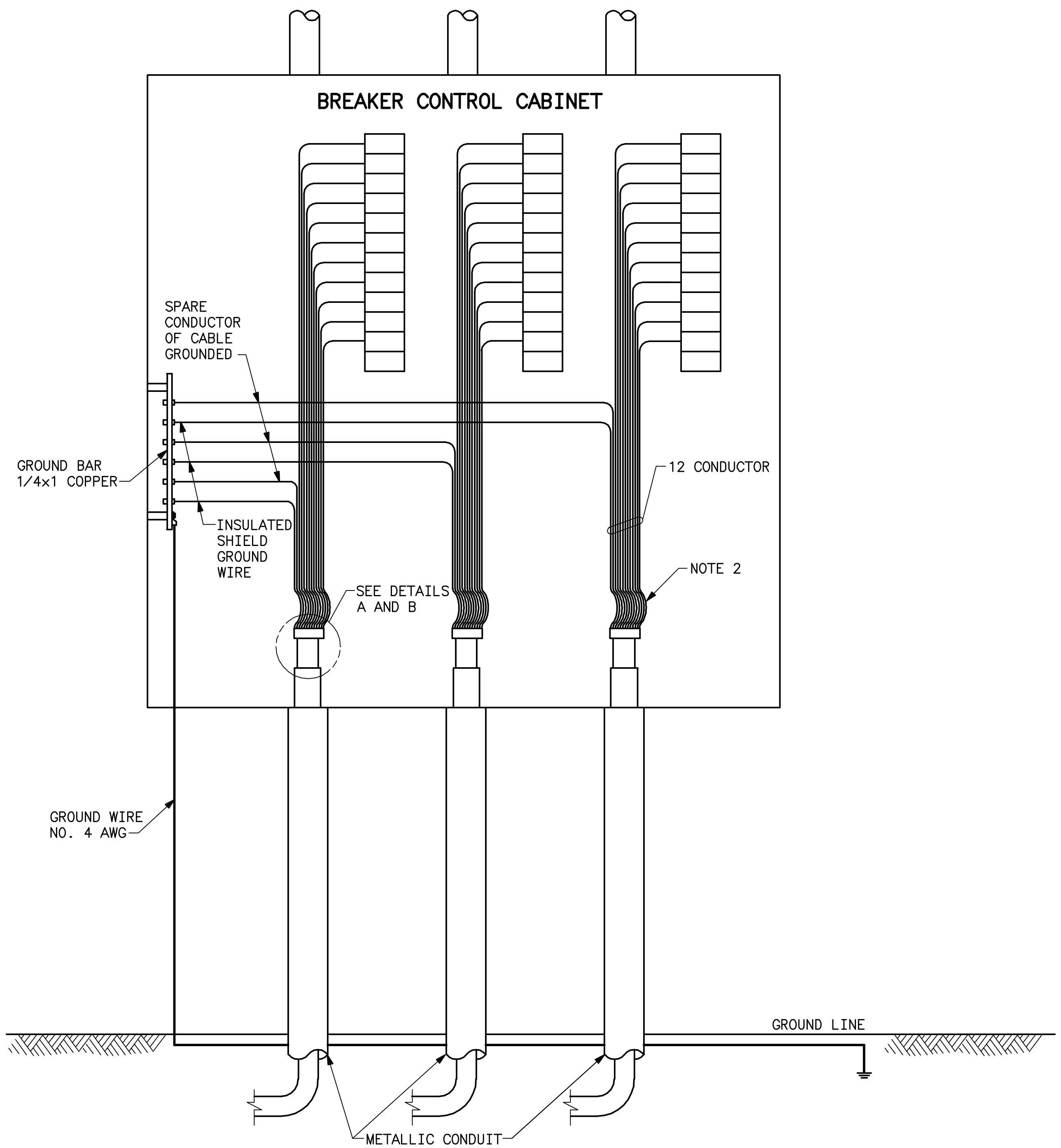
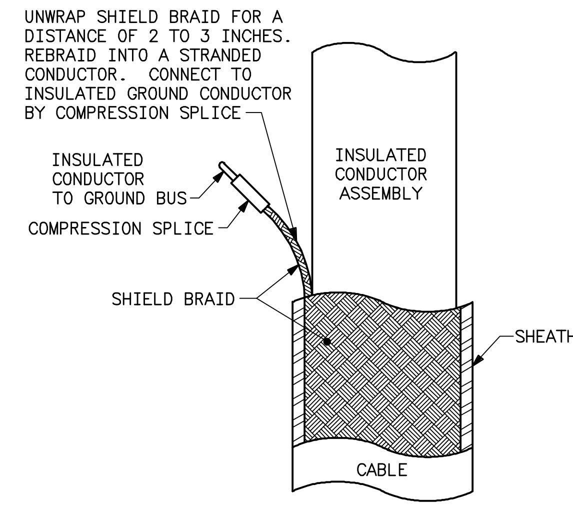
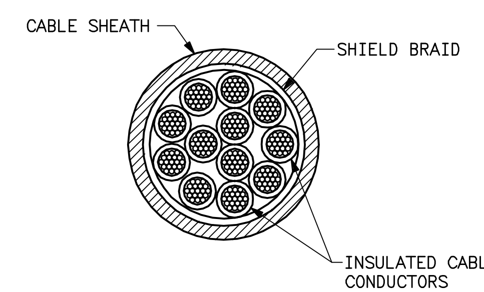




DETAIL A

LONGITUDINAL CABLE SECTION



DETAIL B

CABLE CROSS SECTION

NOTES

1. THIS DRAWING SHOWS THE PREFERRED METHOD OF GROUNDING THE CABLE SHIELD. IF APPROVED BY THE CONTRACTING OFFICER, OTHER METHODS MAY BE USED.
2. SLACK CABLES SHALL BE PROVIDED SO THAT ALL CABLES WILL BE IN SUFFICIENT LENGTH TO REACH THE FARTHEST TERMINAL IN THE CABINET.

E	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
D	2-11-94 A2-RPD	MINOR REVISIONS
C	4-7-93 A2-RPD	REVISED TO SHOW SLACK CABLES
B	9-10-92 A2-RPD	REDRAWN

SUPERSEDES DWG NO. 104-D-944

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

SUBSTATION STANDARDS
PCB CONTROL CABINETS
SHIELDED CABLE GROUNDING

DESIGNED BUREC APPROVED W. A. JACOBY FOR DIRECTOR, DIVISION OF SUBSTATION DESIGN

CAE MARCH 14, 1979 | 31 | 6000

NEMA IDENTIFICATION COLOR CODE FOR CONTROL CABLES

CABLE	NUMBER	ABBRE-VIATION	BASE	TRACER	TRACER
2/C	1	B	BLACK		
	2	W	WHITE		
3/C	3	R	RED		
5/C	4	G	GREEN		
	5	O	ORANGE		
7/C	6	BU	BLUE		
	7	WB	WHITE	BLACK	
9/C	8	RB	RED	BLACK	
	9	GB	GREEN	BLACK	
12/C	10	OB	ORANGE	BLACK	
	11	BUB	BLUE	BLACK	
	12	BW	BLACK	WHITE	
16/C	13	RW	RED	WHITE	
	14	GW	GREEN	WHITE	
	15	BUW	BLUE	WHITE	
	16	BR	BLACK	RED	
37/C	17	WR	WHITE	RED	
	18	OR	ORANGE	RED	
	19	BUR	BLUE	RED	
	20	RG	RED	GREEN	
	21	OG	ORANGE	GREEN	
	22	BWR	BLACK	WHITE	RED
	23	WBR	WHITE	BLACK	RED
	24	RBW	RED	BLACK	WHITE
	25	GBW	GREEN	BLACK	WHITE
	26	OBW	ORANGE	BLACK	WHITE
	27	BUBW	BLUE	BLACK	WHITE
	28	BRG	BLACK	RED	GREEN
	29	WRG	WHITE	RED	GREEN
	30	RBG	RED	BLACK	GREEN
	31	GBO	GREEN	BLACK	ORANGE
	32	OBG	ORANGE	BLACK	GREEN
	33	BUWO	BLUE	WHITE	ORANGE
	34	BWO	BLACK	WHITE	ORANGE
	35	WRO	WHITE	RED	ORANGE
	36	OWBU	ORANGE	WHITE	BLUE
	37	WRBU	WHITE	RED	BLUE

NOTES

1. WHERE POSSIBLE FIELD WILL CONNECT INDIVIDUAL WIRES OF MULTICONDUCTOR CABLES TO TERMINAL BLOCKS IN THE ORDER SHOWN ABOVE, FROM TOP TO BOTTOM FOR VERTICAL BLOCKS AND LEFT TO RIGHT FOR HORIZONTAL.
2. ACTUAL BASE AND TRACER COLORS SHALL BE USED. PRINTED CONDUCTOR NUMBERS AND COLOR DESIGNATIONS WILL NOT BE ACCEPTABLE.

A	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.

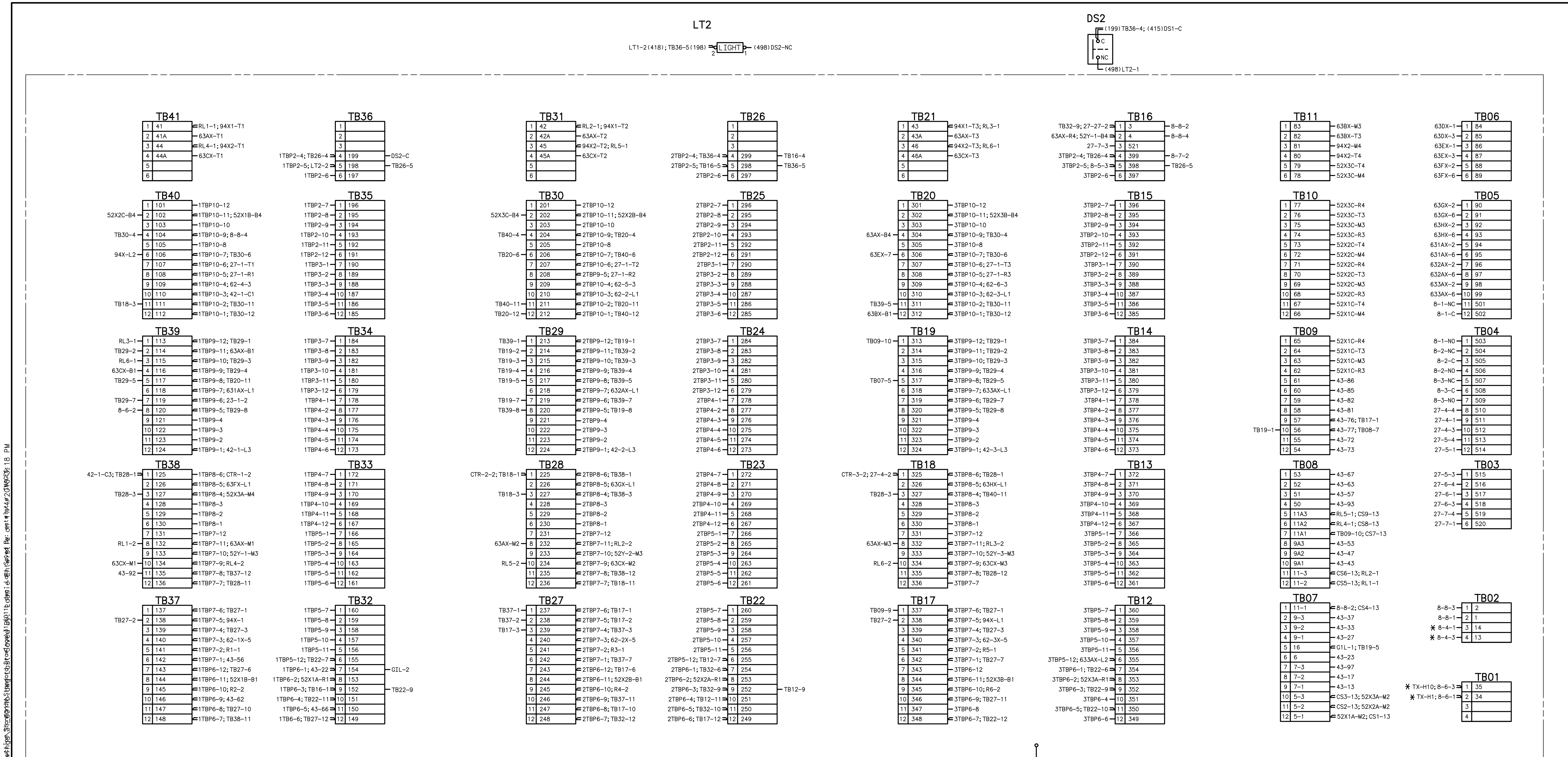
SUPERSEDES DWG NO. 31-1076

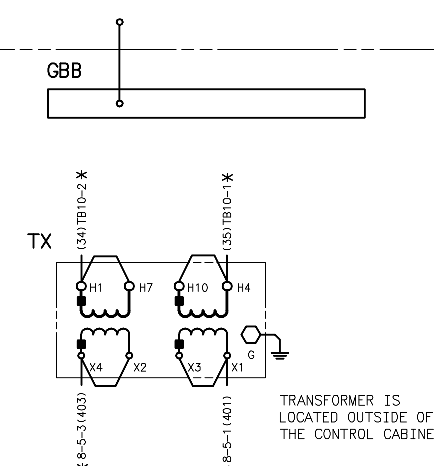
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

SUBSTATION STANDARDS
CONTROL CABLE
COLOR CODE IDENTIFICATION

DESIGNED _____ APPROVED W. A. JACOBY
DIRECTOR, DIVISION OF SUBSTATION DESIGN

CAD	NOVEMBER 13, 1989	31	6005





EXPLANATION

*____DENOTES NO. 10 AWG SIS WIRE

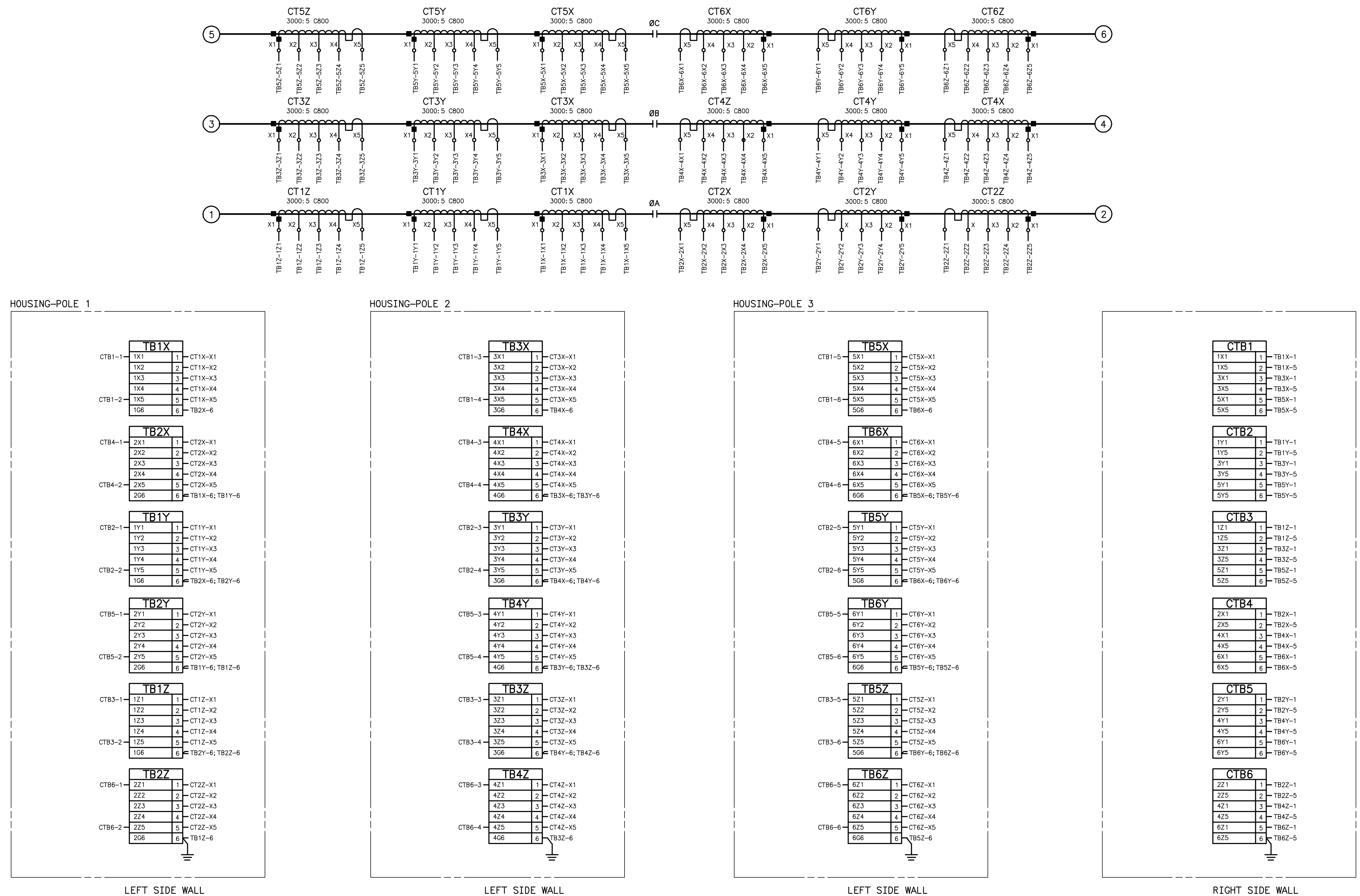
B	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
A	7-27-99 A3-CLC	REMOVED REFERENCE DRAWINGS

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

SUBSTATION STANDARDS
TYPICAL POWER CIRCUIT BREAKER
WIRING DIAGRAM (SH 1 OF 3)

DESIGNED MFR APPROVED H. ELGHANDOUR CHIEF, SUBSTATION CONTROL BRANCH

JULY 13, 1994 | 31 | 6011



B	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
A	7-27-99 A3-CLC	REMOVED REFERENCE DRAWINGS

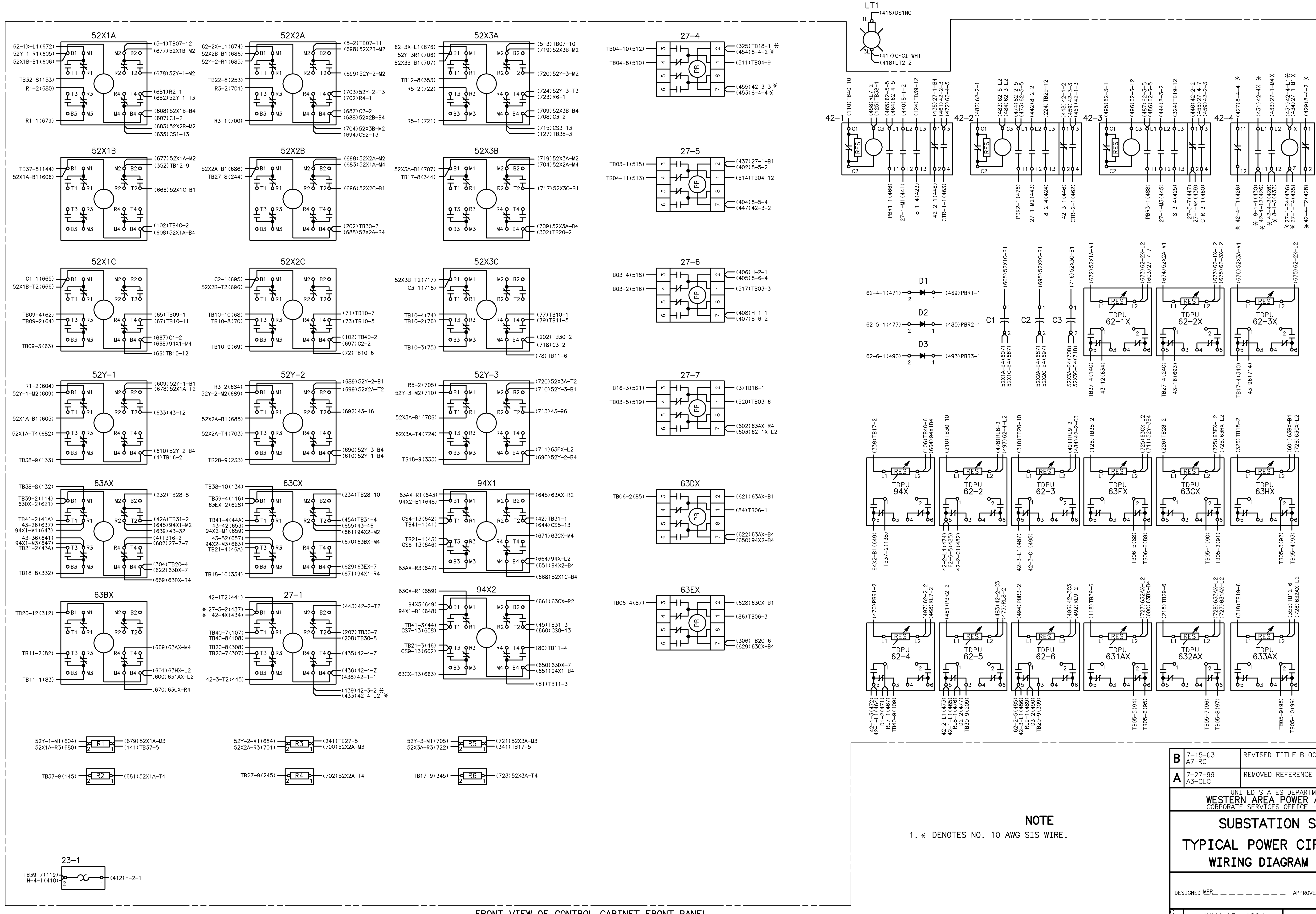
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

SUBSTATION STANDARDS
TYPICAL POWER CIRCUIT BREAKER WIRING DIAGRAM (SH 2 OF 3)

DESIGNED MFR APPROVED H. ELGHANDOUR CHIEF, SUBSTATION CONTROL BRANCH

CAD JULY 13, 1994 | 31 | 6012

Plotted By: entwistle Nov 04, 2010- 3:29pm



NOTE

1. ✱ DENOTES NO. 10 AWG SIS WIRE.

