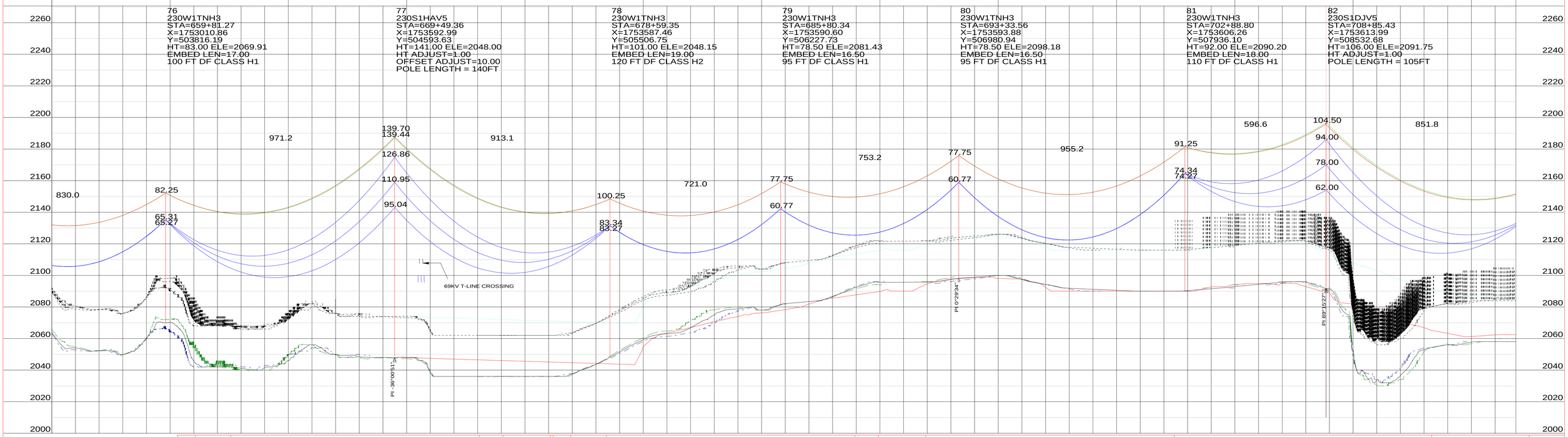
78
230W1TNH3
STA=678+59.35
X=1753587.46
Y=505506.75
HT=101.00 ELE=2048.15
EMBED LEN=19.00
120 FT DF CLASS H2

79
230W1TNH3
STA=685+80.34
X=1753590.60
Y=506227.73
HT=78.50 ELE=2081.43
EMBED LEN=16.50
95 FT DF CLASS H1

80
230W1TNH3
STA=693+33.56
X=1753593.88
Y=506980.94
HT=78.50 ELE=2098.18
EMBED LEN=16.50
95 FT DF CLASS H1

81
230W1TNH3
STA=702+88.80
X=1753606.26
Y=507936.10
HT=92.00 ELE=2090.20
EMBED LEN=18.00
110 FT DF CLASS H1

82
230S1DJV5
STA=708+85.43
X=1753613.99
HT=106.00 ELE=2091.75
HT ADJUST=1.00
POLE LENGTH = 105FT



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B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 14 OF 22 REV. C