B	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
A	7-27-99 A3-CLC	REMOVED REFERENCE DRAWINGS

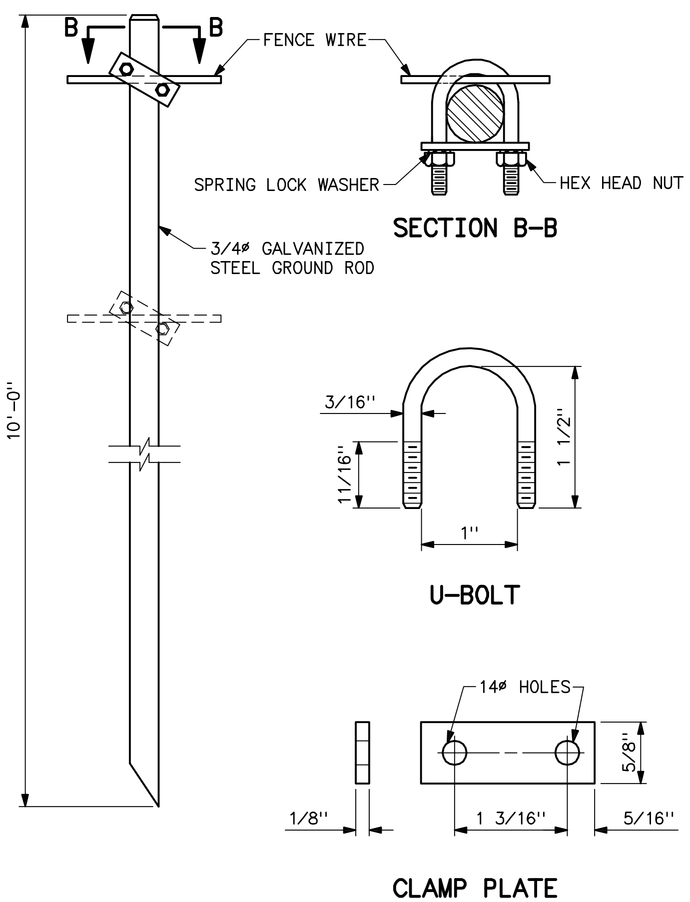
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

SUBSTATION STANDARDS
TYPICAL POWER CIRCUIT BREAKER
WIRING DIAGRAM (SH 3 OF 3)

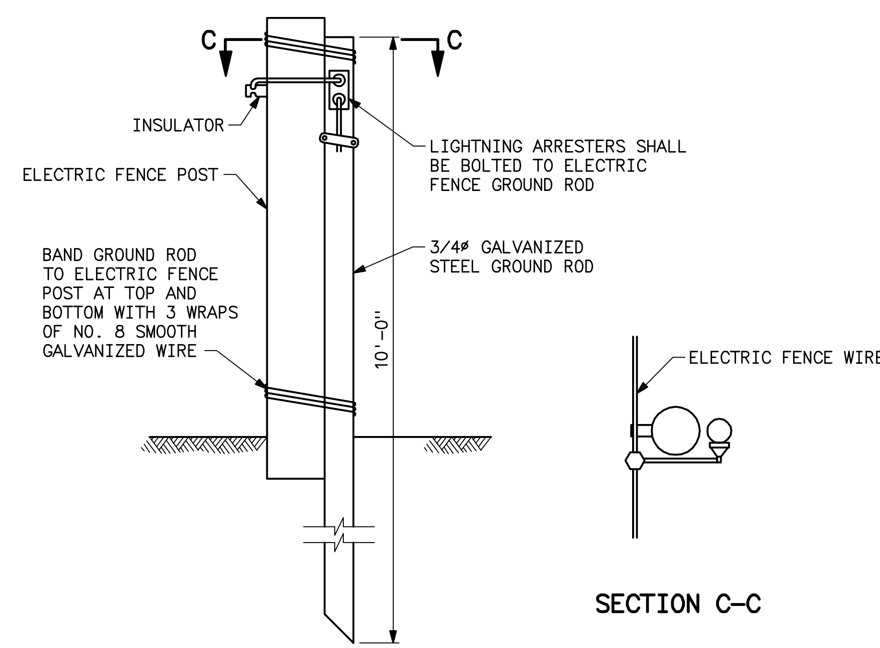
DESIGNED MFR APPROVED H. ELGHANDOUR CHIEF, SUBSTATION CONTROL BRANCH

JULY 13, 1994 | 31 | 6013

Plotted By:entwistle Nov 04, 2010- 3:29pm



NON-ELECTRIC FENCE GROUNDING



ELECTRIC FENCE GROUNDING

NOTES

1. GROUND RODS AND HARDWARE SHALL BE MADE OF STEEL AND GALVANIZED IN ACCORDANCE WITH ASTM DESIGNATION A 153.
2. CLAMP ASSEMBLY INCLUDES U-BOLT, CLAMP PLATE, TWO SPRING LOCKWASHERS AND TWO HEX NUTS.
3. USE ONE CLAMP ASSEMBLY, FOR EACH FENCE WIRE.
4. ELECTRIC FENCES SHALL BE GROUNDED ONLY THROUGH LIGHTNING ARRESTERS AS SHOWN. LIGHTNING ARRESTERS SHALL BE ESPECIALLY DESIGNED FOR USE WITH ELECTRIC FENCES. GROUND RODS SHALL BE DRIVEN AS CLOSE AS POSSIBLE TO, AND BONDED TO, ELECTRIC FENCE POSTS.
5. REMOVE SCALE AND RUST AND THEN COAT WITH NO-OXIDE COMPOUND, ALL FENCE WIRE SURFACES WHICH CONTACT CLAMP ASSEMBLIES.

C	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
B	7-13-99 A3-RMC	REDRAWN.

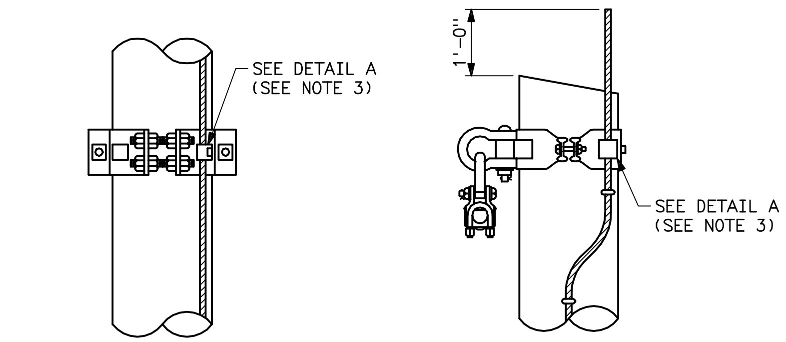
SUPERSEDES DWG NO. E40-D-5017

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

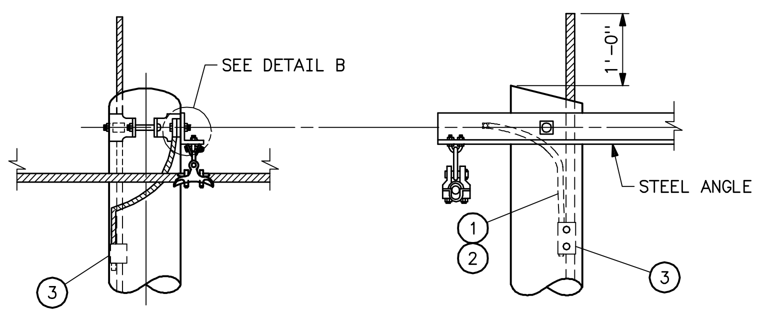
TRANSMISSION LINE STANDARDS
TRANSMISSION LINES
FENCE GROUNDING HARDWARE

DESIGNED BUREC APPROVED ROSS M. CLARK ELECTRICAL ENGINEERING MANAGER

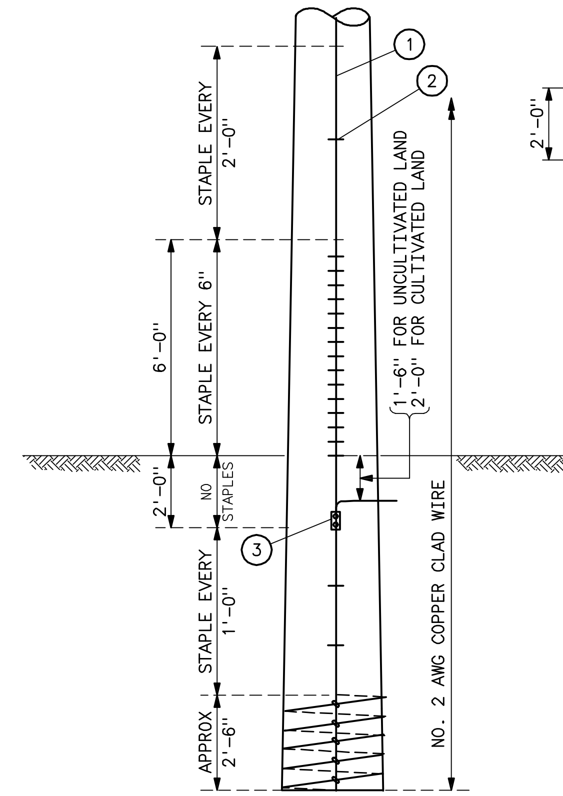
CAE	AUGUST 6, 1979	41	1011



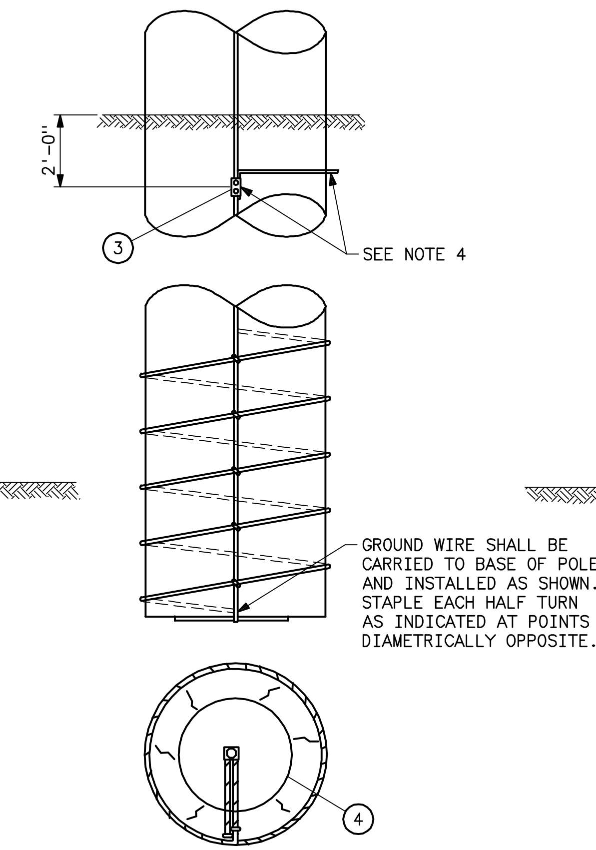
POLE BAND BONDING



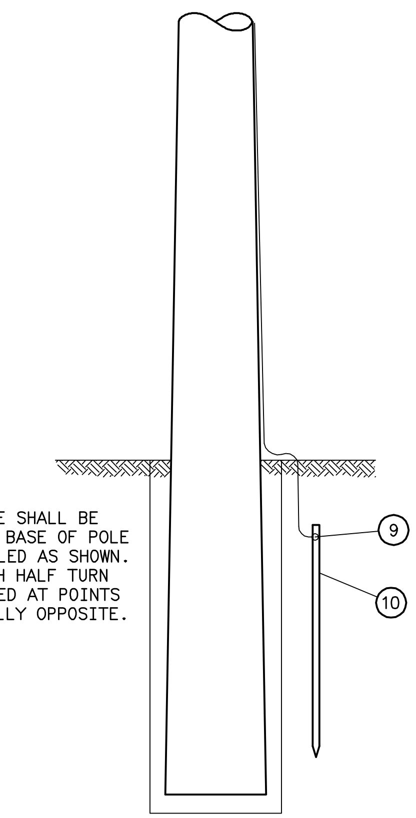
STEEL ANGLE BONDING



GROUND WIRE ATTACHMENT DETAILS



POLE BUTT
WRAPPING DETAIL



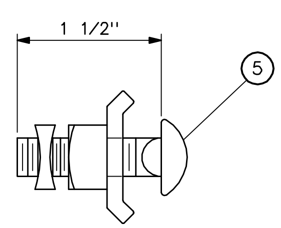
GROUND ROD DETAIL
SEE NOTE 5

MATERIALS LIST

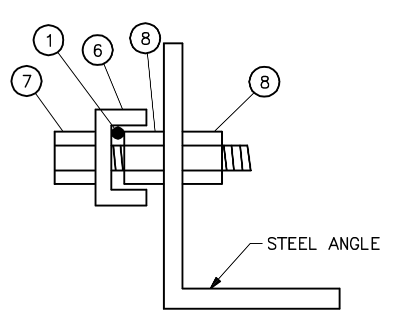
ITEM NO.	DESCRIPTION
1	NO.2 AWG, 30% CONDUCTIVITY, COPPER CLAD WIRE
2	GALVANIZED 2-INCH BARBED STAPLES
3	CLAMP, PARALLEL GROOVE, 2-BOLT COPPER ALLOY
4	POLE BOTTOM PLATE (BLACKBURN NO. GP 110 OR EQUAL) ATTACHED TO POLE
5	GROUNDING CLIP ASSEMBLY (INCLUDES BONDING CLIP, CARRIAGE BOLT, NUT, AND LOCKNUT)
6	BONDING CLIP (EQUAL TO BROOKS MANU. BC SERIES OR HUGHES BROS. NO. 2727)
7	MACHINE BOLT, 1/2x3
8	LOCKNUT FOR 1/2" BOLT
9	CADWELD, THERMOWELD OR EQUAL EXOTHERMIC TYPE CONNECTION
10	GROUND ROD, COPPER-CLAD STEEL 5/8x8 FT

NOTES

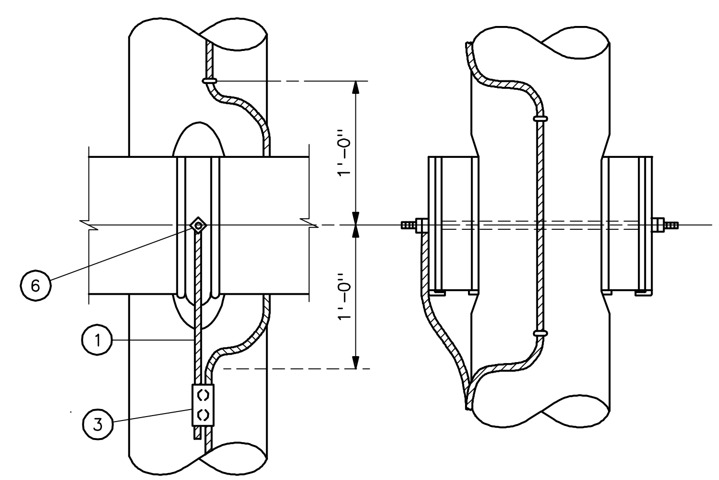
1. INSTALL GROUND WIRE AS INDICATED ON INDIVIDUAL STRUCTURE DRAWINGS.
2. PARALLEL GROOVE CLAMP, BONDING CLIP AND JUMPER FOR BONDING TO CROSSARM IS REQUIRED FOR 230KV STRUCTURES ONLY.
3. USE ONE GROUNDING CLIP ASSEMBLY PER POLE BAND.
4. UNDERGROUND POLE-TO-POLE GROUND WIRE TIE IS REQUIRED FOR ALL STRUCTURES EXCEPT FOR THOSE THAT HAVE STEEL ANGLE BONDING.
5. USE GROUND ROD ONLY WHEN SPECIFIED. THE TOP OF THE GROUND ROD SHALL BE PLACED A MINIMUM OF 6 INCHES BELOW GROUND LEVEL.



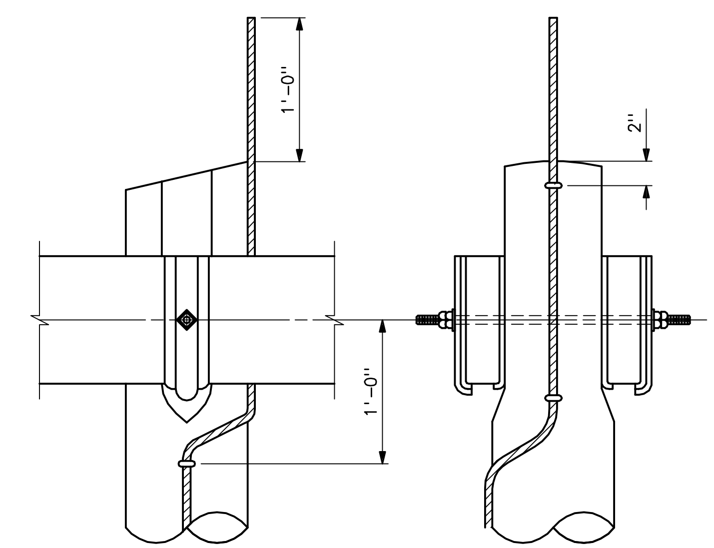
DETAIL A
GROUNDING CLIP ASSEMBLY
(SEE NOTE 3)



DETAIL B
BONDING CLIP ASSEMBLY



CROSSARM DETAIL
AND BONDING
FOR STRUCTURE WITH OGW
(SEE NOTE 2)



CROSSARM DETAIL AND BONDING
FOR STRUCTURE WITHOUT OGW

C	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
B	5-18-95 A2-RMC	REDRAWN.

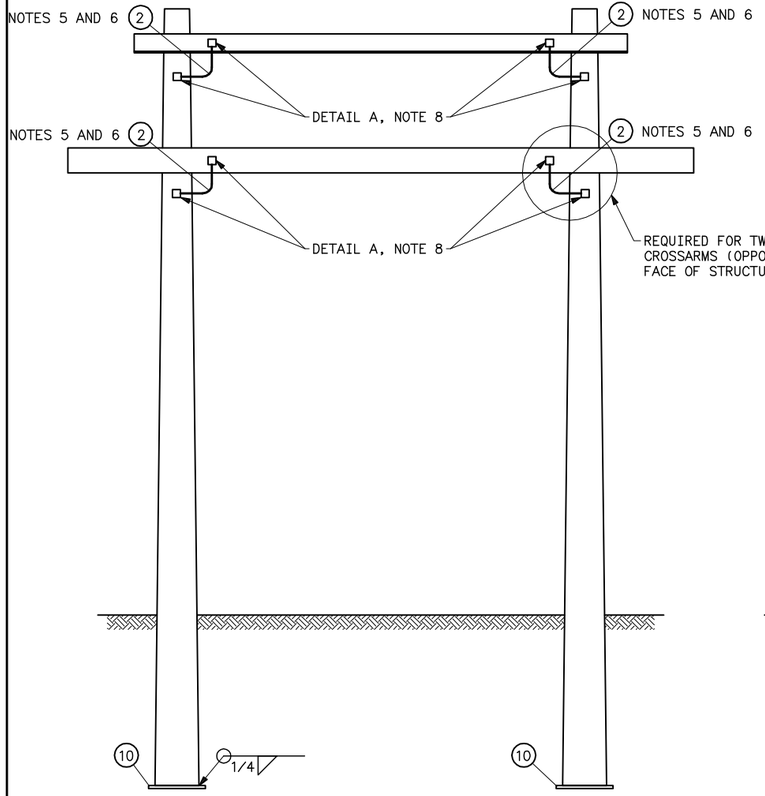
SUPERSEDES DWG NO. 40-D-4978

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

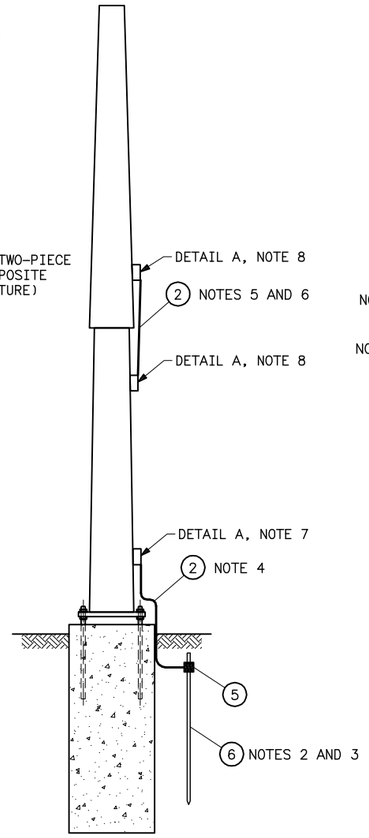
TRANSMISSION LINE STANDARDS
WOOD POLE STRUCTURES
GROUNDING DETAILS

DESIGNED SRR APPROVED ROSS M. CLARK
CHIEF, TRANSMISSION LINE BRANCH

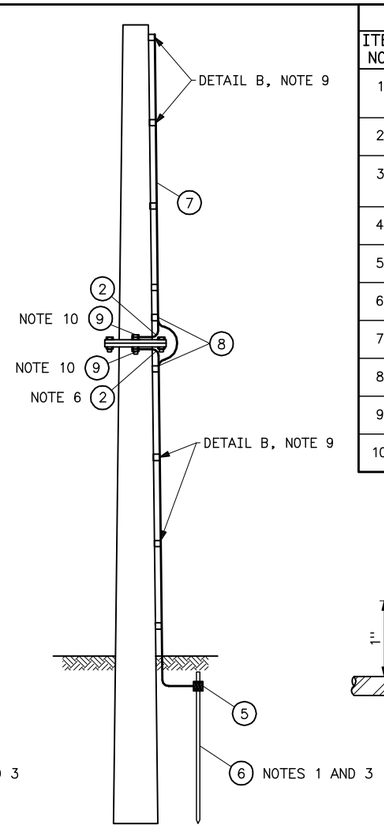
CAE	AUGUST 6, 1979	41	1012



WEATHERING STEEL H-FRAME
NATIVE BACKFILL
NOTE 13



WEATHERING STEEL POLE
CONCRETE FOUNDATION OR CONCRETE BACKFILL
NOTE 13



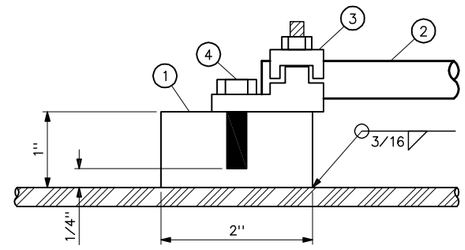
CONCRETE POLE
NATIVE BACKFILL

MATERIAL LIST

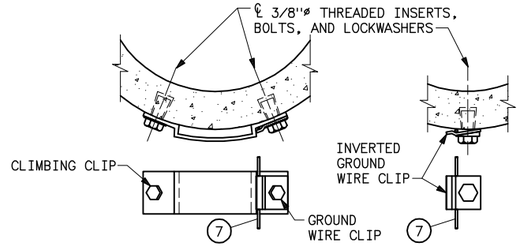
ITEM NO.	DESCRIPTION
1	STAINLESS STEEL GROUND PLATE 2''x2''x1'' CENTER DRILLED AND TAPPED FOR 3/8''ø BOLT – INSTALL AS SHOWN IN DETAIL A
2	PIGTAIL JUMPER, NO. 2 AWG, 30% CONDUCTIVITY, COPPER CLAD WIRE, LENGTH AS REQUIRED
3	TERMINAL SUITABLE FOR NO. 2 AWG COPPER WIRE (BURNDY TYPE QDA OR EQUAL) WITH CONTACT SEALANT
4	3/8''ø STAINLESS STEEL HEX HEAD BOLT, LENGTH AS NECESSARY TO ATTACH TERMINAL
5	CADWELD, THERMOWELD OR EQUAL EXOTHERMIC TYPE CONNECTION
6	GROUND ROD, COPPER COVERED STEEL 5/8''øx8 FEET
7	CONTINUOUS CONCRETE POLE GROUND WIRE, NO. 2 AWG, 30% CONDUCTIVITY, COPPER CLAD WIRE
8	SPLIT-BOLT CONNECTOR (BURNDY TYPE KSA OR EQUAL) WITH CONTACT SEALANT
9	BONDING CLIP (EQUAL TO BROOKS MANUFACTURING BC SERIES OR HUGHES BROTHERS NO. 2727)
10	1/2''-THICK STAINLESS STEEL WELDED HERMETICALLY-SEALED BEARING PLATE

NOTES

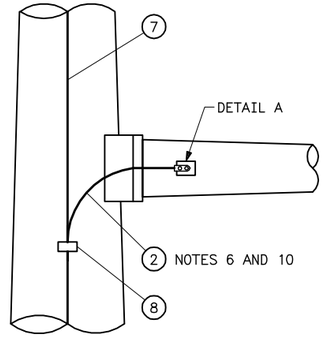
1. GROUND RODS ARE REQUIRED FOR ALL CONCRETE POLES.
2. GROUND RODS ARE REQUIRED FOR ALL WEATHERING STEEL POLES WITH CONCRETE FOUNDATIONS OR CONCRETE BACKFILL.
3. PLACE TOP OF GROUND ROD A MINIMUM OF 6'' BELOW GROUND LINE.
4. PIGTAIL JUMPERS ARE REQUIRED BETWEEN POLE SHAFTS AND GROUND RODS ON WEATHERING STEEL POLE SHAFTS WITH CONCRETE FOUNDATIONS OR CONCRETE BACKFILL.
5. PIGTAIL JUMPERS ARE REQUIRED ON WEATHERING STEEL STRUCTURES ACROSS ALL SLIP JOINTS AND BOLTED CONNECTIONS, INCLUDING DAVIT ARM, CROSSARM, AND POST INSULATOR CONNECTIONS.
6. LENGTHS AND LOCATIONS OF PIGTAIL JUMPERS SHALL NOT INTERFERE WITH CLIMBING.
7. GROUND PLATES ARE REQUIRED 2 FEET ABOVE GROUND LINE ON ALL WEATHERING STEEL POLE SHAFTS WITH CONCRETE FOUNDATIONS OR CONCRETE BACKFILL.
8. WEATHERING STEEL STRUCTURES SHALL HAVE GROUND PLATES ON EITHER SIDE OF SLIP JOINTS AND BOLTED CONNECTIONS, INCLUDING FLANGE JOINTS, DAVIT ARM, AND CROSSARM CONNECTIONS, AND ON THE POLE SHAFT ADJACENT TO POST INSULATOR CONNECTIONS.
9. ATTACH CONTINUOUS GROUND WIRE EVERY 5 FEET (MINIMUM) TO FULL LENGTH OF CONCRETE POLES WITH GALVANIZED STEEL GROUND WIRE CLIPS, THREADED INSERTS BOLTS, AND LOCKWASHERS.
10. ATTACH ALL SPLICE PLATES, CONDUCTOR ATTACHMENTS, DAVIT ARMS, AND POST INSULATOR BASES TO THE GROUND WIRE ON CONCRETE POLES WITH PIGTAIL JUMPERS.
11. COMPOSITE STEEL AND CONCRETE POLES SHALL HAVE A CONTINUOUS GROUND WIRE RUNNING THE FULL LENGTH OF THE CONCRETE SECTION, ATTACHED TO THE STEEL SECTION WITH A GROUND PLATE.
12. CADWELD MAY BE SUBSTITUTED FOR GROUNDING METHOD SHOWN IN DETAIL A.
13. FOR WEATHERING-STEEL STRUCTURES, AFTER INSTALLING FIXED CLIMBING RUNG SECTIONS WITH BOLTS, NUTS, AND LOCKNUTS, SPOT WELD THE RUNG SECTION MOUNTING PLATES TO THE CLIPS ON THE POLE SHAFTS. WELDING SHALL BE SUFFICIENT TO PROVIDE ELECTRICAL CONTINUITY BETWEEN CLIMBING RUNG SECTIONS AND THE POLE SHAFT. PREFERRED WELDING ROD SERIES IS E8018-C3. OTHER ACCEPTABLE SERIES ARE E8018-C1 AND E8018-C2.



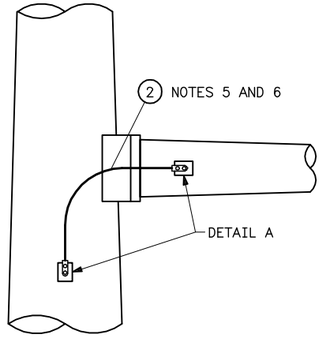
DETAIL A
GROUND PLATE DETAIL
NOTE 12



DETAIL B
CONCRETE POLE
GROUND WIRE CLIP ATTACHMENTS
NOTE 9

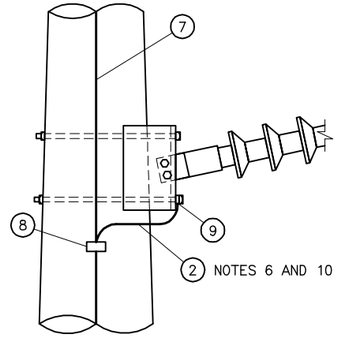


CONCRETE POLE

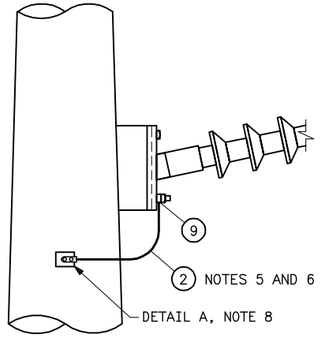


WEATHERING STEEL POLE

DAVIT ARM GROUNDING

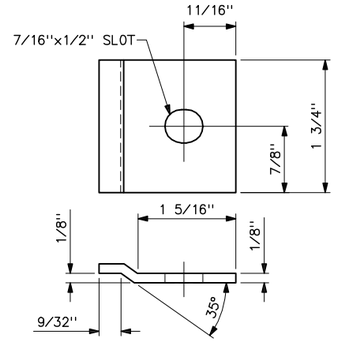


CONCRETE POLE



WEATHERING STEEL POLE

POST INSULATOR GROUNDING



GROUND WIRE CLIP
CONCRETE POLE

K	09-9-09 A7-BGH	ADDED NOTE 13 FOR GROUNDING REQUIREMENTS FOR WEATHERING-STEEL FIXED CLIMBING RUNG SECTIONS.
J	04-5-07 A7-BGH	REVISED GROUNDING REQUIREMENTS FOR WEATHERING STEEL POLE WITH CONCRETE BACKFILL.
I	02-11-05 A7-BGH	DELETED GROUNDING REQUIREMENTS FOR GALVANIZED AND METALLIZED STRUCTURES. REVISED GROUNDING REQUIREMENTS FOR WEATHERING STEEL STRUCTURES AND NOTES.
H	07-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
G	03-30-98 A3-BH	REDRAWN AND REVISED.

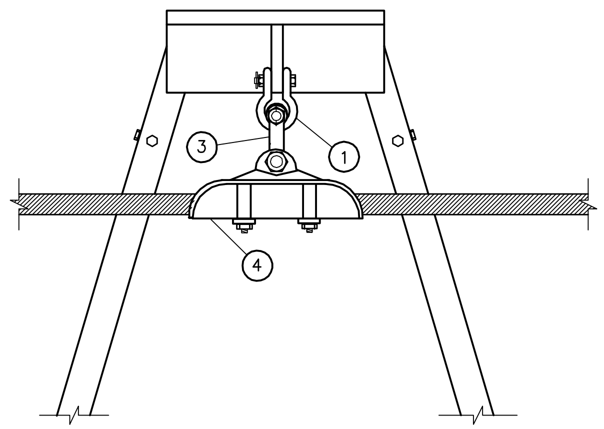
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
WEATHERING STEEL AND CONCRETE POLE STRUCTURES GROUNDING DETAILS

DESIGNED BOBBY HAGLER APPROVED DOUG HANSON
CIVIL ENGINEERING MANAGER

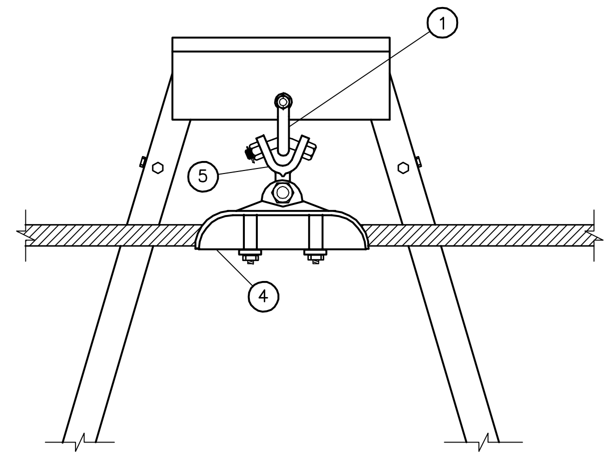
CAE	APRIL 20, 1984	41	1015

MATERIAL LIST					
ITEM NO.	OGW ASSEMBLY QUANTITY SL	SP	TV	TH	DESCRIPTION
1	1	1	2	2	ANCHOR SHACKLE, BNK
2			1	1	COMPRESSION DEADEND, EYE TYPE
3	1				Y-CLEVIS EYE, BNK
4	1	1			SUSPENSION CLAMP, BNK
5		1			Y-CLEVIS EYE 90°, BNK



SUSPENSION ASSEMBLY OGW-SL

FOR ATTACHMENT PLATE AT RIGHT ANGLE TO OGW

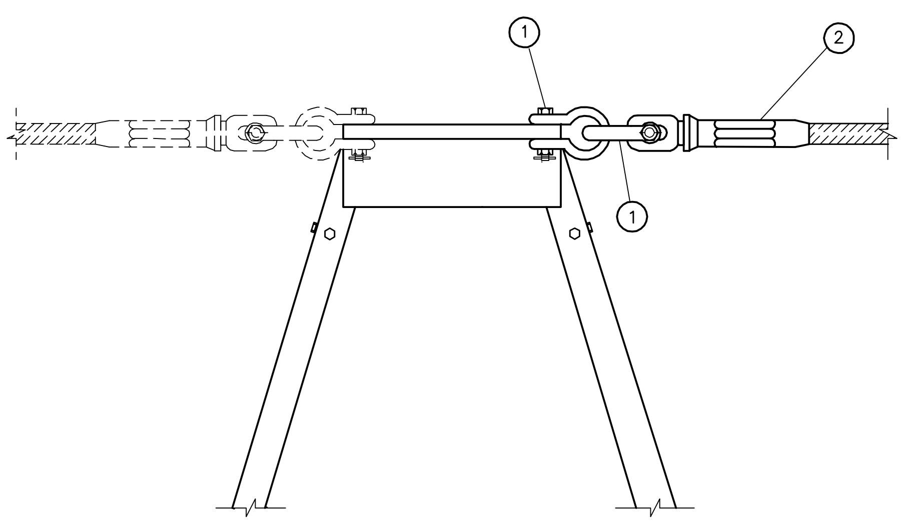


SUSPENSION ASSEMBLY OGW-SP

FOR ATTACHMENT PLATE IN PLANE OF OGW

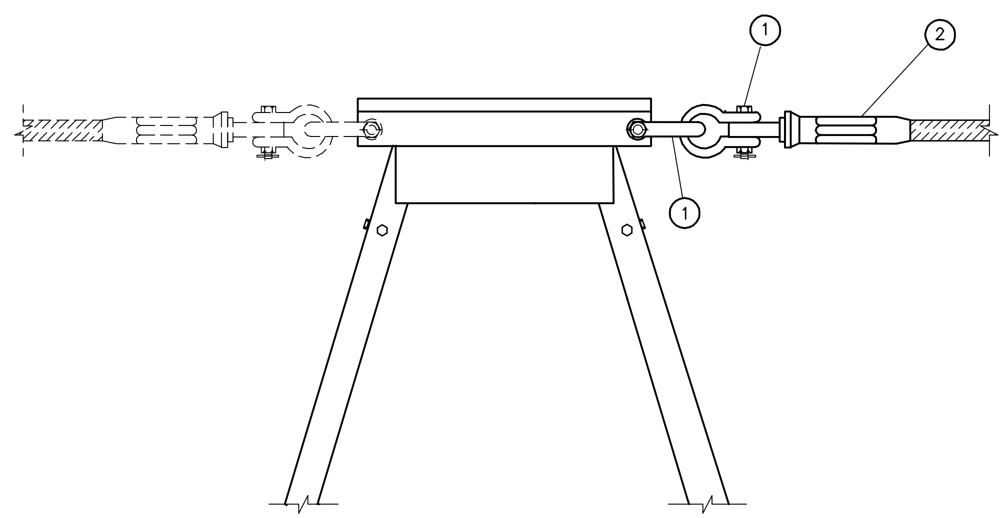
NOTES

1. BNK INDICATES BOLT, NUT, AND STAINLESS STEEL COTTER KEY REQUIRED.



TENSION ASSEMBLY OGW-TV

FOR HORIZONTAL ATTACHMENT PLATE



TENSION ASSEMBLY OGW-TH

FOR VERTICAL ATTACHMENT PLATE

NOT TO SCALE

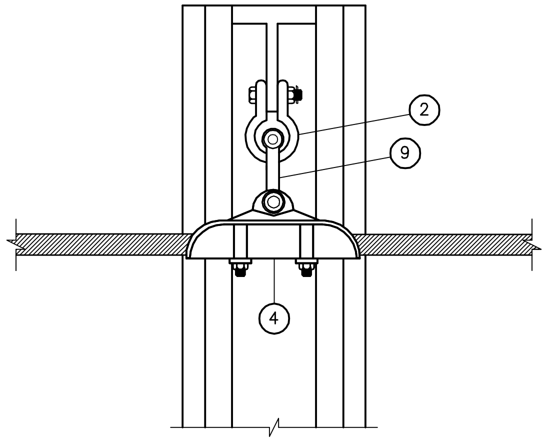
C	7-6-04 A7-FSC	REVISED TENSION ASSEMBLIES TO BE CONSISTENT WITH MATERIAL LIST QUANITIES. ADDED QUANTITIES AND TYPE DESIGNATIONS.
B	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
A	5-17-95 A2-RMC	REMOVED STRUCTURE GROUNDING