MD+32900

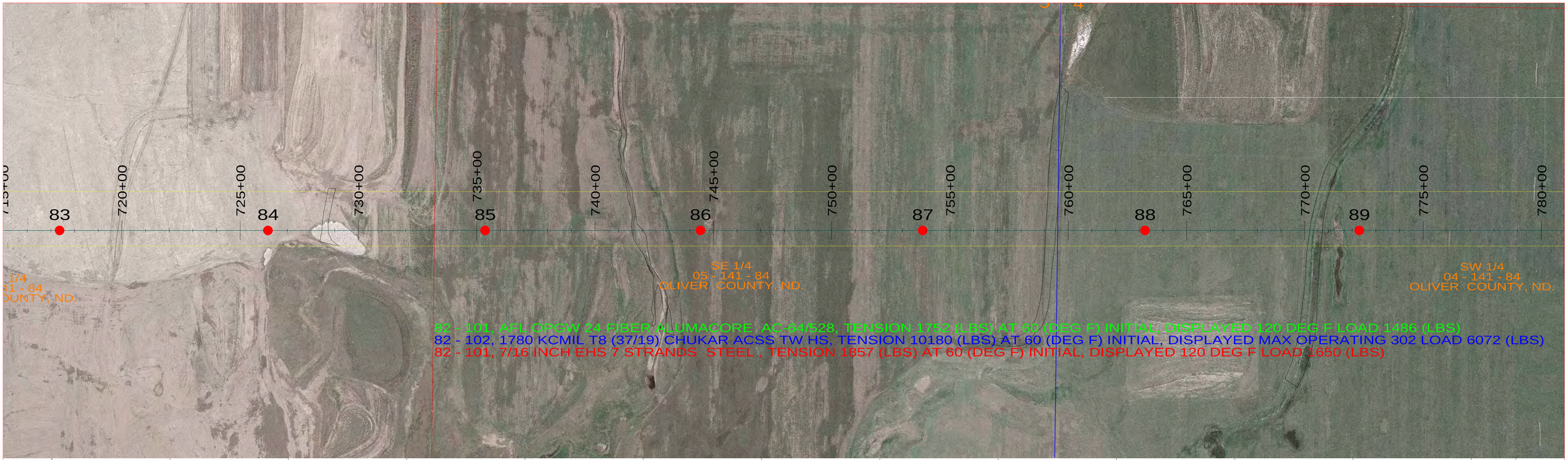
IMAGESITE2PROJECT_NAME

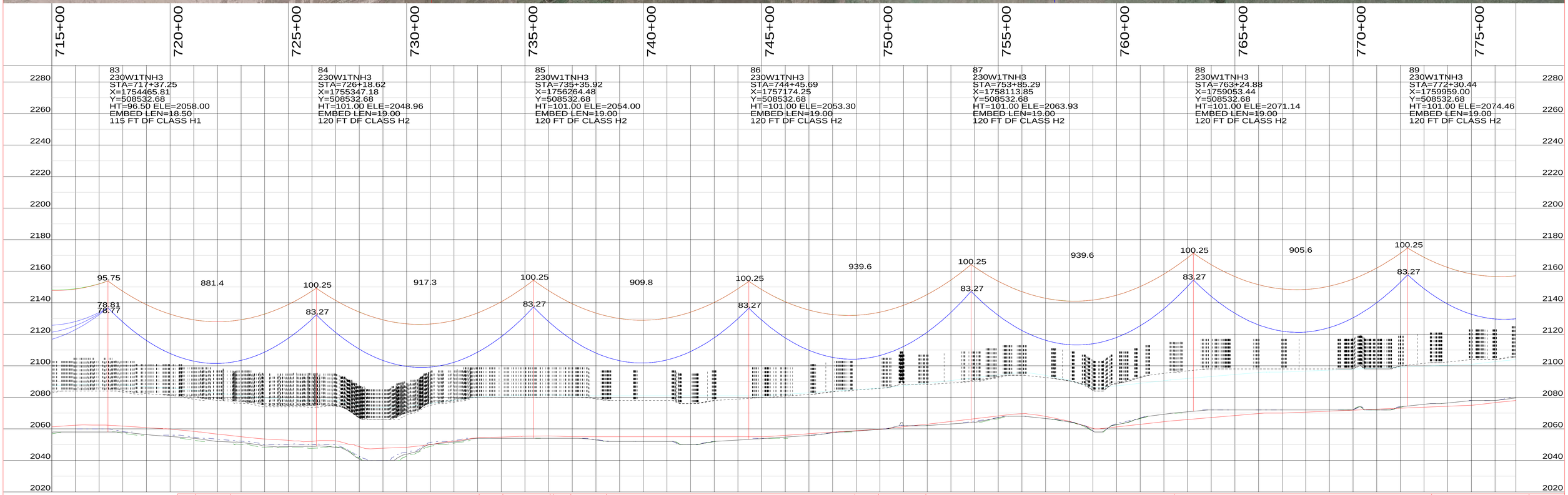
CADD DRAWING - FOR REPRODUCTION ONLY

SCALE:

MICROFILMED / /

CODE ALPHA BROAD FINE





NORTH

200.0 FT. HORIZ. SCALE

30.0 FT. VERT. SCALE

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 15 OF 22 REV. C

MD+32900

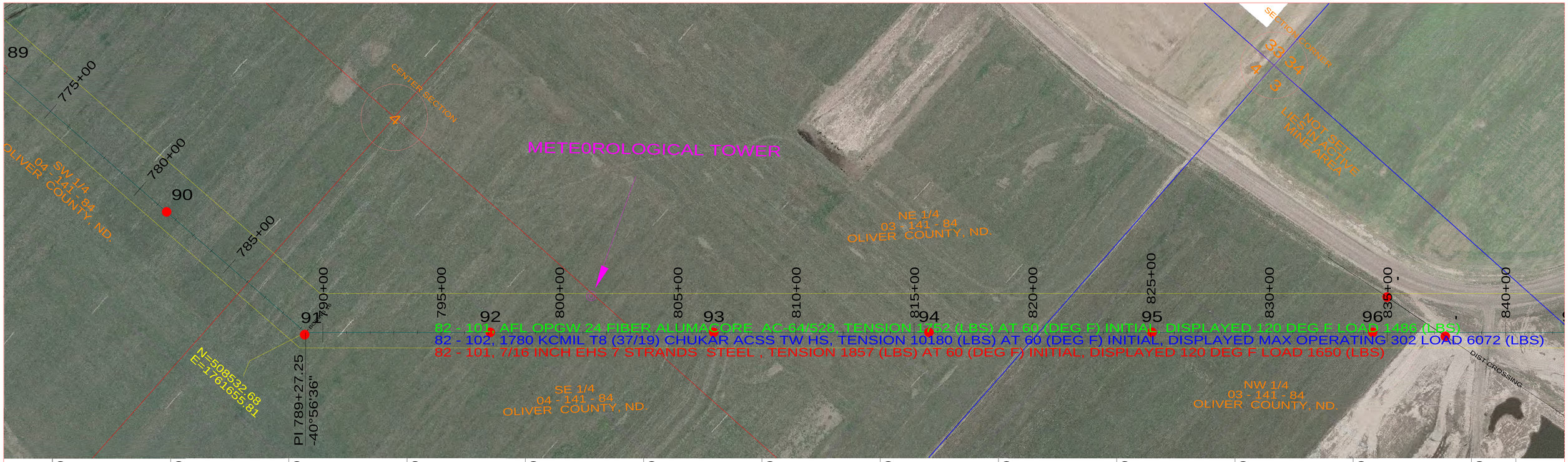
IMAGESITE PROJECT_NAME

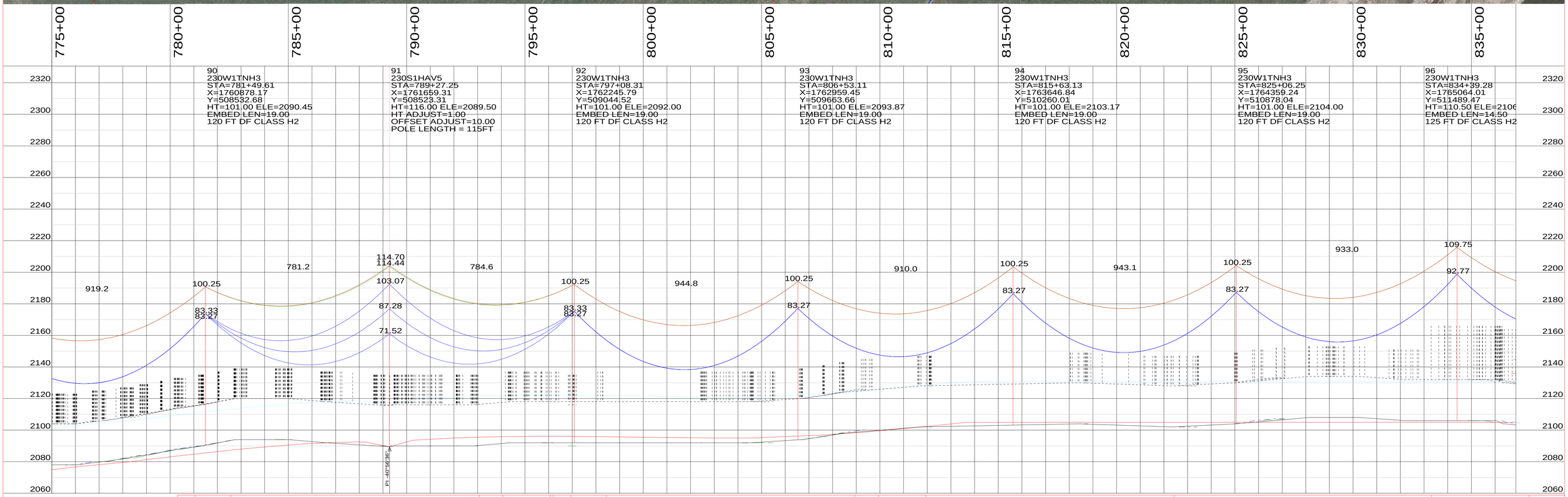
CADD DRAWING - FOR REPRODUCTION ONLY

SCALE:

MICROFILMED / /

CODE ALPHA BROAD FINE





NORTH

200.0 FT. HORIZ. SCALE

30.0 FT. VERT. SCALE

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED

MINNESOTA POWER

230 KV BISON - CENTER LINE N0. 84

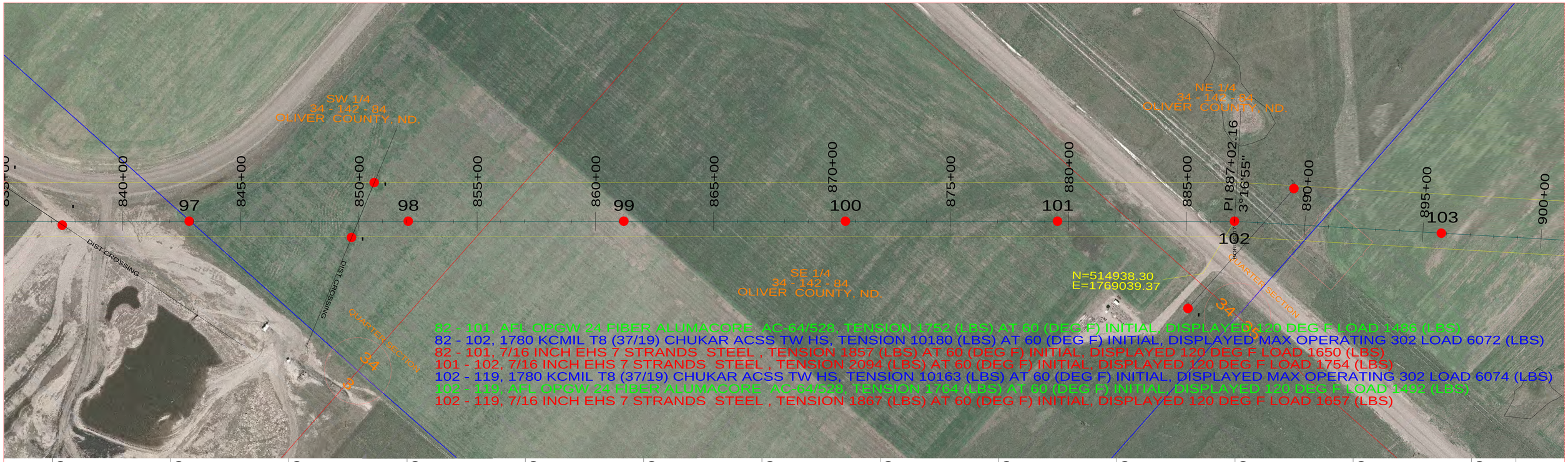
SHEET 16 OF 22 REV. C

MD+32900

IMAGESITE PROJECT_NAME

SCALE:

MICROFILMED		CODE		
/	/	ALPHA	BROAD	FINE



835+00 840+00 845+00 850+00 855+00 860+00 865+00 870+00 875+00 880+00 885+00 890+00 895+00

DISTRIBUTION POLE (3 WIRE) DE
STA=1287+83.00
X=1765306.76
Y=511678.47
HT=45.00 ELE=2102.62

97
230W1TNH3
STA=842+83.16
X=1765701.44
Y=512042.47
HT=110.50 ELE=2094.89
EMBED LEN=14.50
125 FT DF CLASS H2

98
230W1TNH3
STA=852+09.13
X=1766400.88
Y=512649.27
HT=101.00 ELE=2094.40
EMBED LEN=19.00
120 FT DF CLASS H2

99
230W1TNH3
STA=861+20.49
X=1767089.28
Y=513246.50
HT=101.00 ELE=2088.08
EMBED LEN=19.00
120 FT DF CLASS H2

100
230W1TNH3
STA=870+57.14
X=1767796.79
Y=513860.30
HT=101.00 ELE=2080.00
EMBED LEN=19.00
120 FT DF CLASS H2

101
230W1TNH3
STA=879+53.99
X=1768474.23
Y=514448.01
HT=101.00 ELE=2074.22
EMBED LEN=19.00
120 FT DF CLASS H2

102
230S1DJV5
STA=887+02.16
X=1769039.37
Y=514938.30
HT=131.00 ELE=2071.00
HT ADJUST=1.00
POLE LENGTH = 130FT

103
230W1TNH3
STA=895+78.44
X=1769733.06
Y=515473.70
HT=96.50 ELE=2084.
EMBED LEN=19.50
115 FT DF CLASS H1

2300 2280 2260 2240 2220 2200 2180 2160 2140 2120 2100 2080 2060 2040

843.9 109.75 92.77 926.0 100.25 83.27 911.4 100.25 83.27 936.6 100.25 83.27 896.8 99.75 99.25 83.33 83.27 748.2 129.50 119.00 103.00 87.00 876.3 95.75 78.80