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

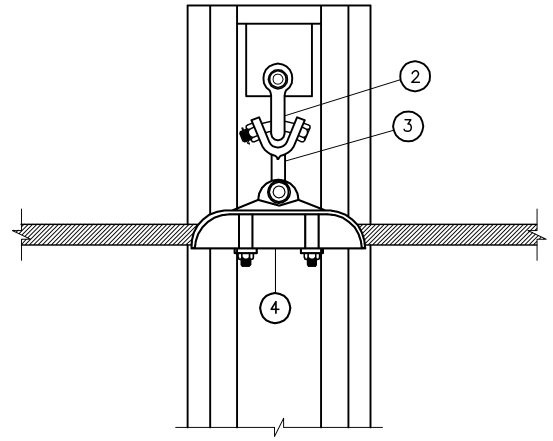
TRANSMISSION LINE STANDARDS
STEEL TOWERS
OVERHEAD GROUND WIRE ASSEMBLY

DESIGNED SRR APPROVED ROSS M. CLARK CHIEF, TRANSMISSION LINE ELECTRICAL BRANCH

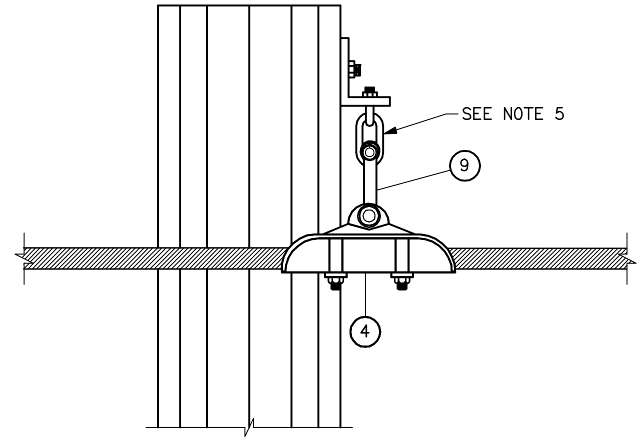
CAD | MARCH 9, 1993 | 41 | 1017



SUSPENSION ASSEMBLY OGW-SL
FOR ATTACHMENT HOLE IN-LINE WITH OGW



SUSPENSION ASSEMBLY OGW-SP
FOR ATTACHMENT HOLE PERPENDICULAR TO OGW

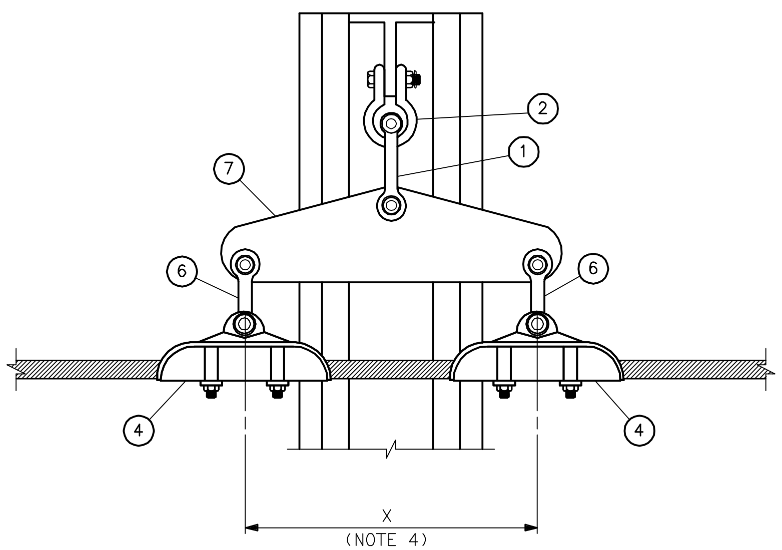


SUSPENSION ASSEMBLY OGW-SH
FOR ATTACHMENT TO STEEL ANGLE

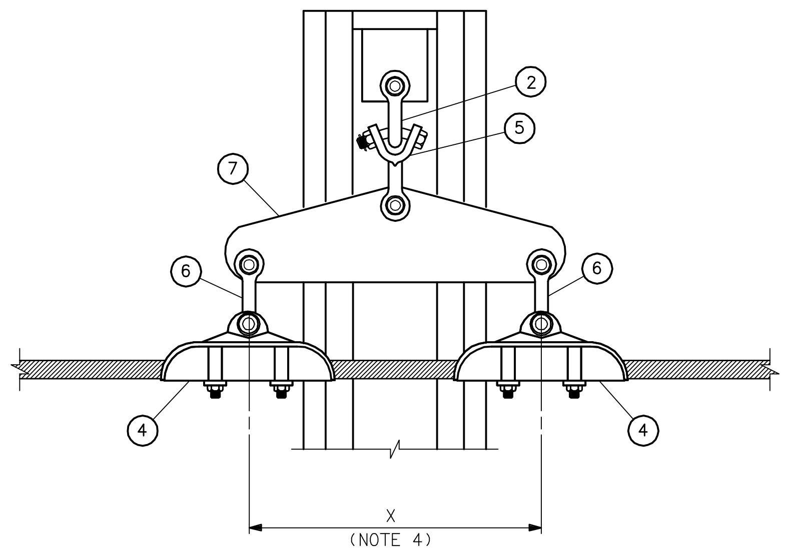
MATERIALS LIST									
ITEM NO.	OGW ASSEMBLY QUANTITY								DESCRIPTION
	SL	SP	SH	SYL	SYP	TV	TH	TY	
1				1					Y-CLEVIS CLEVIS, BNK
2	1	1		1	1	2	2	4	ANCHOR SHACKLE, BNK
3		1							Y-CLEVIS EYE 90°, BNK
4	1	1	1	2	2				SUSPENSION CLAMP, BNK
5					1				Y-CLEVIS CLEVIS 90°, BNK
6				2	2				CLEVIS EYE, BNK
7				1	1			1	YOKE PLATE
8						1	1	2	COMPRESSION DEADEND, EYE TYPE
9	1		1						Y-CLEVIS EYE, BNK

NOTES

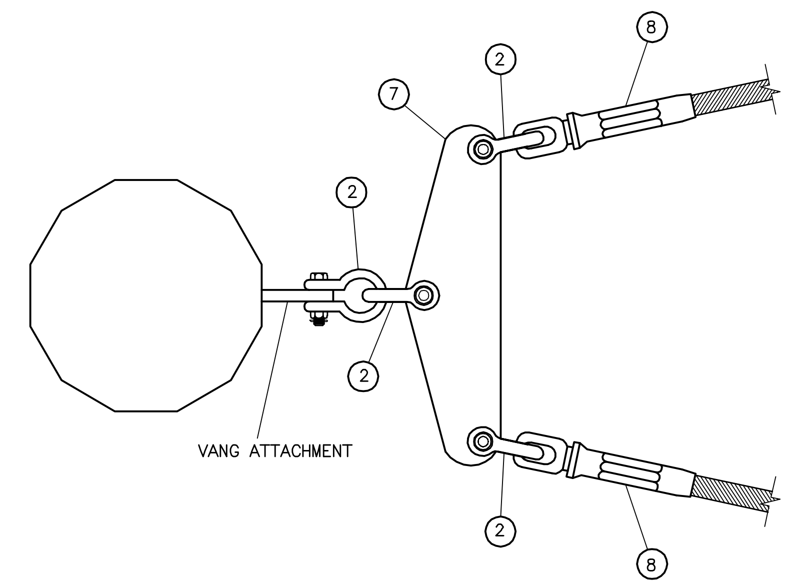
1. BNK INDICATES BOLT, NUT AND STAINLESS STEEL COTTER KEY REQUIRED.
2. SEE SPECIFICATIONS FOR STRENGTH RATING OF COUPLING HARDWARE.
3. ASSEMBLIES OGW-SYL AND OGW-SYP ARE USED FOR RUNNING ANGLES OF 30° TO 60°.
4. LENGTH OF SUSPENSION CLAMP PLUS 3 INCHES MINIMUM.
5. FURNISHED AS PART OF STRUCTURE.



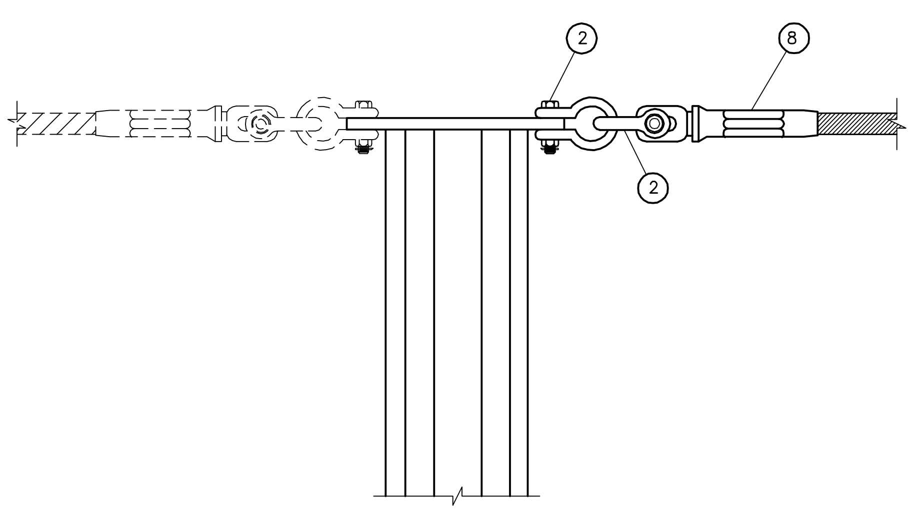
SUSPENSION ASSEMBLY OGW-SYL
FOR ATTACHMENT HOLE IN-LINE WITH OGW



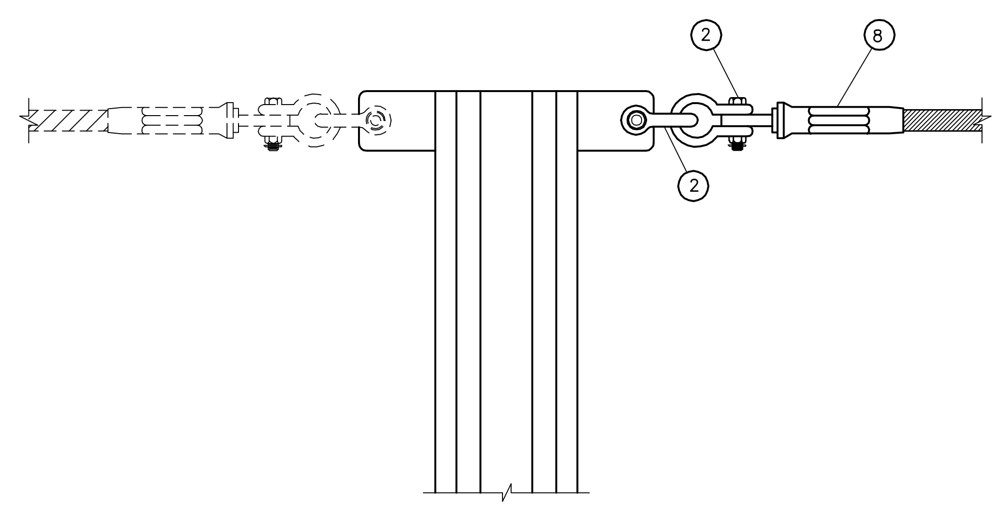
SUSPENSION ASSEMBLY OGW-SYP
FOR ATTACHMENT HOLE PERPENDICULAR TO OGW



TENSION ASSEMBLY OGW-TY
FOR HORIZONTAL ATTACHMENT HOLE
(OVERHEAD VIEW)



TENSION ASSEMBLY OGW-TV
FOR VERTICAL ATTACHMENT HOLE



TENSION ASSEMBLY OGW-TH
FOR HORIZONTAL ATTACHMENT HOLE

NOT TO SCALE

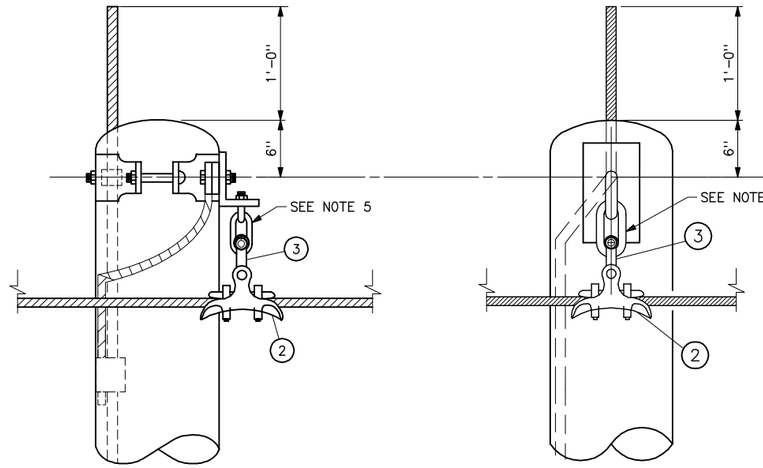
REV.	DATE	DESCRIPTION
C	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
B	3-1-00 A3-RMC	MINOR CHANGES.
A	11-20-98 A3-RMC	ATTACHMENT TYPES OGW-SH AND OGW-TY WERE ADDED.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
STEEL AND CONCRETE
POLE STRUCTURES
OVERHEAD GROUND WIRE ASSEMBLY

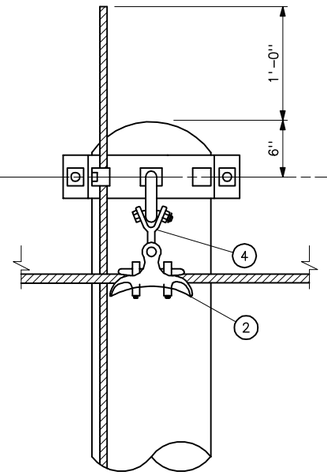
DESIGNED SRR   APPROVED ROSS M. CLARK
CHIEF, TRANSMISSION LINE BRANCH

NOVEMBER 14, 1995 | 41 | 1018



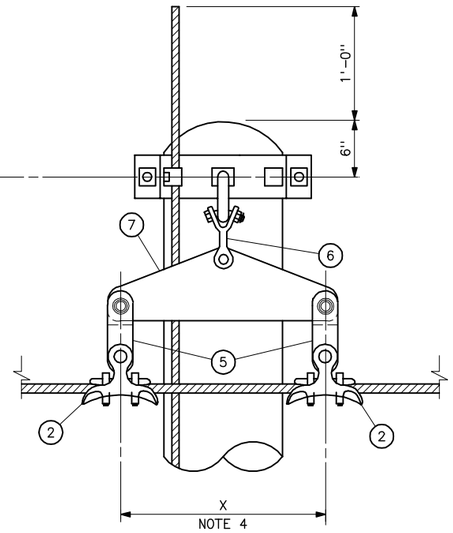
SUSPENSION ASSEMBLY OGW-SA

FOR ATTACHMENT TO STEEL ANGLE
OR SUPPORT BRACKET



SUSPENSION ASSEMBLY OGW-PB

FOR ATTACHMENT TO POLE BAND



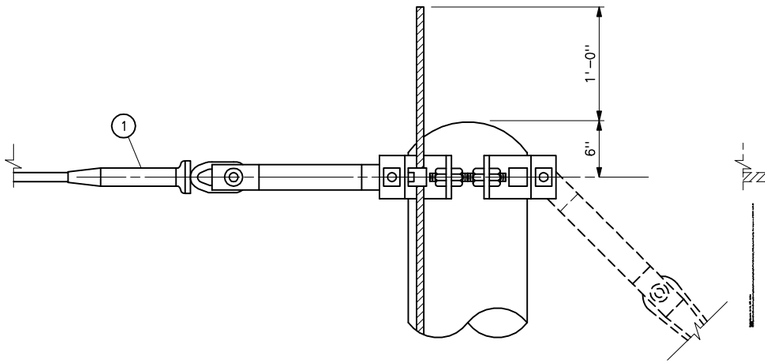
SUSPENSION ASSEMBLY OGW-PBY

FOR ATTACHMENT TO POLE BAND

MATERIAL LIST							
ITEM NO.	OGW ASSEMBLY QUANTITY						DESCRIPTION
	SA	PB	PBY	TH	TV	TW	
1				1	1	1	COMPRESSION DEADEND, EYE TYPE
2	1	1	2				SUSPENSION CLAMP,BNK (SEE NOTE 7)
3	1						Y-CLEVIS EYE,BNK (SEE NOTE 7)
4		1					Y-CLEVIS EYE 90° ,BNK (SEE NOTE 7)
5			2				CLEVIS EYE, BNK
6			1				Y-CLEVIS CLEVIS 90° , BNK
7			1				YOKE PLATE
8				2	2		ANCHOR SHACKLE, BNK

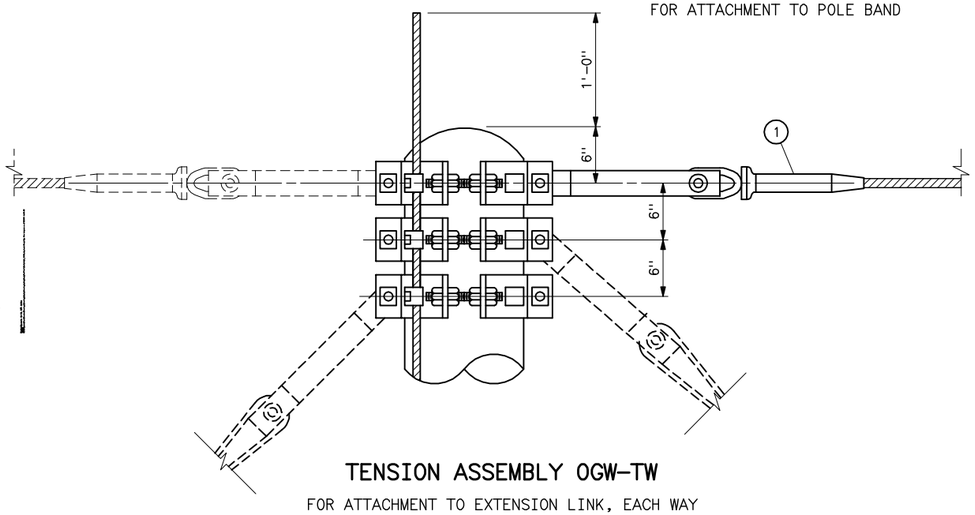
NOTES

1. BNK INDICATE BOLT, NUT, AND STAINLESS STEEL COTTER KEY REQUIRED.
2. SEE SPECIFICATIONS FOR STRENGTH RATING OF COUPLING HARDWARE.
3. ASSEMBLY OGW-PBY SHALL BE USED FOR LINE ANGLES OF 30° TO 60° .
4. LENGTH OF SUSPENSION CLAMP PLUS 3 INCHES MINIMUM.
5. CHAIN LINK FURNISHED AS PART OF STRUCTURE FOR NEW CONSTRUCTION.
6. USE OGW-TV FOR GLUED LAMINATED WOOD TENSION STRUCTURES WITH LINE ANGLES GREATER THAN 1° .
7. SIZE WIDTH OF EYE ON Y-CLEVIS TO FIT BETWEEN EARS OF SUSPENSION CLAMP.



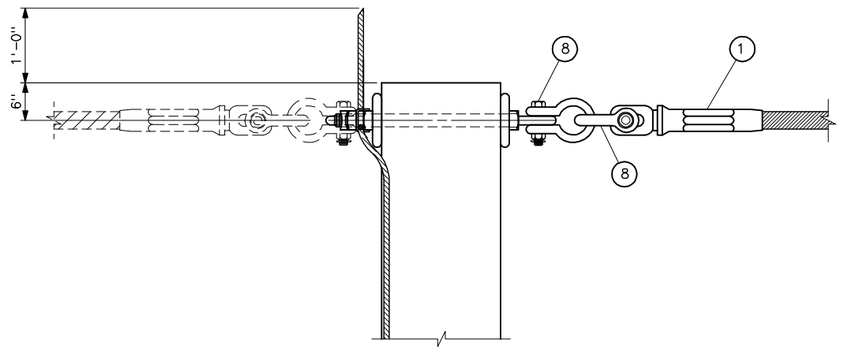
TENSION ASSEMBLY OGW-TW

FOR ATTACHMENT TO EXTENSION LINK, ONE WAY



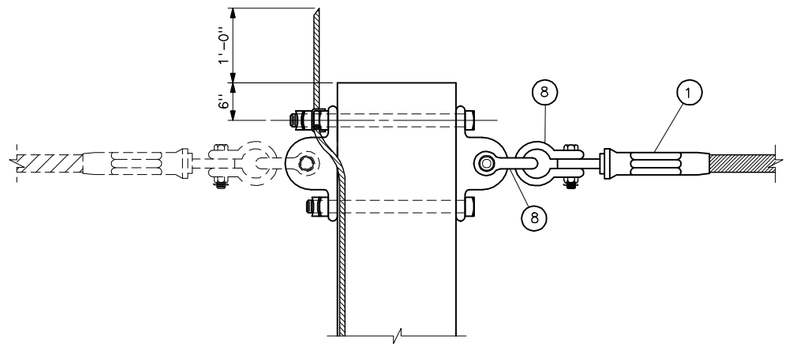
TENSION ASSEMBLY OGW-TW

FOR ATTACHMENT TO EXTENSION LINK, EACH WAY



TENSION ASSEMBLY OGW-TV

FOR VERTICAL ATTACHMENT HOLE
(NOTE 6)



TENSION ASSEMBLY OGW-TH

FOR HORIZONTAL ATTACHMENT HOLE

D	4-19-11 A7-KKR	ADDED SUPPORT BRACKET ASSEMBLY AND OGW-TH, OGW-TV ASSEMBLIES. ADDED NOTE 6 AND 7.
C	7-2-04 A7-FSC	REVISED OGW-TW TO BE CONSISTENT WITH MATERIAL LIST QUANITIES. REVISED NOTE 5.
B	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
A	10-13-95 A2-RMC	ADDED ASSEMBLY NAMES AND ASSEMBLY OGW-PBY.

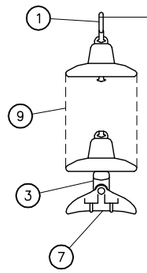
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
WOOD POLE STRUCTURES
OVERHEAD GROUND WIRE ASSEMBLY

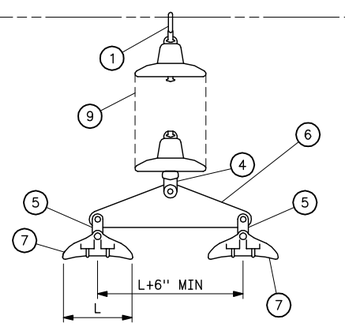
DESIGNED STEVE ROCK APPROVED ROSS M. CLARK
CHIEF, TRANSMISSION LINE BRANCH

A1	AUGUST 21, 1995	41	1019

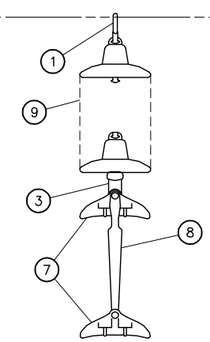
SI11–A



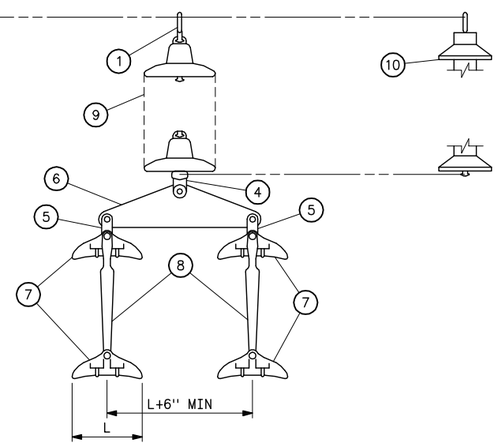
SIA11–A



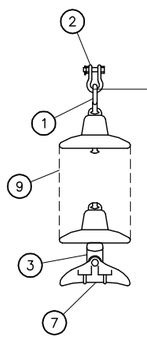
SI12–A



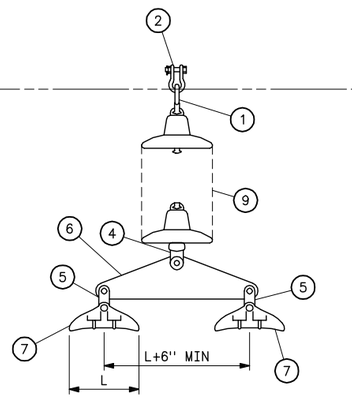
SIA12–A



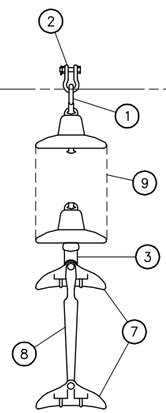
SI11–B



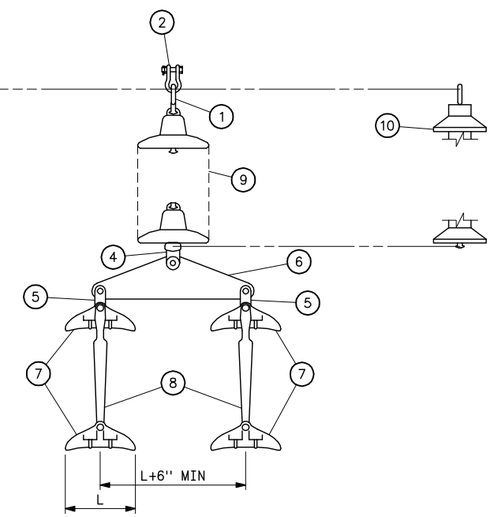
SIA11–B



SI12–B



SIA12–B



SUSPENSION INSULATOR ASSEMBLIES

ULTIMATE INSULATOR ASSEMBLY STRENGTH AS SPECIFIED

(NOTE 2)

MATERIALS LIST	
ITEM NO.	DESCRIPTION
1	OVAL EYE BALL
2	ANCHOR SHACKLE, BNK
3	SOCKET EYE
4	SOCKET CLEVIS, BNK
5	CLEVIS EYE, BNK
6	YOKE PLATE
7	SUSPENSION CLAMP, BNK
8	VERTICAL BUNDLE YOKE, 18'' SPACING
9	INSULATOR STRING, PORCELAIN UNITS
10	INSULATOR STRING, POLYMER FIBERGLASS, OVAL EYE–BALL LENGTH AS SPECIFIED)

NOTES

1. BNK INDICATES BOLT, NUT AND STAINLESS STEEL COTTER KEY REQUIRED.
2. STRENGTH OF HARDWARE COMPONENTS SHALL BE EQUAL TO OR GREATER THAN THE INSULATOR ASSEMBLY ULTIMATE STRENGTH, EXCEPT THAT PARALLEL COMPONENTS IN INSULATOR ASSEMBLIES SIA11 AND SIA12 MAY HAVE 50% OF ASSEMBLY ULTIMATE STRENGTH.

TABLE A – PORCELAIN UNITS				
VOLTAGE (KV)	UNIT QUANTITY PER ASSEMBLY			
	SI11 AND SI12		SIA11 AND SIA12	
	WOOD STRUCTURES	STEEL STRUCTURES	WOOD STRUCTURES	STEEL STRUCTURES
69	4	6	6	6
115	7	9	9	9
138	8	10	10	10
161	10	11	11	11
230	12	14	13	14

INSULATOR ASSEMBLY TYPE NO.

EXAMPLE: SIA11 – B

- SIA11 – TYPE OF STRUCTURE ATTACHMENT HARDWARE
- B – ONE (1) OR TWO (2) SUBCONDUCTORS
- 1 – SINGLE (1) OR DOUBLE (2) INSULATOR STRING
- A – RUNNING ANGLE APPLICATION 15° – 60°
- I – ''I–STRING''
- S – SUSPENSION ASSEMBLY

B	7–15–03 A7–RC	REVISED TITLE BLOCK ONLY.
A	6–29–00 A3	REVISED ULTIMATE STRENGTH REQUIREMENTS. MINOR REVISIONS.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS

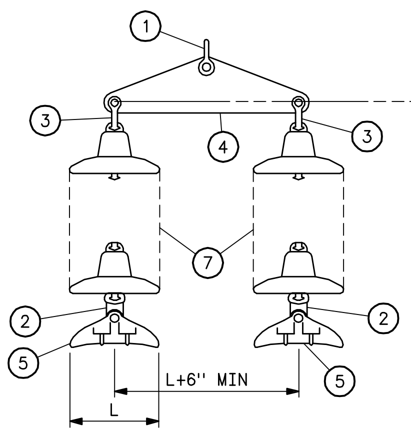
SUSPENSION INSULATOR ASSEMBLIES

SINGLE STRING

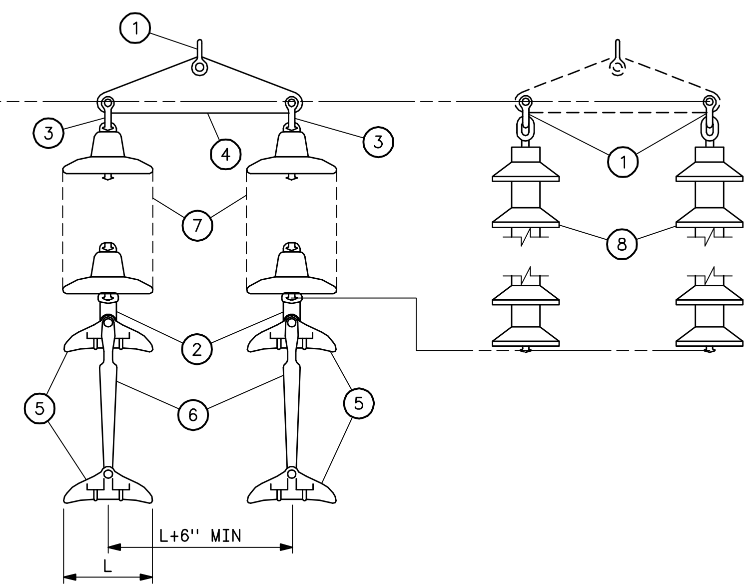
DESIGNED F.S. COOK APPROVED ROSS CLARK
ELECTRICAL ENGINEERING MANAGER

CAE	OCTOBER 10, 1997	41	1020

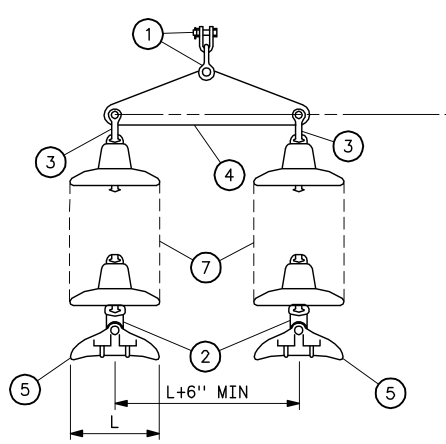
SIA21-A



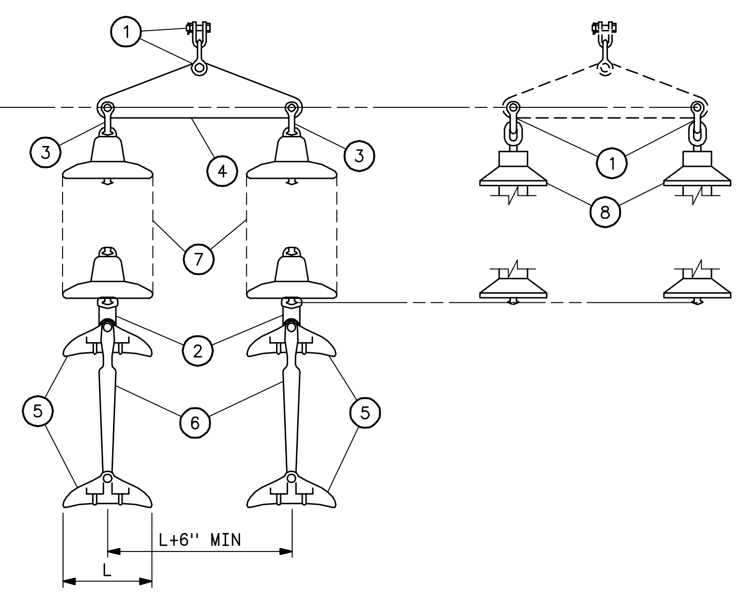
SIA22-A



SIA21-B



SIA22-B



SUSPENSION INSULATOR ASSEMBLIES

ULTIMATE INSULATOR ASSEMBLY STRENGTH AS SPECIFIED

(NOTE 2)

MATERIALS LIST

ITEM NO.	DESCRIPTION
1	ANCHOR SHACKLE, BNK
2	SOCKET EYE
3	CLEVIS BALL, BNK
4	YOKE PLATE
5	SUSPENSION CLAMP, BNK
6	VERTICAL BUNDLE YOKE, 18" SPACING
7	INSULATOR STRING, PORCELAIN UNITS
8	INSULATOR STRING, POLYMER FIBERGLASS, OVAL EYE-BALL (LENGTH AS SPECIFIED)

NOTES

1. BNK INDICATES BOLT, NUT AND STAINLESS STEEL COTTER KEY REQUIRED.
2. STRENGTH OF HARDWARE COMPONENTS SHALL BE EQUAL TO OR GREATER THAN THE INSULATOR ASSEMBLY ULTIMATE STRENGTH, EXCEPT THAT PARALLEL COMPONENTS IN INSULATOR ASSEMBLIES SIA21 AND SIA22 MAY HAVE 50% OF ASSEMBLY ULTIMATE STRENGTH.

TABLE A – PORCELAIN UNITS

VOLTAGE (KV)	UNIT QUANTITY PER ASSEMBLY	
	SIA21 AND SIA22	
	WOOD STRUCTURES	STEEL STRUCTURES
69	12	12
115	18	18
138	20	20
161	22	22
230	26	28

INSULATOR ASSEMBLY TYPE NO.

EXAMPLE: SIA22 – B

- B – TYPE OF STRUCTURE ATTACHMENT HARDWARE
- 2 (second digit) – ONE (1) OR TWO (2) SUBCONDUCTORS
- 2 (first digit) – SINGLE (1) OR DOUBLE (2) INSULATOR STRING
- A – RUNNING ANGLE APPLICATION 15° – 60°
- I – "I-STRING"
- S – SUSPENSION ASSEMBLY

B	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
A	6-29-00 A2-RMC	REVISED ULTIMATE STRENGTH REQUIREMENT. MINOR REVISIONS.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
SUSPENSION INSULATOR ASSEMBLIES
DOUBLE STRING

DESIGNED F.S. COOK APPROVED ROSS CLARK ELECTRICAL ENGINEERING MANAGER

CAE | OCTOBER 10, 1997 | 41 | 1021

Plotted By: entwistle Nov 04, 2010- 3:29pm

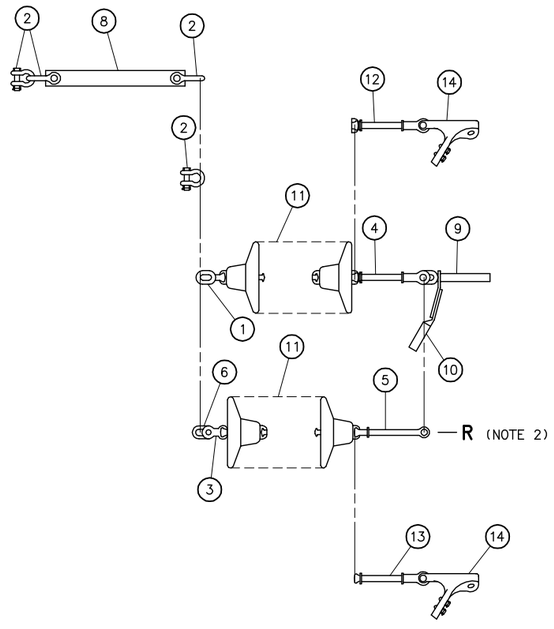
TABLE A – PORCELAIN UNITS		
VOLTAGE (KV)	UNIT QUANTITY PER ASSEMBLY	
	T11 AND T12	
	WOOD STRUCTURES	STEEL STRUCTURES
69	5	7
115	8	10
138	10	11
161	11	12
230	13	15

MATERIALS LIST	
ITEM NO.	DESCRIPTION
1	OVAL EYE BALL
2	ANCHOR SHACKLE, BNK
3	SOCKET CLEVIS, BNK
4	SOCKET CLEVIS, HOT LINE, BNK
5	CLEVIS BALL, HOT LINE, BNK
6	CHAIN LINK
7	YOKE PLATE
8	EXTENSION STRAP (LENGTH AS SPECIFIED)
9	COMPRESSION DEAD END FITTING, EYE, SINGLE TONGUE
10	COMPRESSION JUMPER TERMINAL
11	INSULATOR STRING, PORCELAIN UNITS
12	SOCKET EYE, HOT LINE
13	BALL EYE, HOT LINE
14	STRAIN CLAMP, BNK
15	CLEVIS EYE, BNK

T11–C

T11–B

T11–A

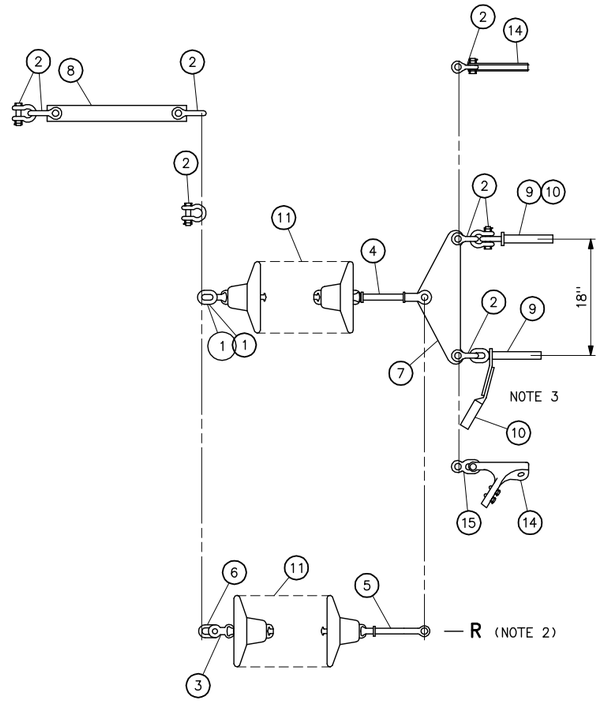


TYPE T11
SINGLE INSULATOR STRING, ONE SUBCONDUCTOR

T12–C

T12–B

T12–A



TYPE T12
SINGLE INSULATOR STRING, TWO SUBCONDUCTORS

NOTES

1. BNK INDICATES BOLT, NUT AND STAINLESS STEEL COTTER KEY REQUIRED.
2. ASSEMBLIES DESIGNATED WITH AN R SHALL HAVE THE INSULATOR CAPS AT THE CONDUCTOR END OF THE ASSEMBLY AS SHOWN, AND ARE FOR USE WHEN THE CONDUCTOR ATTACHMENT POINT IS AT A HIGHER ELEVATION THAN THE STRUCTURE ATTACHMENT POINT.
3. FOR DOUBLE CONDUCTOR ASSEMBLIES, THE PADS ON THE CONDUCTOR DEADENDS SHALL BE TURNED OUT TO EACH SIDE IN ORDER TO CLEAR HARDWARE AND PROVIDE A SMOOTH TRANSITION INTO A BUNDLE AT THE JUMPER INSULATOR ASSEMBLY.
4. DUE TO TORSIONAL STRESS, POLYMER FIBERGLASS INSULATORS SHALL NOT BE USED IN SINGLE STRING TENSION CONFIGURATIONS.

INSULATOR ASSEMBLY TYPE NO.

EXAMPLE: T12 – B

- TYPE OF STRUCTURE ATTACHMENT HARDWARE
- ONE (1) OR TWO (2) SUBCONDUCTORS
- SINGLE (1) OR DOUBLE (2) INSULATOR STRING
- TENSION ASSEMBLY

SINGLE STRING
TENSION INSULATOR ASSEMBLIES

ULTIMATE INSULATOR ASSEMBLY STRENGTH AS SPECIFIED

(NOTE 4)

B	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
A	6/13/00 A3-RMC	ADDED STRAIN CLAMPS

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
TENSION INSULATOR ASSEMBLIES
SINGLE STRING

DESIGNED F.S. COOK APPROVED ROSS CLARK, ELECTRICAL ENGINEERING MANAGER

CAE	OCTOBER 10, 1997	41	1022

DOUBLE STRING
TENSION INSULATOR ASSEMBLIES
ULTIMATE INSULATOR ASSEMBLY STRENGTH AS SPECIFIED

(NOTE 2)

T21–A

T21–B

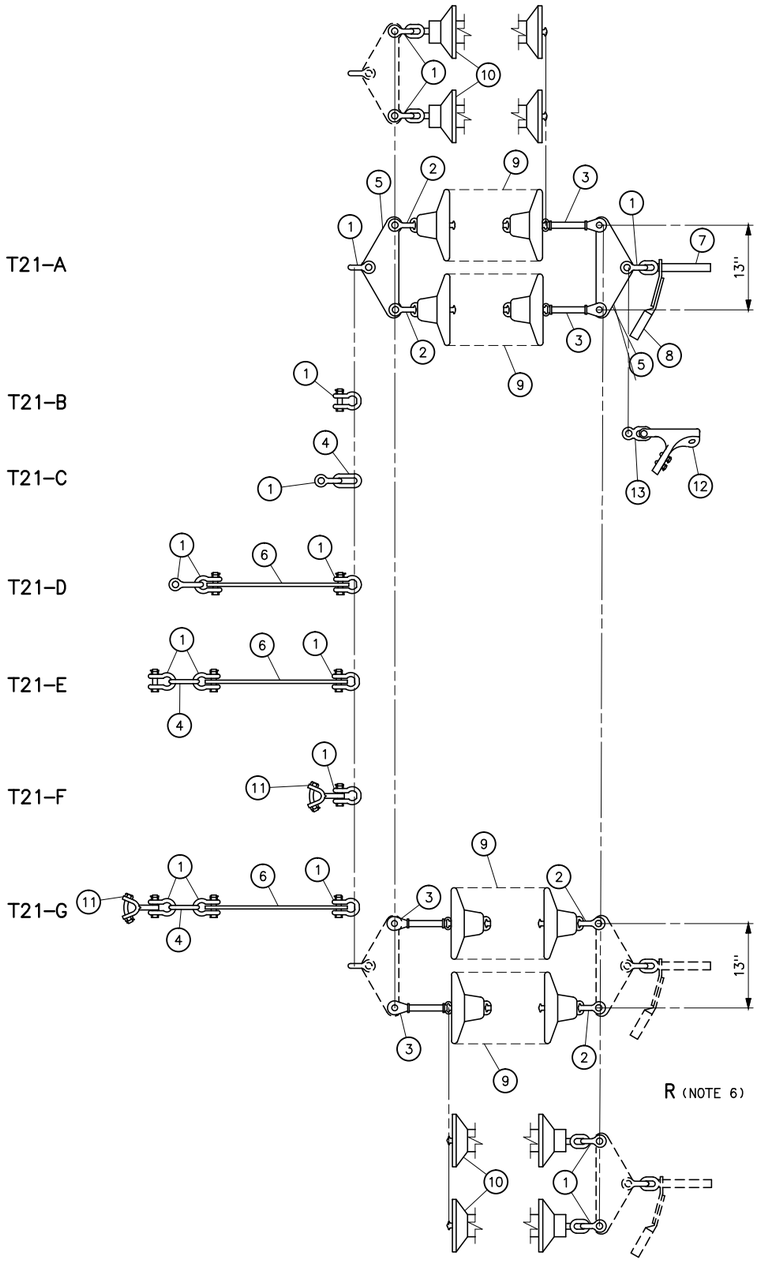
T21–C

T21–D

T21–E

T21–F

T21–G



T21
DOUBLE INSULATOR STRING, SINGLE CONDUCTOR
(NOTE 3)