EXISTING DSBN LINE
EXISTING 115 KV LINE
PI 3°16'55"

NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 17 OF 22 REV. C

MD+32900

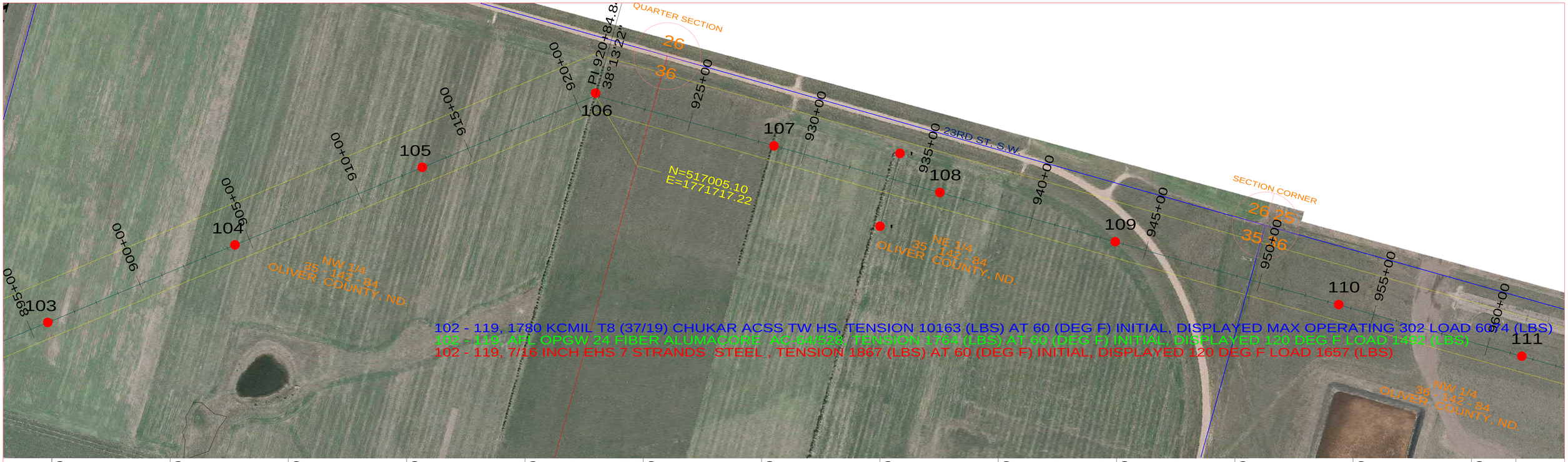
IMAGESITE PROJECT_NAME

CADD DRAWING - FOR REPRODUCTION ONLY

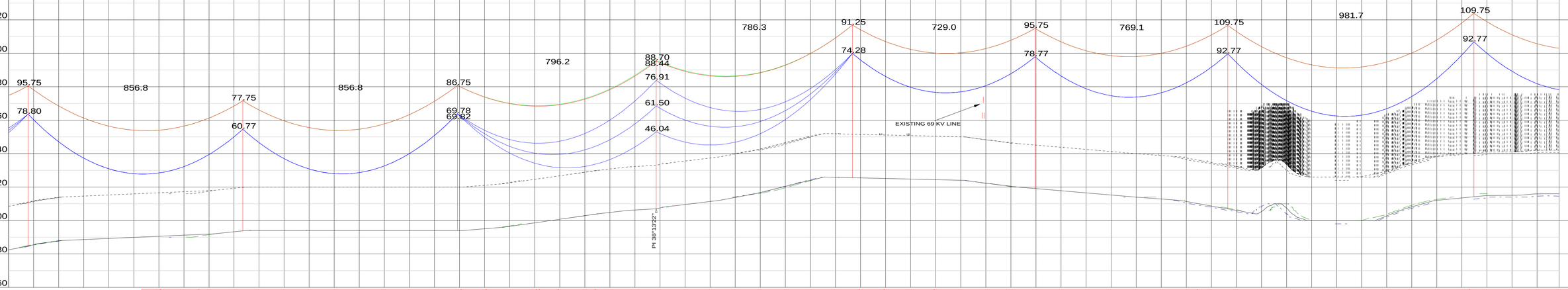
SCALE:

MICROFILMED / /

CODE ALPHA BROAD FINE



103	104	105	106	107	108	109	110
230W1TNH3	230W1TNH3	230W1TNH3	230S1HAV5	230W1TNH3	230W1TNH3	230W1TNH3	230W1TNH3
STA=895+78.44	STA=904+35.23	STA=912+92.02	STA=920+84.84	STA=928+67.84	STA=935+96.80	STA=943+65.90	STA=953+47.60
X=1769733.06	X=1770411.33	X=1771089.59	X=1771714.04	X=1772500.18	X=1773229.11	X=1773998.17	X=1774979.82
Y=515473.70	Y=515997.19	Y=516520.69	Y=517014.58	Y=516997.43	Y=516990.29	Y=516982.76	Y=516973.14
HT=96.50 ELE=2084.77	HT=78.50 ELE=2093.81	HT=87.50 ELE=2094.00	HT=90.00 ELE=2107.00	HT=92.00 ELE=2125.60	HT=96.50 ELE=2119.12	HT=110.50 ELE=2106.93	HT=110.50 ELE=2114.13
EMBED LEN=18.50	EMBED LEN=16.50	EMBED LEN=17.50	OFFSET ADJUST=-10.00	EMBED LEN=18.00	EMBED LEN=18.50	EMBED LEN=14.50	EMBED LEN=14.50
115 FT DF CLASS H1	95 FT DF CLASS H1	105 FT DF CLASS H1	POLE LENGTH = 90FT	110 FT DF CLASS H1	115 FT DF CLASS H1	125 FT DF CLASS H2	125 FT DF CLASS H2



NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 18 OF 22 REV. C

MD+32900

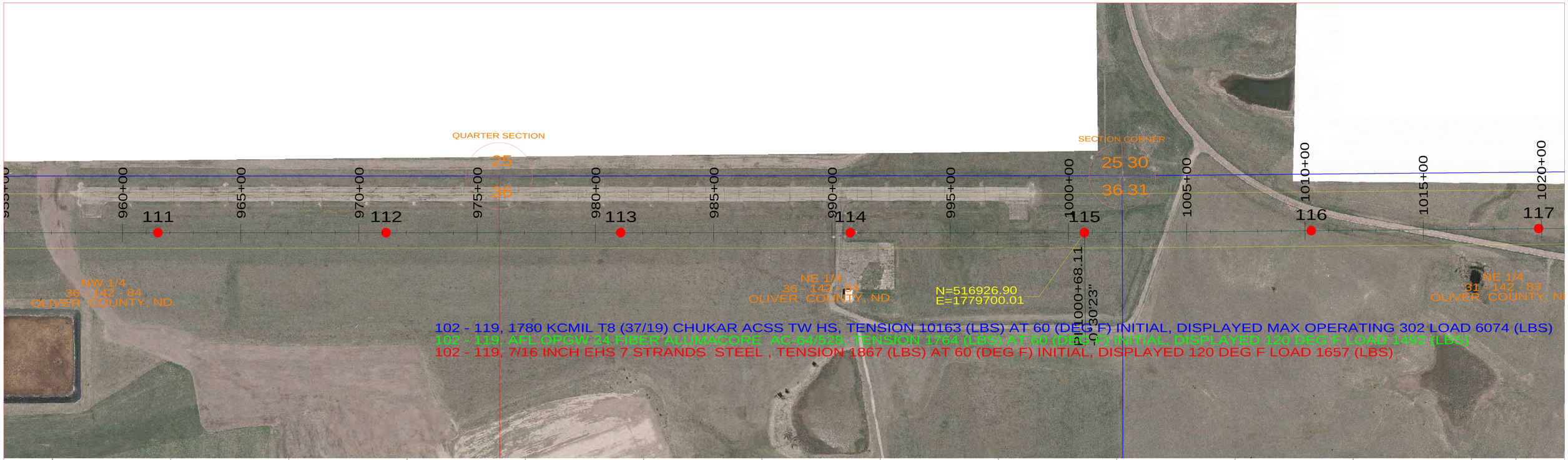
SCALE:

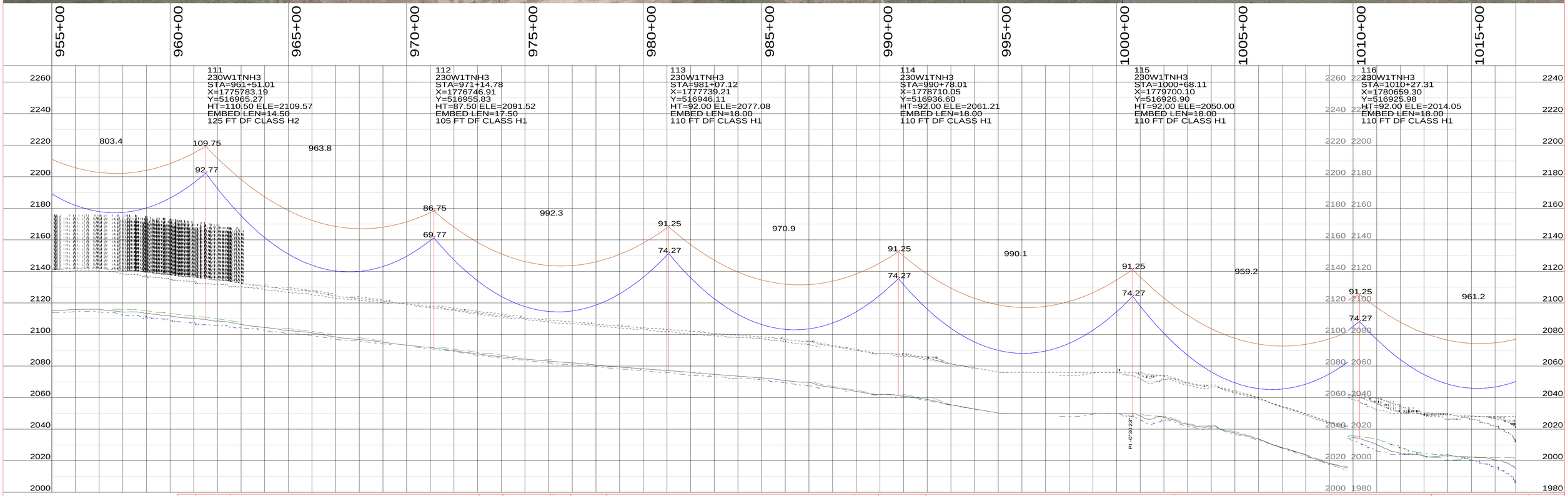
MICROFILMED / /

CODE: ALPHA BROAD FINE

IMAGESITE\PROJECT_NAME

CADD DRAWING - FOR REPRODUCTION ONLY





NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 19 OF 22 | REV. C

MD+32900

IMAGESITE PROJECT_NAME

CADD DRAWING - FOR REPRODUCTION ONLY

SCALE:

MICROFILMED / /

CODE: ALPHA | BROAD | FINE

SE 1/4
30 - 142 - 83
OLIVER COUNTY, ND.