T22–A

T22–B

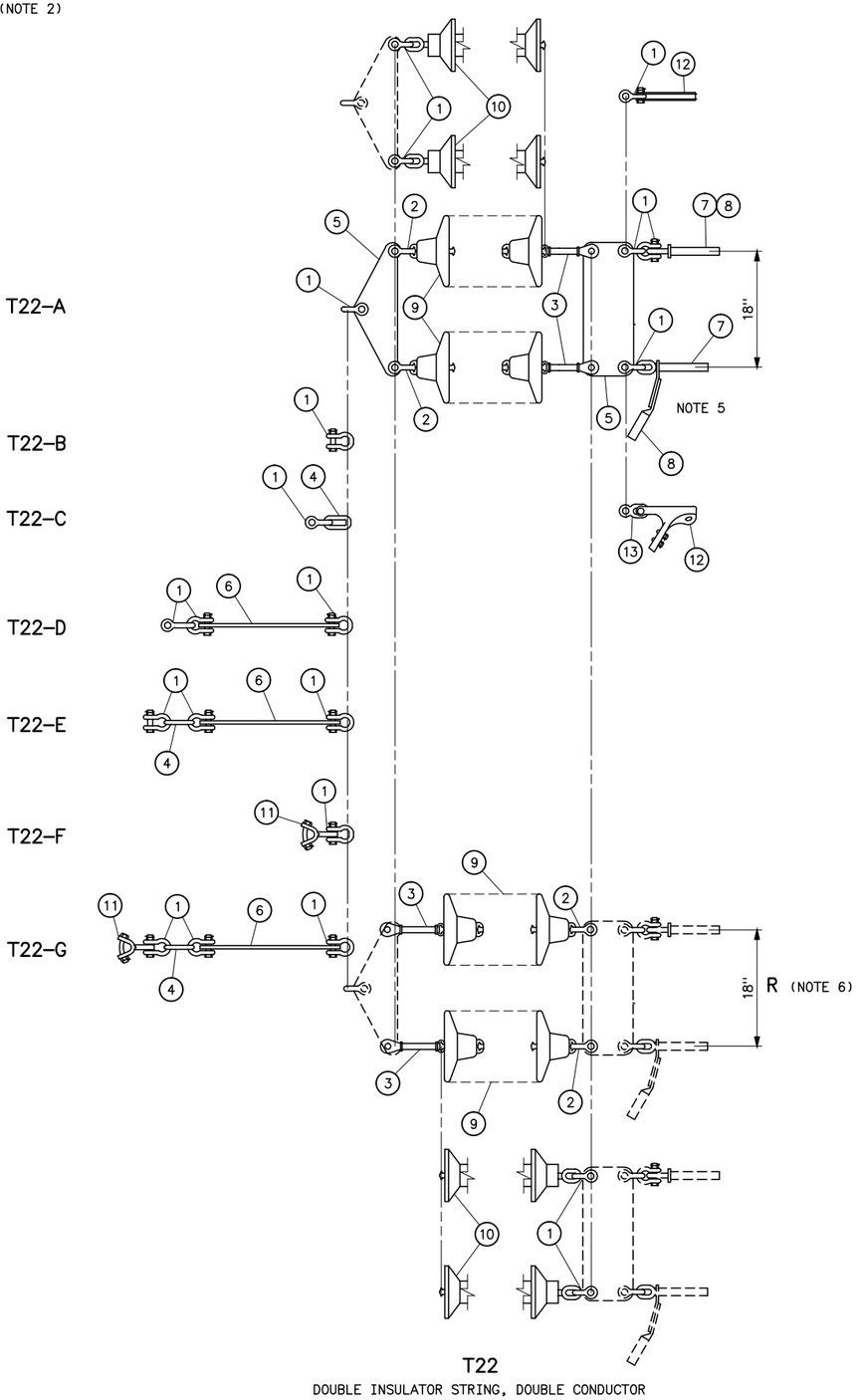
T22–C

T22–D

T22–E

T22–F

T22–G



T22
DOUBLE INSULATOR STRING, DOUBLE CONDUCTOR
(NOTE 4)

MATERIALS LIST

ITEM NO.	DESCRIPTION
1	ANCHOR SHACKLE, BNK
2	CLEVIS BALL, BNK
3	SOCKET CLEVIS, HOT LINE, BNK
4	CHAIN LINK
5	YOKE PLATE, WITH WORKING HOLE
6	EXTENSION STRAP (LENGTH AS SPECIFIED)
7	COMPRESSION DEAD END FITTING, EYE, SINGLE TONGUE
8	COMPRESSION JUMPER TERMINAL
9	INSULATOR STRING, PORCELAIN UNITS
10	INSULATOR STRING, POLYMER FIBERGLASS, OVAL EYE-BALL (LENGTH AS SPECIFIED)
11	Y-CLEVIS EYE, BNK
12	STRAIN CLAMP, BNK
13	CLEVIS EYE, BNK

NOTES

1. BNK INDICATES BOLT, NUT AND STAINLESS STEEL COTTER KEY REQUIRED.
2. STRENGTH OF HARDWARE COMPONENTS SHALL BE EQUAL TO OR GREATER THAN THE INSULATOR ASSEMBLY ULTIMATE STRENGTH, EXCEPT THAT PARALLEL COMPONENTS IN DOUBLE INSULATOR ASSEMBLIES T21, AND T22 MAY HAVE 50% OF ULTIMATE ASSEMBLY STRENGTH.
3. DOUBLE STRING, SINGLE CONDUCTOR ASSEMBLIES SHALL HAVE THE INSULATOR STRING PARALLEL IN A HORIZONTAL PLANE.
4. DOUBLE STRING, DOUBLE CONDUCTOR ASSEMBLIES SHALL HAVE THE INSULATOR STRINGS PARALLEL IN THE SAME PLANE AS THE CONDUCTORS (USUALLY VERTICAL).
5. FOR DOUBLE CONDUCTOR ASSEMBLIES, THE PADS ON THE CONDUCTOR DEADENDS SHALL BE TURNED OUT TO EACH SIDE IN ORDER TO CLEAR HARDWARE AND PROVIDE A SMOOTH TRANSITION INTO A BUNDLE AT THE JUMPER INSULATOR ASSEMBLY.
6. ASSEMBLIES DESIGNATED WITH AN R SHALL HAVE THE INSULATOR CAPS AT THE CONDUCTOR END OF THE ASSEMBLY AS SHOWN, AND ARE FOR USE WHEN THE CONDUCTOR ATTACHMENT POINT IS AT A HIGHER ELEVATION THAN THE STRUCTURE ATTACHMENT POINT.

TABLE A – PORCELAIN UNITS

VOLTAGE (KV)	UNIT QUANTITY PER ASSEMBLY T21 AND T22	
	WOOD STRUCTURES	STEEL STRUCTURES
69	10	14
115	16	20
138	20	22
161	22	24
230	26	30

INSULATOR ASSEMBLY TYPE NO.

EXAMPLE: T22 – B

- T22 – B: TYPE OF STRUCTURE ATTACHMENT HARDWARE
- T22 – B: ONE (1) OR TWO (2) SUBCONDUCTORS
- T22 – B: SINGLE (1) OR DOUBLE (2) INSULATOR STRING
- T22 – B: TENSION ASSEMBLY

D	07-11-07 A7-RMC	REVISED DESCRIPTION OF MATERIAL ITEM NO. 5
C	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
B	6/13/00 A3-RMC	ADDED STRAIN CLAMPS.

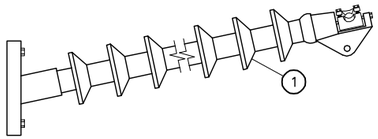
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
TENSION INSULATOR ASSEMBLIES
DOUBLE STRING

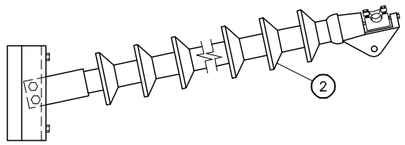
DESIGNED F.S. COOK APPROVED ROSS CLARK, ELECTRICAL ENGINEERING MANAGER

CAD	OCTOBER 10, 1997	41	1023

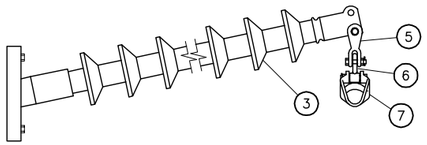
Plotted By: Lampman Nov 08, 2010 – 10:47am
IN: \Specifications\2009 Construction Standards\Standard Drawings\41_1023d.dwg Last Saved By: Eva Lampman on 11/8/2010 10:22 AM



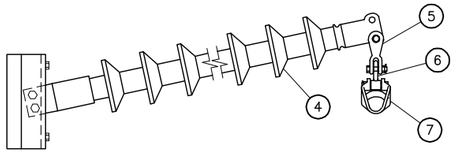
ASSEMBLY TYPE HF1–F
SINGLE CONDUCTOR
FIXED
FLAT BASE



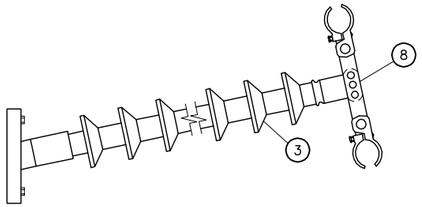
ASSEMBLY TYPE HF1–G
SINGLE CONDUCTOR
FIXED
GAIN BASE



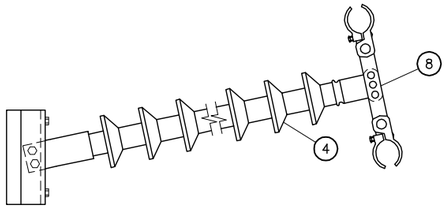
ASSEMBLY TYPE HS1–F
SINGLE CONDUCTOR
SUSPENSION
FLAT BASE



ASSEMBLY TYPE HS1–G
SINGLE CONDUCTOR
SUSPENSION
GAIN BASE



ASSEMBLY TYPE HF2–F
DOUBLE CONDUCTOR
FIXED
FLAT BASE



ASSEMBLY TYPE HF2–G
DOUBLE CONDUCTOR
FIXED
GAIN BASE

HORIZONTAL POST INSULATOR ASSEMBLIES

(NOTE 2)

MATERIALS LIST

ITEM NO.	DESCRIPTION
1	HORIZONTAL POST INSULATOR, POLYMER – FIBERGLASS, CLAMP – TOP ADAPTER, FLAT BASE
2	HORIZONTAL POST INSULATOR, POLYMER – FIBERGLASS, CLAMP – TOP ADAPTER, GAIN BASE
3	HORIZONTAL POST INSULATOR, POLYMER – FIBERGLASS, TWO–HOLE END FITTING, FLAT BASE
4	HORIZONTAL POST INSULATOR, POLYMER – FIBERGLASS, TWO–HOLE END FITTING, GAIN BASE
5	Y–CLEVIS – CLEVIS, 90°, BNK
6	OVAL EYE – EYE
7	SUSPENSION CLAMP, BNK
8	VERTICAL JUMPER YOKE

NOTES

1. BNK INDICATES BOLT, NUT AND STAINLESS STEEL COTTER KEY REQUIRED.
2. SEE SPECIFICATIONS FOR INSULATOR AND HARDWARE ELECTRICAL AND MECHANICAL RATINGS.

INSULATOR ASSEMBLY TYPE NO.

EXAMPLE: HF1 – G

- HF1 – TYPE OF STRUCTURE ATTACHMENT FLAT (F) OR GAIN (G) BASE
- HF1 – ONE (1) OR TWO (2) SUBCONDUCTORS
- HF1 – CONDUCTOR ATTACHMENT, FIXED (F) OR SUSPENSION (S)
- HF1 – HORIZONTAL POST INSULATOR ASSEMBLY

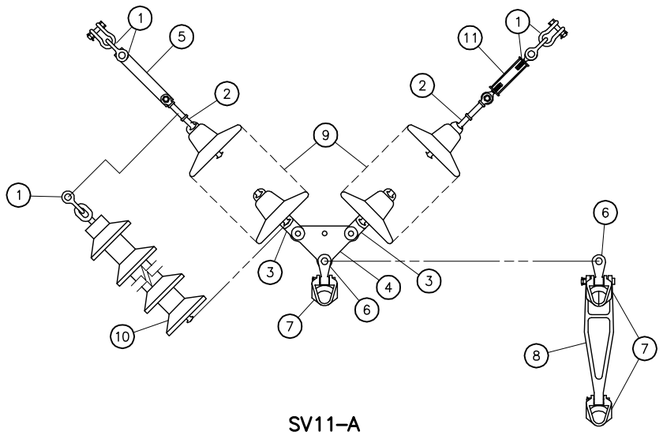
A	7–15–03 A7–RC	REVISED TITLE BLOCK ONLY.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

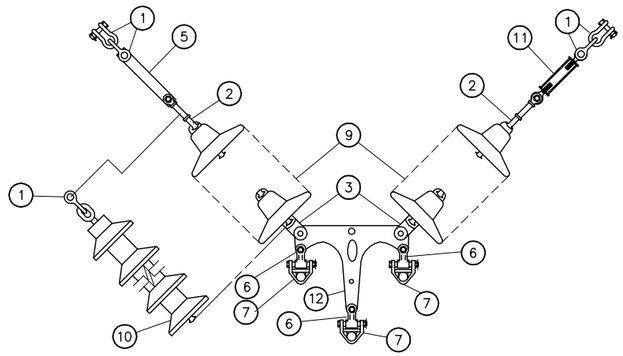
TRANSMISSION LINE STANDARDS
HORIZONTAL POST
INSULATOR ASSEMBLIES

DESIGNED F.S. COOK APPROVED ROSS CLARK
ELECTRICAL ENGINEERING MANAGER

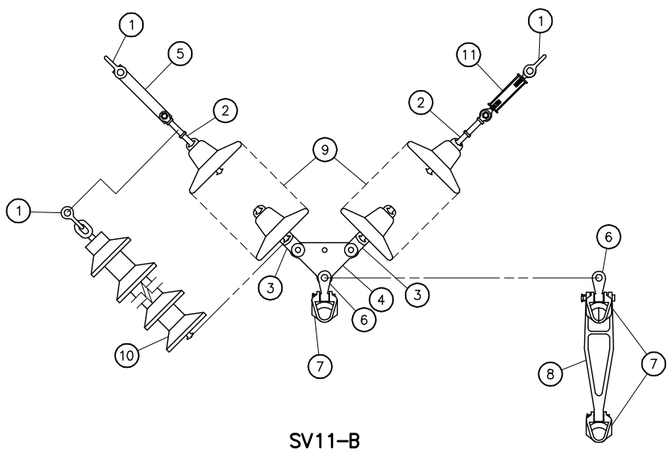
CAE	OCTOBER 10, 1997	41	1024



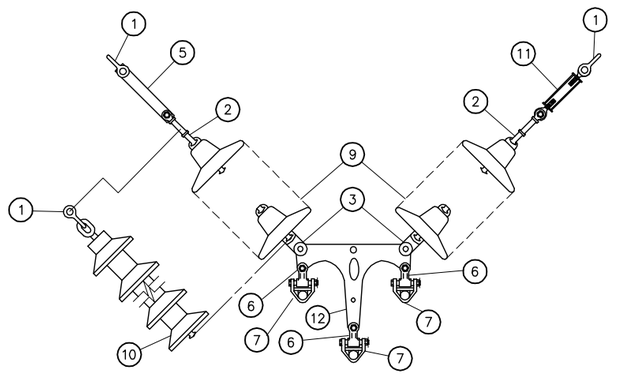
SV11–A



SV13–A



SV11–B



SV13–B

SV12–A

SV12–B

MATERIALS LIST

ITEM NO.	DESCRIPTION
1	ANCHOR SHACKLE, BNK
2	HOT LINE Y-CLEVIS BALL, BNK
3	SOCKET Y-CLEVIS, BNK
4	YOKE PLATE
5	EXTENSION STRAP, EYE-EYE (LENGTH AS REQUIRED)
6	Y-CLEVIS EYE, 90°, BNK
7	SUSPENSION CLAMP, BNK
8	VERTICAL BUNDLE YOKE, 18" SPACING
9	INSULATOR STRING, PORCELAIN UNITS
10	INSULATOR STRING, POLYMER FIBERGLASS, OVAL EYE-BALL (LENGTH AS SPECIFIED)
11	TURNBUCKLE, OVAL EYE – OVAL EYE, LENGTH AS REQUIRED
12	YOKE PLATE, TRIPLE BUNDLE, 18" SPACING

NOTES

1. BNK INDICATES BOLT, NUT AND STAINLESS STEEL COTTER KEY REQUIRED.
2. STRENGTH OF HARDWARE COMPONENTS SHALL BE EQUAL TO OR GREATER THAN THE SPECIFIED INSULATOR ASSEMBLY ULTIMATE STRENGTH, EXCEPT THAT COMPONENTS DUPLICATED BELOW THE TRIANGULAR YOKE PLATE MAY HAVE 50% OF ASSEMBLY ULTIMATE STRENGTH FOR TYPE SV12 AND 33% OF ASSEMBLY ULTIMATE STRENGTH FOR THE TYPE SV13.

TABLE A – PORCELAIN UNITS

VOLTAGE (KV)	UNIT QUANTITY/ASSEMBLY TYPE		
	STEEL STRUCTURES		
	SV11	SV12	SV13
69	12	12	12
115	18	18	18
138	20	20	20
161	22	22	22
230	28	28	28
345	36	36	36
500	62	62	62

INSULATOR ASSEMBLY TYPE NO.

EXAMPLE: SV13 – A

- A – TYPE OF STRUCTURE ATTACHMENT HARDWARE
- 3 – ONE (1), TWO (2), OR (3) THREE SUBCONDUCTORS
- V – SINGLE (1) OR DOUBLE (2) INSULATOR STRING
- E – "VEE" STRING
- S – SUSPENSION ASSEMBLY

VEE STRING INSULATOR ASSEMBLIES
ULTIMATE INSULATOR ASSEMBLY STRENGTH AS SPECIFIED
(NOTE 2)

VEE STRING INSULATOR ASSEMBLIES
ULTIMATE INSULATOR ASSEMBLY STRENGTH AS SPECIFIED
(NOTE 2)

B	9-14-06 A7-FSC	MODIFIED TITLE BLOCK, MATERIALS LIST, NOTES, TABLE A, AND ADDED TRIPLE BUNDLE ASSEMBLIES.
A	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

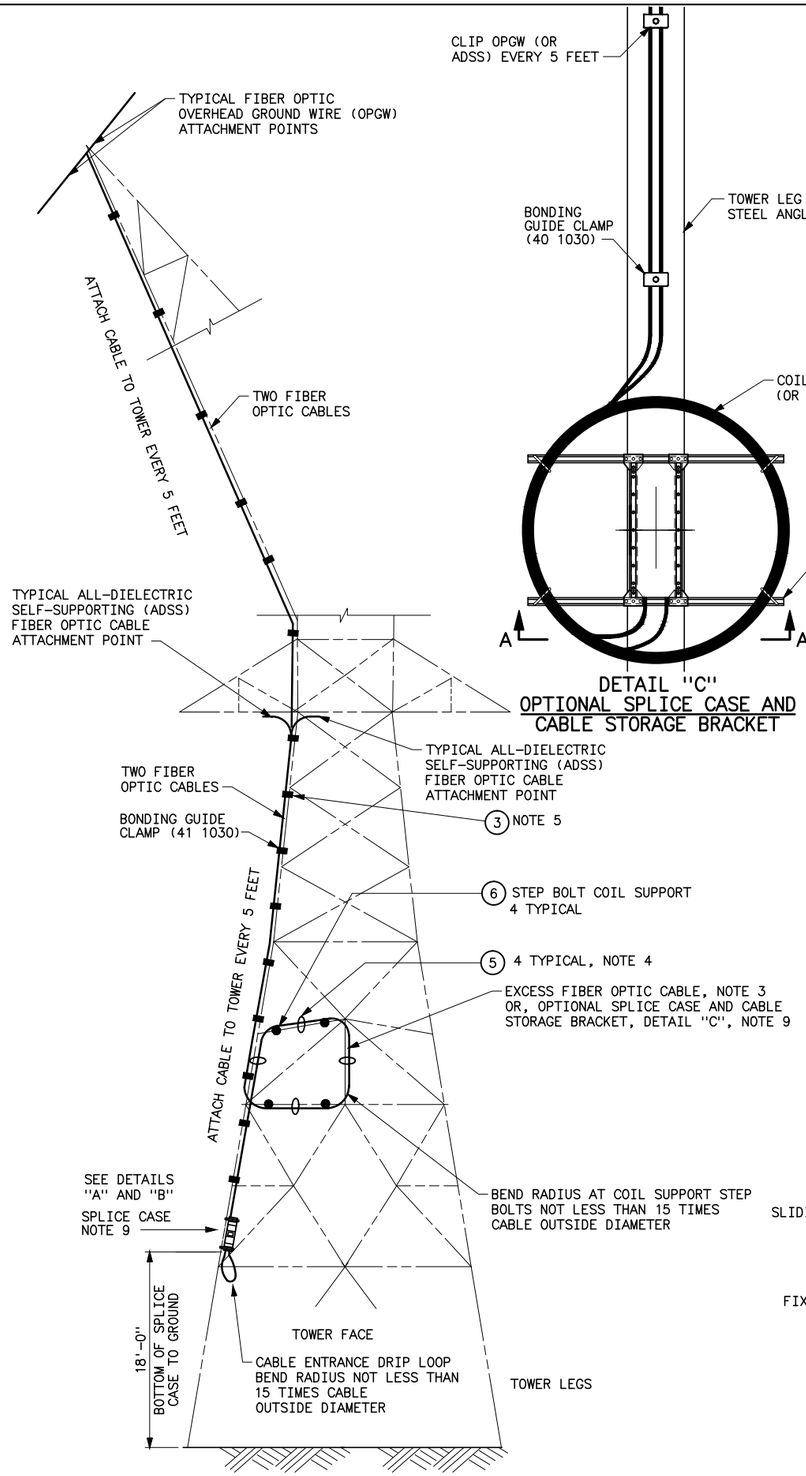
TRANSMISSION LINE STANDARDS
SUSPENSION INSULATOR ASSEMBLIES
VEE STRING, SINGLE STRING

DESIGNED F.S. COOK APPROVED ROSS CLARK, ELECTRICAL ENGINEERING MANAGER

CAE	OCTOBER 10, 1997	41	1025

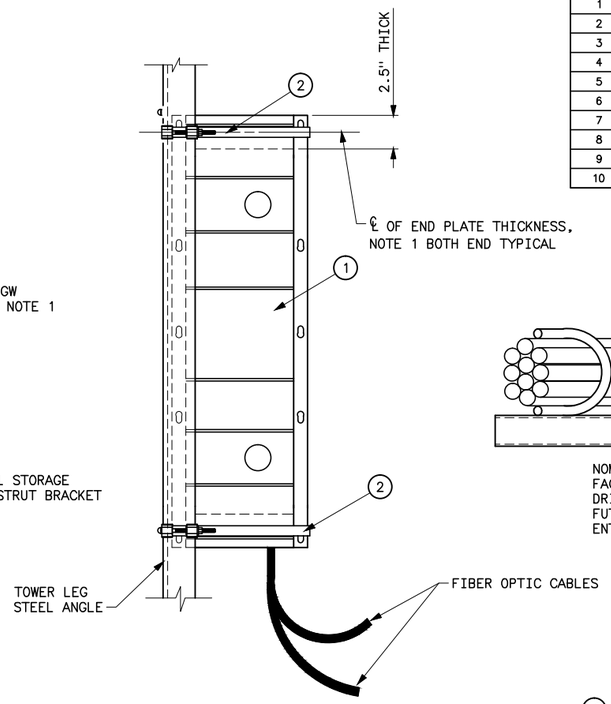
ADSS OR OPGW AERIAL FIBER OPTIC CABLE SPLICE CASE MOUNTING MATERIAL LIST

ITEM NO.	ITEM DESCRIPTION	PART NUMBER (OR EQUAL)	MANUFACTURER (OR EQUAL)	QUANTITY
1	FIBER OPTIC SPLICE CASE			1
2	STAINLESS STEEL BAND FOR SPLICE CASE, 3/4" W, 48" L (NOTE 6)	BAB-3848	ALUMA-FORM	2
3	DOWNLEAD CLAMP (FOR LATTICE STEEL STRUCTURE)	NOTE 5	ALCOA FUJIKURA LTD.	
4	END PLATE			1
5	STAINLESS STEEL CABLE TIES, HEAVY CROSS	MLT-H SERIES	PANDUIT CORP.	4
6	STEP BOLTS, 9" LENGTH X 5/8" DIAMETER	K4262	KORTICK CO.	4
7	STEEL CHANNEL STRUT (NOTE 6)	CB-44	ACA (AFL)	1
8	HOOK			
9	CHANNEL STRUT NUTS WITH SPRINGS, 5/16" 18 THREAD	K4262	KORTICK CO.	4
10	HEX HEAD MOUNT BOLT 5/16"ø			4

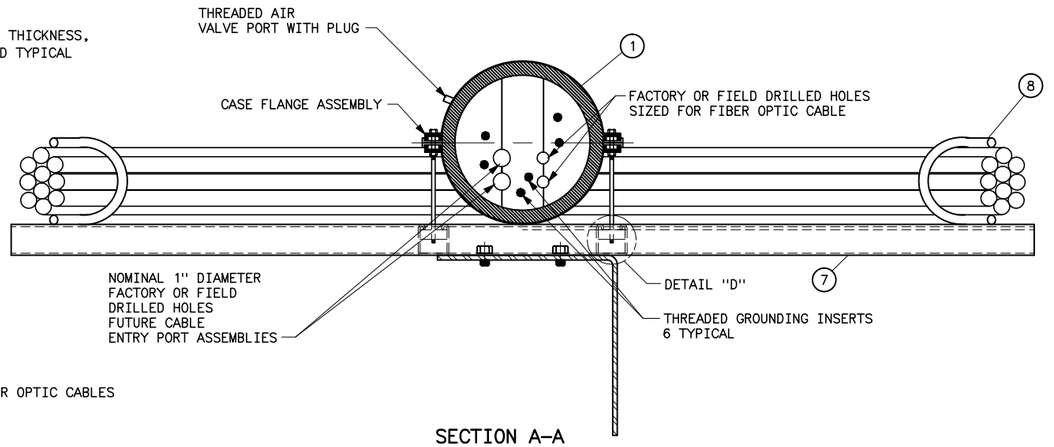


TYPICAL LATTICE STEEL TOWERS

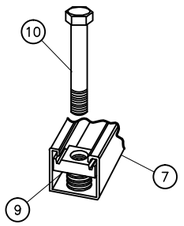
DETAIL "C"
OPTIONAL SPLICE CASE AND CABLE STORAGE BRACKET



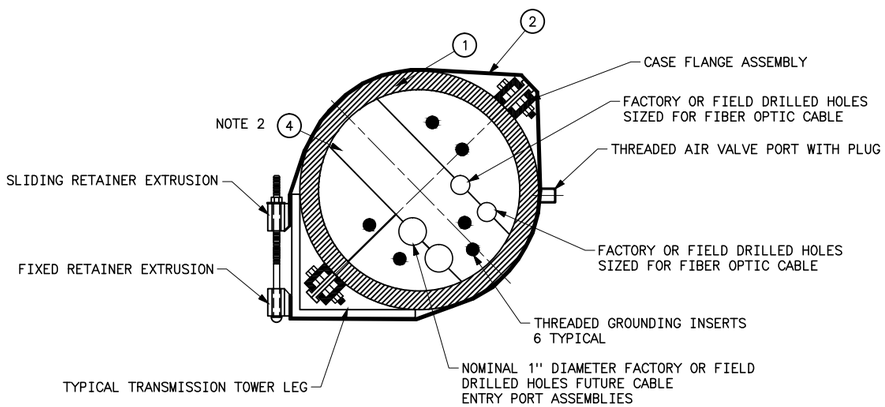
DETAIL "B"
OPTICAL FIBER SPLICE CASE MOUNTING
BAND ATTACHMENT



SECTION A-A
OPTICAL FIBER SPLICE CASE
CABLE OPENING END PLATE
NOTE 10



DETAIL "D"



DETAIL "A"
OPTICAL FIBER SPLICE CASE MOUNTING
CABLE OPENING END PLATE
(BOTTOM VIEW)

NOTES

1. USE TWO STAINLESS STEEL BANDS TO ATTACH THE SPLICE CASE TO THE TOWER, ONE AT THE TOP OF THE SPLICE CASE, THE OTHER AT THE BOTTOM. ATTACH EACH BAND OVER THE CENTER OF THE THICKEST DIMENSION OF THE END PLATES.
2. ORIENT SPLICE CASE WITH CABLE OPENING END PLATE FACING THE GROUND, AND FLANGE OF SPLICE CASE BISECTING THE TOWER LEG ANGLE MEMBER.
3. REMOVE 25 FEET OF CABLE DAMAGED DURING STRINGING OPERATIONS. THE SPARE CABLE ALLOWANCE FROM THE CABLE ATTACHMENT POINT TO THE SPLICE CASE IS 190 FEET COMPUTED AS FOLLOWS: 100 FEET TO REACH THE GROUND FOR NOMINAL STRUCTURE ATTACHMENT HEIGHT + 75 FEET HORIZONTAL DISTANCE TO GROUND SPLICE TRAILER + 15 FEET SPLICE ALLOWANCE.
4. PANDUIT, OR EQUAL, STAINLESS STEEL TIES, MLT-H SERIES, ARE USED TO SECURE THE CABLE LOOP INTO A COIL, WHICH IS THEN ATTACHED TO THE TOWER BY PANDUIT, OR EQUAL, STAINLESS STEEL CABLE TIES, MLT-H SERIES.
5. SEE DRAWING 41 1030 FOR FIBER OPTIC CABLE DOWNLEAD CLAMP.
6. SEE DRAWING 41 1030 FOR STAINLESS STEEL BAND.
7. FIBER OPTIC CABLE SHALL ENTER THE BOTTOM OF THE SPLICE CASE WITH DRIP LOOPS AT THE BOTTOM ENTRANCE.
8. USE ONE OR TWO VERTICAL STRUTS DEPENDING ON THE TYPE OF SPLICE CASE.
9. THE TYPE OF SPLICE CASE INSTALLATION SHALL BE DETERMINED BY THE COR.

D	1-14-11 A7-JSR	REVISED NOTE 3.
C	5-15-09 A7-MK	REMOVED NOTE 10.
B	3-17-09 A7-RC	ADDED STEEL CHANNEL STRUT OPTION.
A	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.

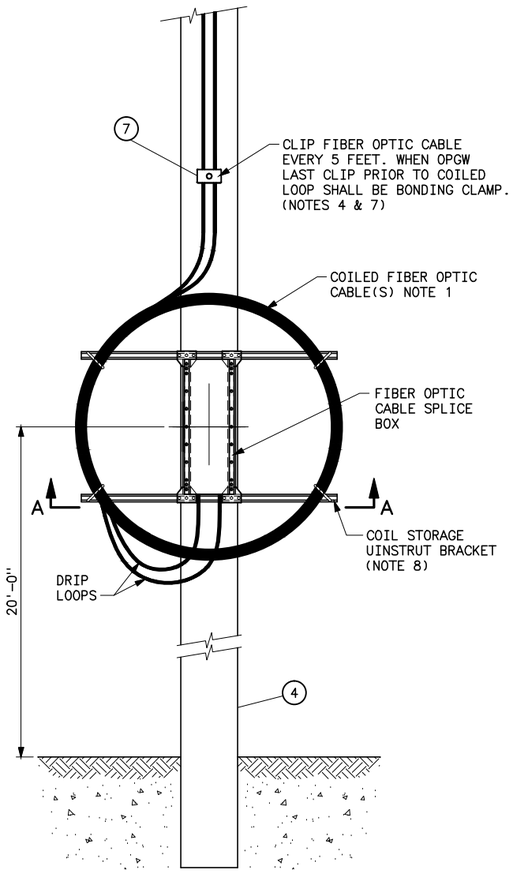
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

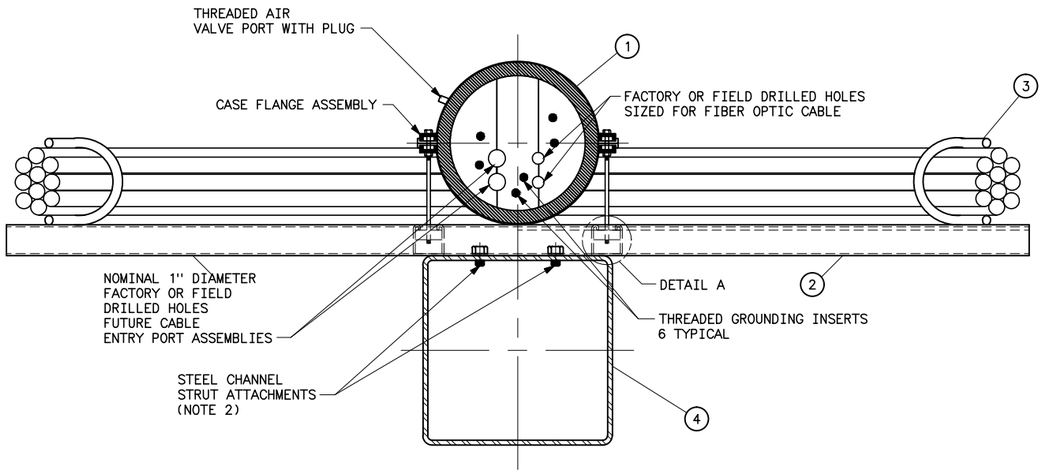
TRANSMISSION LINE STANDARDS
LATTICE STEEL STRUCTURES
FIBER OPTIC CABLE MOUNTING

DESIGNED STEVE ROCK APPROVED ROSS CLARK, ELECTRICAL ENGINEERING MANAGER

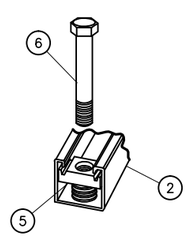
CAE	AUGUST 1, 2000	41	1027

OPGW OR ADSS AERIAL FIBER OPTIC CABLE SPLICE CASE MOUNTING MATERIAL LIST				
ITEM NO.	ITEM DESCRIPTION	PART NUMBER (OR EQUAL)	MANUFACTURER (OR EQUAL)	QUANTITY
1	FIBER OPTIC SPLICE CASE			1
2	STEEL CHANNEL STRUT (NOTE 6)	CB-44	ACA (AFL)	1
3	HOOK			
4	CONCRETE OR STEEL POLE STRUCTURE			
5	CHANNEL STRUT NUTS WITH SPRINGS, 5/16" 18 THREAD	P1007	UNISTRUT CORP	4
6	HEX HEAD MOUNT BOLT 5/16"#			4
7	STRUCTURE DOWNLEAD CLAMP (FOR STEEL POLE)	NOTE 4	ACA (AFL)	

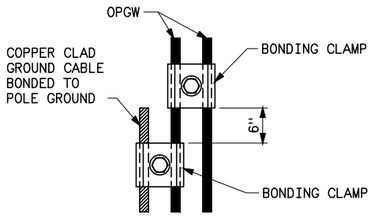




SECTION A-A
OPTICAL FIBER SPLICE CASE
CABLE OPENING END PLATE



DETAIL A



DETAIL B

NOTES

1. REMOVE 25 FEET OF CABLE DAMAGED DURING STRINGING OPERATIONS. THE AMOUNT OF SPARE CABLE TO BE COILED, IS THE HEIGHT OF THE SPLICE BOX PLUS 30 FEET, OR AS DIRECTED BY THE COR DUE TO ACCESS FOR THE SPLICE VAN.
2. PERMANENTLY ATTACH STEEL CHANNEL STRUTS TO STEEL POLES WITH SCREWS AS DIRECTED BY THE COR.
3. FOR CONCRETE POLES, USE GENERAL PURPOSE POLE BAND MOUNT D-4080 FROM ALUMA-FORM (OR EQUAL) AND STAINLESS STEEL POLE BANDS, SEE DRAWING 41 1030.
4. SEE DRAWING 41 1030 FOR FIBER OPTIC CABLE DOWNLEAD CLAMP, AND BONDING CLAMP.
5. FIBER OPTIC CABLE SHALL ENTER THE BOTTOM OF THE SPLICE CASE WITH DRIP LOOPS AT THE BOTTOM ENTRANCE.
6. USE ONE OR TWO VERTICAL STRUTS DEPENDING ON THE TYPE OF SPLICE CASE.
7. IF STRUCTURE IS PROPERLY GROUNDED THEN DRILL AND TAP BONDING CLAMP TO ATTACH TO POLE. OTHERWISE USE TWO BONDING CLAMPS AND RUN GROUND CABLE FROM BONDING CLAMP TO STRUCTURE GROUND AS SHOWN IN DETAIL B. IF BONDING CLAMP(S) ARE NOT SECURED TO THE POLE THEN A DOWNLEAD CLAMP SHALL BE PLACED WITHIN 1 FOOT ABOVE BONDING CLAMP.
8. PREFABRICATED COIL BRACKET MAY BE USED DEPENDING UPON THE SPLICE CASE THAT IS FURNISHED.

D	1-14-11 A7-JSR	REVISED MATERIAL LIST
C	5-15-09 A7-MK	REVISED BONDING CLAMP & MATERIAL LIST
B	6-8-06 A7-RC	REVISED SPARE COIL QUANTITY, LOOP, AND ATTACHMENT TO STEEL POLE.

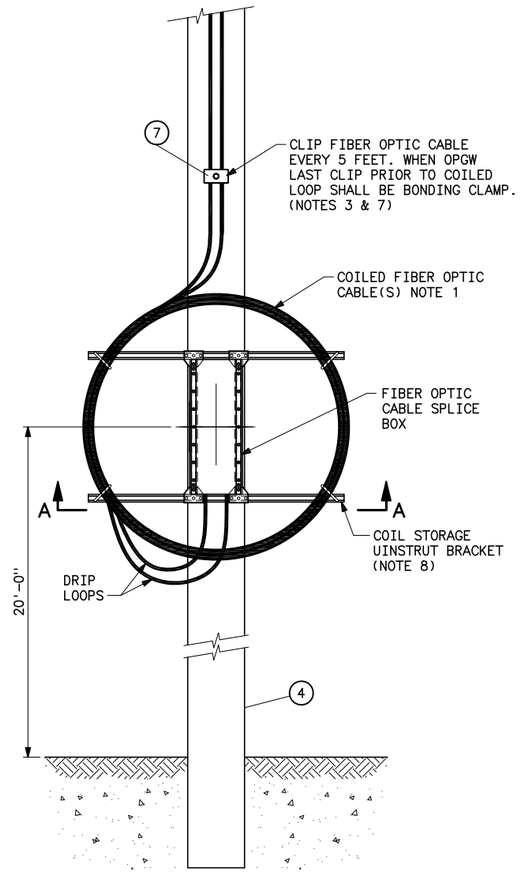
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

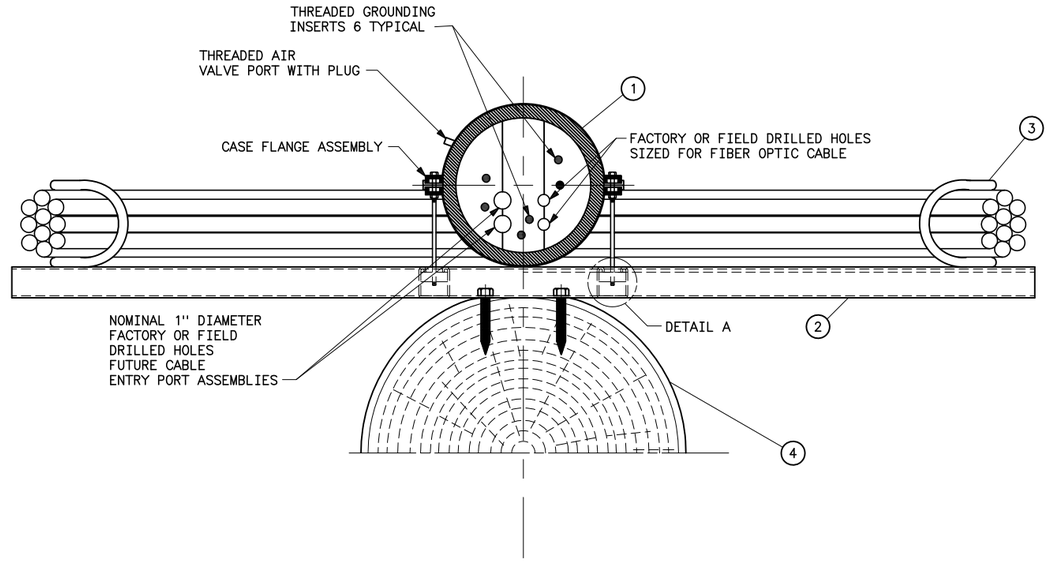
TRANSMISSION LINE STANDARDS
STEEL AND CONCRETE
POLE STRUCTURES
FIBER OPTIC CABLE MOUNTING

DESIGNED STEVE ROCK APPROVED ROSS CLARK, ELECTRICAL ENGINEERING MANAGER

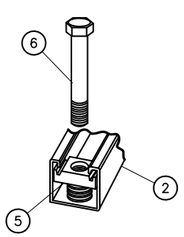
CAE	AUGUST 1, 2000	41	1028

OPGW OR ADSS AERIAL FIBER OPTIC CABLE SPLICE CASE MOUNTING MATERIAL LIST				
ITEM NO.	ITEM DESCRIPTION	PART NUMBER (OR EQUAL)	MANUFACTURER (OR EQUAL)	QUANTITY
1	FIBER OPTIC SPLICE CASE			1
2	STEEL CHANNEL STRUT, (NOTE 6)	CB-44	ACA (AFL)	1
3	HOOK			
4	WOOD POLE STRUCTURE			
5	CHANNEL STRUT NUTS WITH SPRINGS, 5/16" 18 THREAD	P1007	UNISTRUT CORP	4
6	HEX HEAD MOUNT BOLT, 5/16"ø	HHCS031125 EG	UNISTRUT CORP	4
7	STRUCTURE DOWNLEAD CLAMP (FOR WOOD POLE)	NOTE 4	ALCOA FUJIKURA LTD.	