P3

P1

SE 1/4
29 - 142 - 83
OLIVER COUNTY, ND.

PI 1037+58.45
35°34'35"

SECTION CORNER

30

31

32

29

N=517412.88
E=1783235.95

N=517396.56
E=1785115.73

PI 1056+38.28
-0°00'04"

SECTION CORNER

PI 1070+88.71
-0°00'03"

N=517374.73
E=1787630.55

SE 1/4
31 - 142 - 83
OLIVER COUNTY, ND.

N=516923.95
E=1782539.43

PI 1029+07.98
35°07'57"

102 - 119, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 10163 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 6074 (LBS)
102 - 119, AFL OPGW 24 FIBER ALUMACORE, AC-64/528, TENSION 1764 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1492 (LBS)
102 - 119, 7/16 INCH EHS 7 STRANDS, STEEL , TENSION 1867 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1657 (LBS)
119 - 121, 7/16 INCH EHS 7 STRANDS, STEEL , TENSION 1802 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1621 (LBS)
119 - 121, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 9894 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 6145 (LBS)
119 - 121, 7/16 INCH EHS 7 STRANDS, STEEL , TENSION 1800 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1620 (LBS)
121 - 123, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 9181 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 6798 (LBS)
121 - 123, AFL OPGW 24 FIBER ALUMACORE, AC-64/528, TENSION 1501 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1397 (LBS)
121 - 123, 7/16 INCH EHS 7 STRANDS, STEEL , TENSION 1635 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1550 (LBS)

1015+00 1020+00 1025+00 1030+00 1035+00 1040+00 1045+00 1050+00 1055+00 1060+00 1065+00 1070+00 1075+00

117
230W1TNH3
STA=1019+88.48
X=1781620.47
Y=516925.06
HT=101.00 ELE=1998.70
EMBED LEN=19.00
120 FT DF CLASS H2

118
230S1HAV5
STA=1029+07.98
X=1782542.98
Y=516914.64
HT=116.00 ELE=2014.18
HT ADJUST=1.00
OFFSET ADJUST=10.00
POLE LENGTH = 115FT

119
230S1DJV5
STA=1037+58.45
X=1783235.97
Y=517412.93
HT=141.00 ELE=2003.87
HT ADJUST=1.00
POLE LENGTH = 140FT

120
230W1TNH3
STA=1046+43.00
X=1784120.50
Y=517405.23
HT=110.50 ELE=1952.92
EMBED LEN=14.50
COUNTER WEIGHT: CONDUCTOR, 500 LBS
125 FT DF CLASS H2

121
230S1D2H5
STA=1056+38.28
X=1785115.73
Y=517396.56
HT=141.00 ELE=1930.16
HT ADJUST=1.00
POLE LENGTH = 140FT

122
230S1TNH3
STA=1070+88.71
X=1786566.11
Y=517383.96
HT=136.00 ELE=1945.64
HT ADJUST=1.00
POLE LENGTH = 135FT

961.2 922.6 995.3 1450.4 1064.5

100.25 83.31 83.27 114.70 114.44 102.50 86.57 70.65 139.50 129.00 113.00 97.00 109.75 92.78 140.25 119.00 135.25 117.35

PI 35°07'57"
PI 35°34'35"
PI -0°00'04"
PI -0°00'03"

NELSON LAKE

2160 2140 2120 2100 2080 2060 2040 2020 2000 1980 1960 1940 1920 1900

NORTH
200.0 FT. HORIZ. SCALE
30.0 FT. VERT. SCALE

NO.	DATE	REVISION DESCRIPTION	BY	APPROVED
A	9/30/09	PRELIMINARY REVIEW ISSUE	B&V	
B	10/20/09	PRELIMINARY REVIEW ISSUE	B&V	
C	12/09/09	ISSUED FOR PSC REVIEW	B&V	

MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 20 OF 22 REV. C

MD+32900

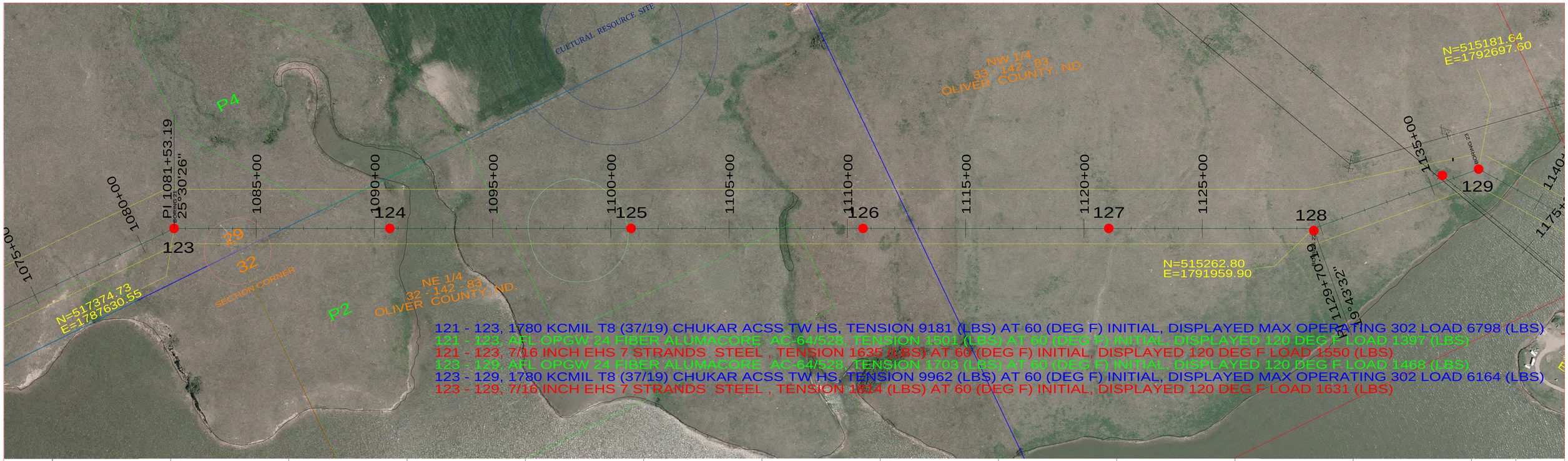
SCALE:

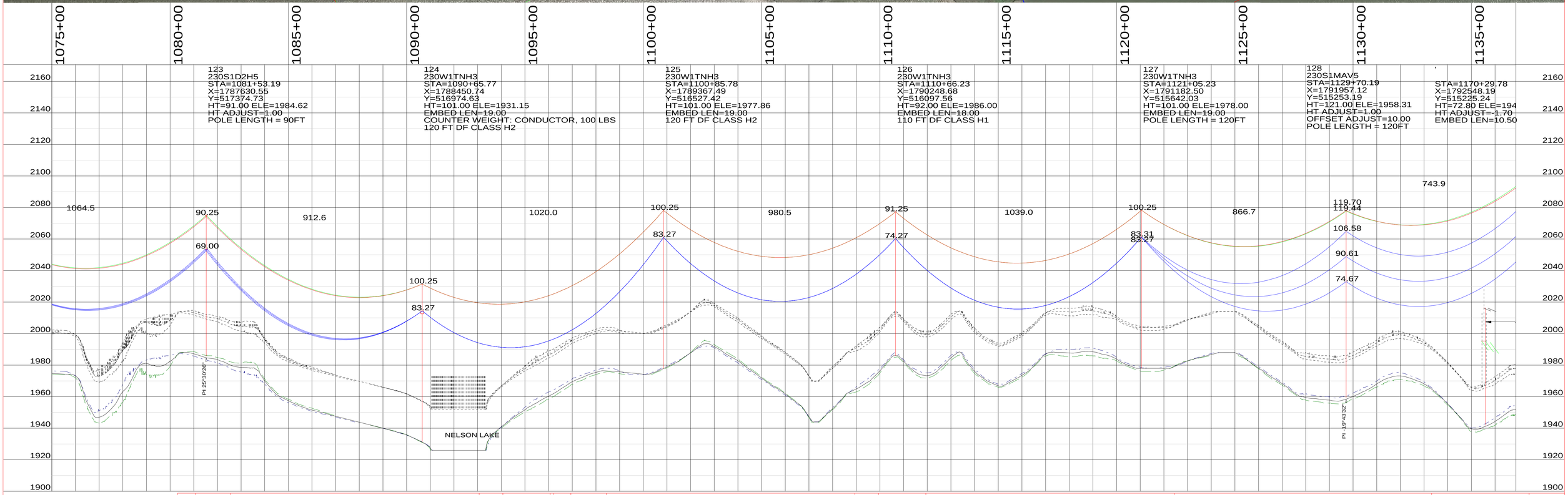
MICROFILMED / /

CODE ALPHA BROAD FINE

IMAGESITE PROJECT_NAME

PLS-CADD DRAWIN





NORTH

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MINNESOTA POWER

230 KV BISON - CENTER LINE N0. 84

SHEET 21 OF 22 REV. C

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SCALE:

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CODE ALPHA BROAD FINE

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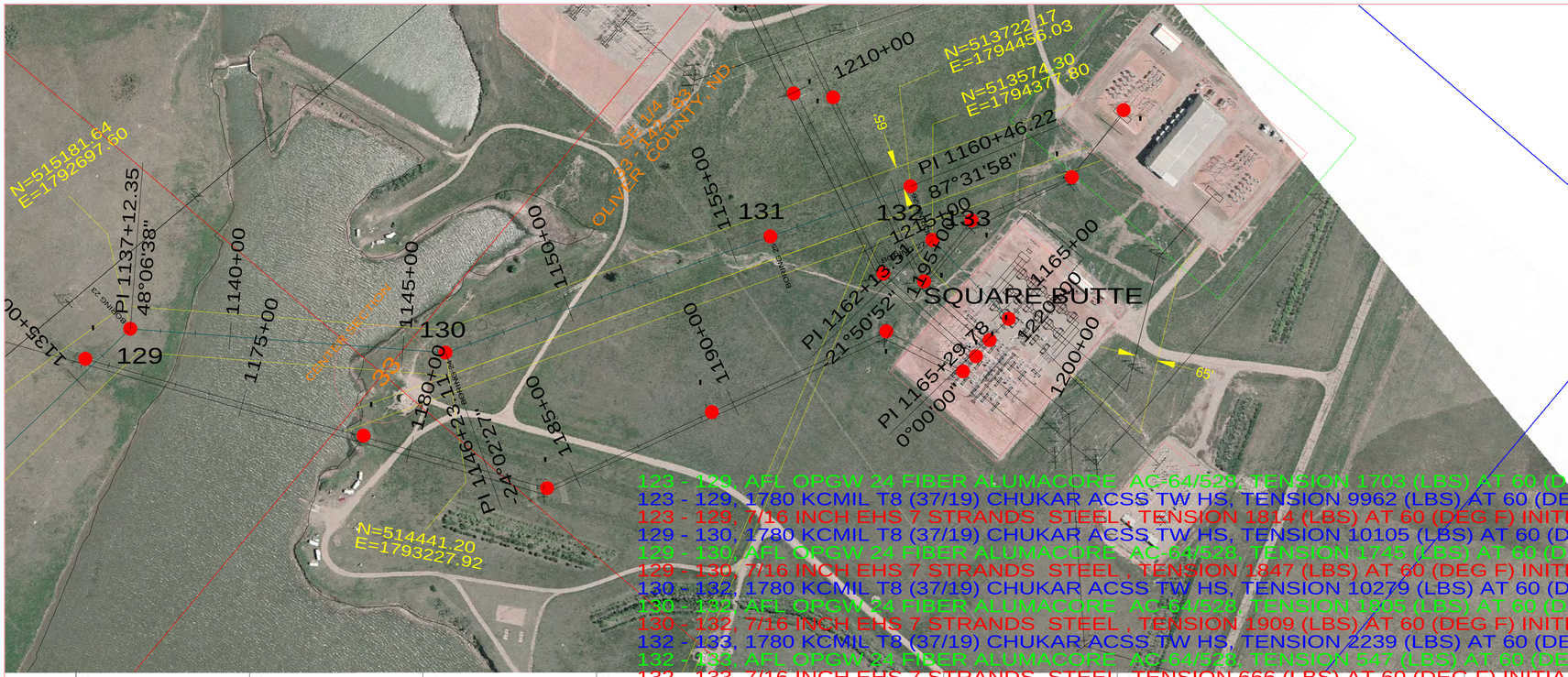
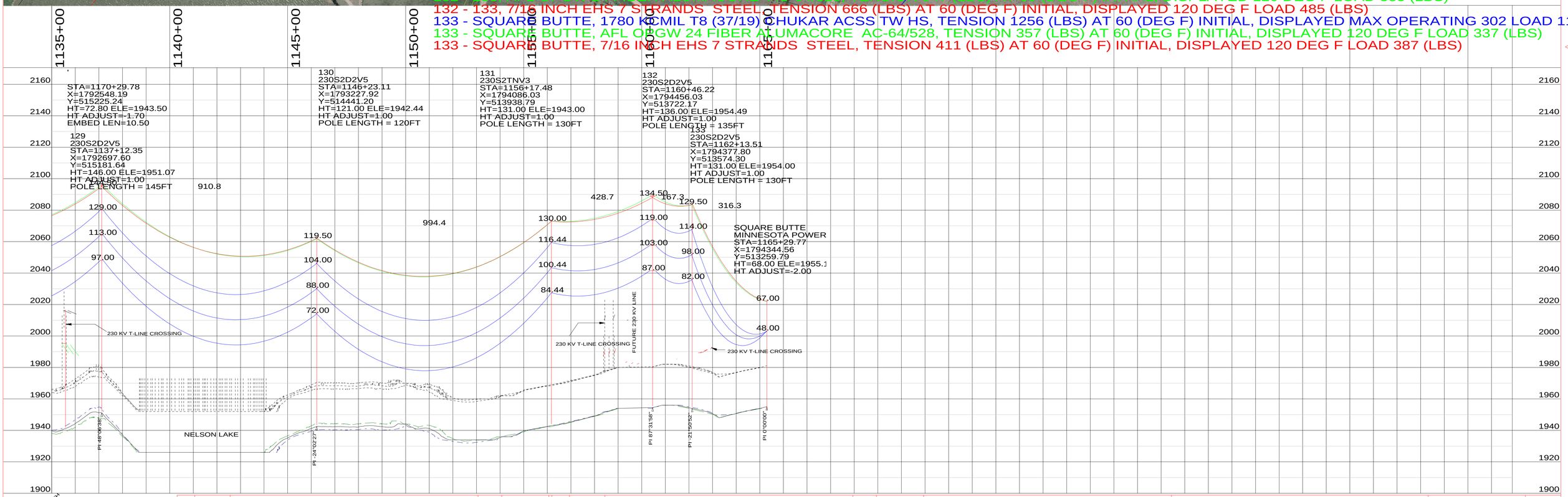


123 - 129, AFL OPGW 24 FIBER ALUMACORE AC-64/528, TENSION 1703 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1468 (LBS)
123 - 129, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 9962 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 6164 (LBS)
123 - 129, 7/16 INCH EHS 7 STRANDS STEEL, TENSION 1814 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1631 (LBS)
129 - 130, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 10105 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 6088 (LBS)
129 - 130, AFL OPGW 24 FIBER ALUMACORE AC-64/528, TENSION 1745 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F CREEP 1446 (LBS)
129 - 130, 7/16 INCH EHS 7 STRANDS STEEL, TENSION 1847 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1646 (LBS)
130 - 132, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 10279 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 5999 (LBS)
130 - 132, AFL OPGW 24 FIBER ALUMACORE AC-64/528, TENSION 1805 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1505 (LBS)
130 - 132, 7/16 INCH EHS 7 STRANDS STEEL, TENSION 1909 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 1674 (LBS)
132 - 133, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 2239 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 1272 (LBS)
132 - 133, AFL OPGW 24 FIBER ALUMACORE AC-64/528, TENSION 547 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 385 (LBS)
132 - 133, 7/16 INCH EHS 7 STRANDS STEEL, TENSION 666 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 485 (LBS)
133 - SQUARE BUTTE, 1780 KCMIL T8 (37/19) CHUKAR ACSS TW HS, TENSION 1256 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED MAX OPERATING 302 LOAD 116
133 - SQUARE BUTTE, AFL OPGW 24 FIBER ALUMACORE AC-64/528, TENSION 357 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 337 (LBS)
133 - SQUARE BUTTE, 7/16 INCH EHS 7 STRANDS STEEL, TENSION 411 (LBS) AT 60 (DEG F) INITIAL, DISPLAYED 120 DEG F LOAD 387 (LBS)



NORTH

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MINNESOTA POWER

230 KV BISON - CENTER
LINE N0. 84

SHEET 22 OF 22 | REV. C

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