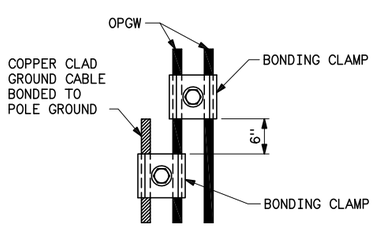




SECTION A-A
OPTICAL FIBER SPLICE CASE
CABLE OPENING END PLATE



DETAIL A



DETAIL B

NOTES

1. REMOVE 25 FEET OF CABLE DAMAGED DURING STRINGING OPERATIONS. THE AMOUNT OF SPARE CABLE TO BE COILED, IS THE HEIGHT OF THE SPLICE BOX PLUS 30 FEET, + 30 FEET FOR SPLICING
2. CONTRACTOR SHALL MATCH GROOVE A DIAMETER TO THE OPGW DIAMETER SIZE AND MATCH GROOVE B DIAMETER TO THE GROUND CABLE DIAMETER SIZE.
3. SEE DRAWING 41 1030 FOR FIBER OPTIC CABLE DOWNLEAD CLAMP, AND BONDING CLAMP.
4. PANDUIT, OR EQUAL, STAINLESS STEEL TIES, MLT-H SERIES, ARE USED TO SECURE THE CABLE LOOP INTO A COIL, WHICH IS THEN ATTACHED TO THE STRUCTURE BY PANDUIT, OR EQUAL, STAINLESS STEEL CABLE TIES, MLT-H SERIES.
5. FIBER OPTIC CABLE SHALL ENTER THE BOTTOM OF THE SPLICE CASE WITH DRIP LOOPS AT THE BOTTOM ENTRANCE.
6. USE ONE OR TWO VERTICAL STRUTS DEPENDING ON THE TYPE OF SPLICE CASE.
7. IF STRUCTURE GROUND IS 180° FROM SPLICE BOX THEN USE BONDING CLAMP FOR WOOD POLE STRUCTURE AS SHOWN ON DRAWING 41 1030. OTHERWISE USE TWO BONDING CLAMPS AND RUN GROUND CABLE FROM BONDING CLAMP TO STRUCTURE GROUND AS SHOWN IN DETAIL B. IF BONDING CLAMP(S) ARE NOT SECURED TO THE POLE THEN A DOWNLEAD CLAMP SHALL BE PLACED WITHIN 1 FOOT ABOVE BONDING CLAMP.
8. PREFABRICATED COIL BRACKET MAY BE USED DEPENDING UPON THE SPLICE CASE THAT IS FURNISHED.

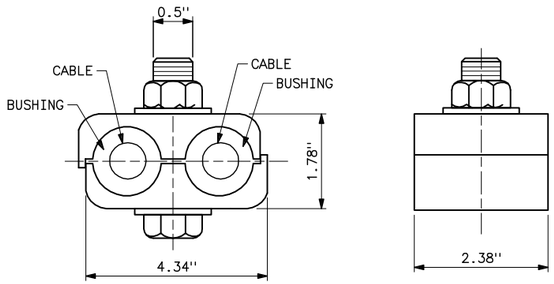
F	1-14-11 A7-JSR	REVISED NOTE 1 AND NOTE 7. REVISED TABLE NUMBERS AND ITEMS
E	5-15-09 A7-MK	REVISED BONDING CLAMP & MATERIAL LIST.
D	6-8-06 A7 - RC	REVISED SPARE COIL QUANTITY, LOOP, AND ATTACHMENT TO WOOD POLE.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

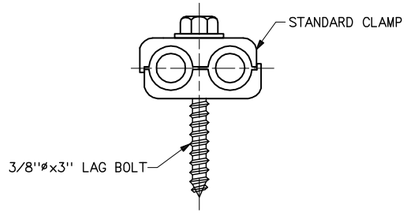
TRANSMISSION LINE STANDARDS
WOOD POLE STRUCTURES
FIBER OPTIC CABLE MOUNTING

DESIGNED STEVE ROCK APPROVED ROSS CLARK, ELECTRICAL ENGINEERING MANAGER

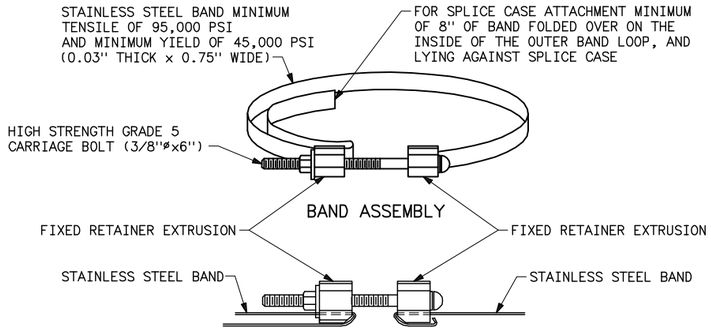
CAF	AUGUST 1, 2000	41	1029



STANDARD CLAMP

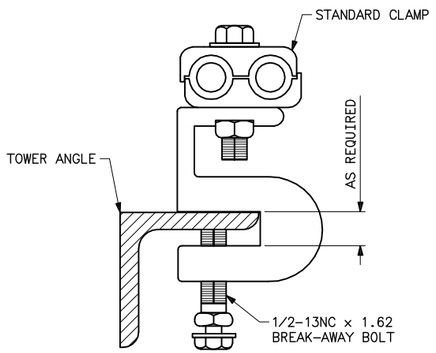


STANDARD CLAMP WITH LAG BOLT

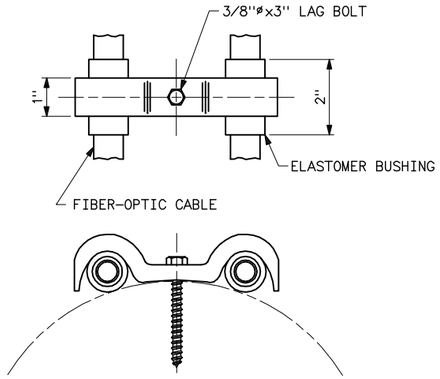


INSIDE BAND FOLD, EDGE VIEW

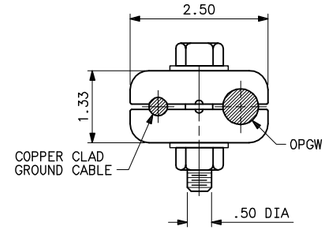
STAINLESS STEEL BAND



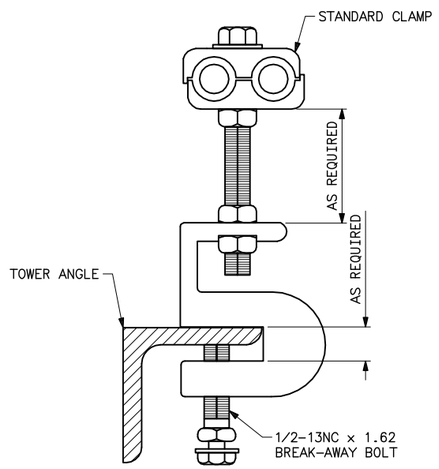
STANDARD CLAMP WITH ANGLE ATTACHMENT



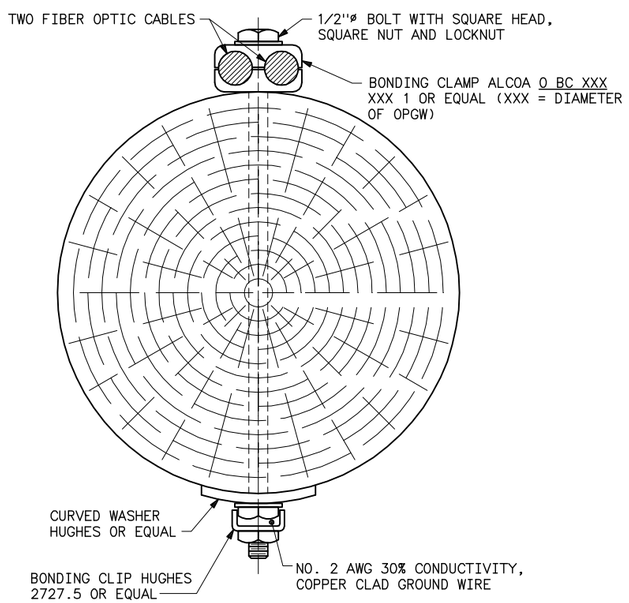
DOWNLEAD CLAMP FOR WOOD POLE STRUCTURE



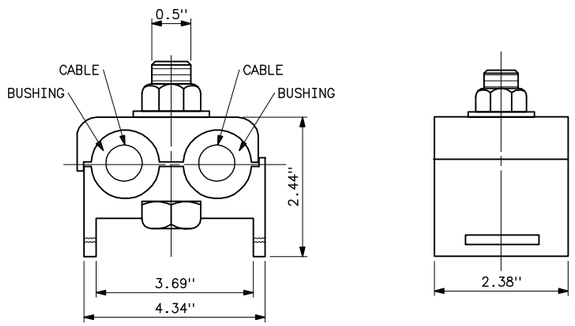
BONDING CLAMP FOR GROUNDING



STANDARD CLAMP WITH ANGLE ATTACHMENT AND STANDOFF BOLT



BONDING CLAMP FOR WOOD POLE STRUCTURE



BANDING CLAMP

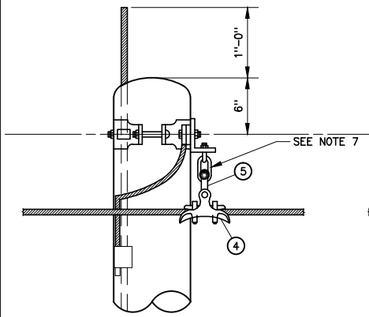
D	4-7-11 A7-RC	ADDED STANDOFF BOLT OPTION.
C	5-15-09 A7-MK	REVISED BAND NOTE AND ADDED BONDING CLAMP.
B	01-31-05 A7-KKR	ADDED BONDING CLAMP FOR WOOD POLE STRUCTURE DETAIL.
A	07-15-03 A7-RC	REVISED TITLE BLOCK.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

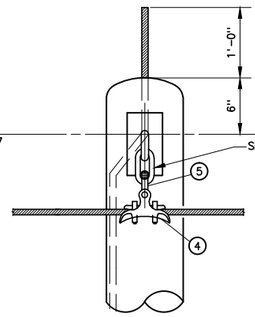
TRANSMISSION LINE STANDARDS
FIBER OPTIC CABLE MOUNTING
DOWNLEAD CLAMPS AND BANDS

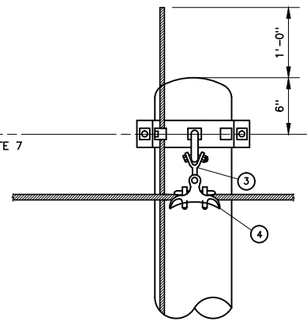
DESIGNED STEVE ROCK _____ APPROVED ROSS CLARK _____
ELECTRICAL ENGINEERING MANAGER

CAE	AUGUST 01, 2000	41	1030

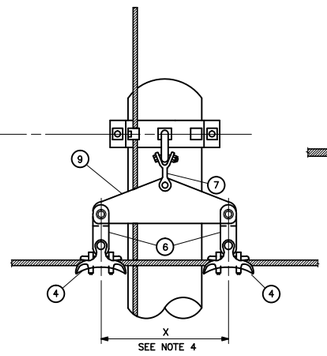


SUSPENSION ASSEMBLY OPGW-SA
FOR ATTACHMENT TO STEEL ANGLE OR SUPPORT BRACKET

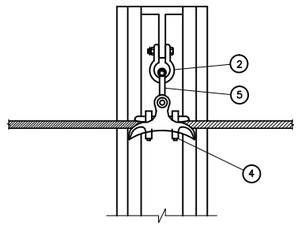




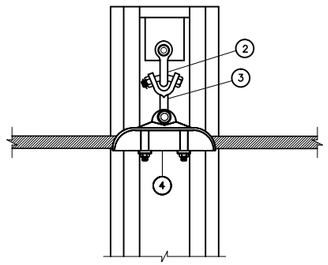
SUSPENSION ASSEMBLY OPGW-PB
FOR ATTACHMENT TO POLE BAND



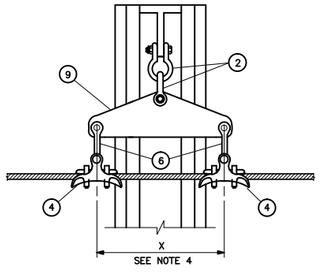
SUSPENSION ASSEMBLY OPGW-PBY
FOR ATTACHMENT HOLE IN-LINE WITH OPGW



SUSPENSION ASSEMBLY OPGW-SL
FOR ATTACHMENT HOLE IN-LINE WITH OPGW



SUSPENSION ASSEMBLY OPGW-SP
FOR ATTACHMENT HOLE PERPENDICULAR TO OPGW



SUSPENSION ASSEMBLY OPGW-SYL
FOR ATTACHMENT HOLE IN-LINE WITH OPGW

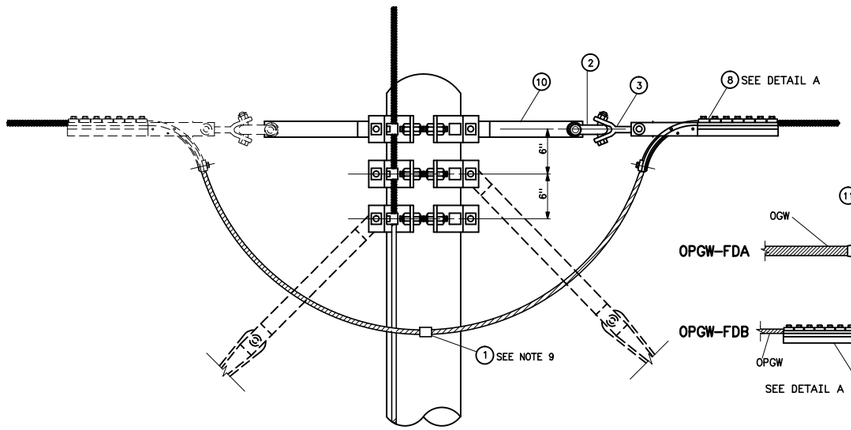
MATERIALS LIST

ITEM NO.	OPGW ASSEMBLY QUANTITY											DESCRIPTION
	SA	PB	PBY	SL	SP	SYL	TW	TV	TH	TLV	FDA FDB	
1	SEE NOTE 9											GUIDE CLAMP
2				1	1	2	1	1	1	2	5* 4*	ANCHOR SHACKLE, BNK
3		1			1		1		1		1* 2*	Y-CLEVIS EYE 90°, BNK(SEE NOTE 13)
4	1	1	2	1	1	2						SUSPENSION CLAMP, BNK(SEE NOTE 13)
5	1			1				1				Y-CLEVIS EYE, BNK(SEE NOTE 13)
6			2			2						CLEVIS EYE, BNK
7			1									Y-CLEVIS CLEVIS 90°, BNK
8							1	1	1	1	1 2	OPGW DEADEND, BNK
9			1			1					1 1	YOKE PLATE
10							1			1	2* 2*	CONNECTING LINK
11											1	COMPRESSION FITTING, EYE TYPE
12											2* 2*	OVAL EYE-OVAL EYE TURNBUCKLE (16")

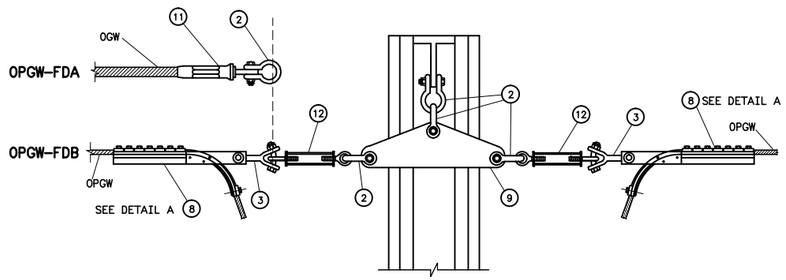
* QUANTITY DEPENDS UPON HARDWARE OPTION THAT WILL BE USED.

NOTES

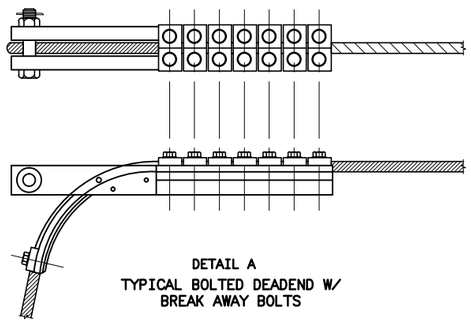
1. BNK INDICATE BOLT, NUT AND STAINLESS STEEL COTTER KEY REQUIRED.
2. SEE SPECIFICATIONS FOR STRENGTH RATING OF COUPLING HARDWARE.
3. ASSEMBLIES OPGW-PBY AND OPGW-SYL SHALL BE USED FOR LINE ANGLES OF 30° TO 60°.
4. LENGTH OF SUSPENSION CLAMP PLUS 3 INCHES MINIMUM.
5. OPGW REFERS TO THE OPTICAL GROUND WIRE.
6. GROUNDING OF THE OPGW ATTACHMENT ASSEMBLIES SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.
7. CHAIN LINK FURNISHED AS PART OF THE STRUCTURE FOR NEW CONSTRUCTION.
8. THE SHACKLE TO Y-CLEVIS CONNECTION IS REQUIRED TO PROVIDE 360° MOVEMENT.
9. PREVENT THE OPGW FROM CLASHING WITH ALL POLES AND TOWERS BY PROVIDING SUFFICIENT NUMBER OF GUIDE CLAMPS TO ATTACH THE LOOP TO THE STRUCTURE OR BY LOOPING THE CABLE OVER THE TOP OR AROUND THE SIDES OF POLES.
10. ANY PROPOSED CHANGE OF HARDWARE SHALL REQUIRE THE CONTRACTOR TO RECEIVE APPROVAL FROM ENGINEERING PRIOR TO THE CHANGE.
11. HARDWARE SHALL HAVE MINIMUM RATED STRENGTH OF 17,000 LBS.
12. ADD 9-INCH CONNECTING LINK FOR USE WITH DEAD-END TEES.
13. SIZE WIDTH OF EYE ON Y-CLEVIS TO FIT BETWEEN EARS OF SUSPENSION CLAMP.
14. USE OPGW-TV FOR GLUED LAMINATED WOOD TENSION STRUCTURES WITH LINE ANGLES GREATER THAN 1°.



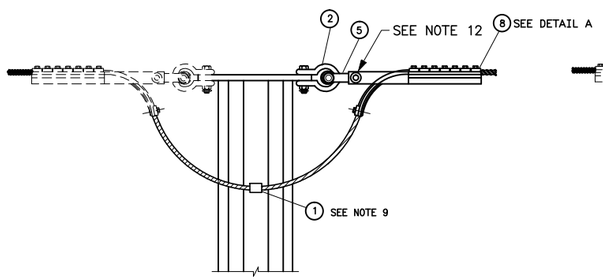
TENSION ASSEMBLY OPGW-TW
FOR ATTACHMENT TO EXTENSION LINK, EACH WAY



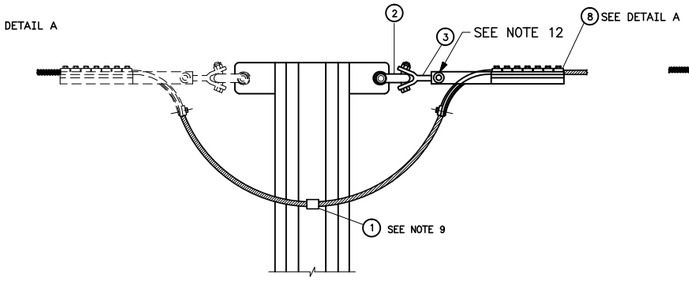
FLOATING DEADEND ASSEMBLIES
FOR ATTACHMENT HOLE IN-LINE WITH OPGW AND OGW



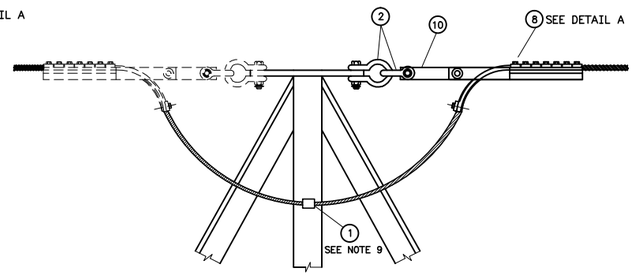
DETAIL A
TYPICAL BOLTED DEADEND W/ BREAK AWAY BOLTS



TENSION ASSEMBLY OPGW-TV
FOR VERTICAL ATTACHMENT HOLE (SEE NOTE 14)



TENSION ASSEMBLY OPGW-TH
FOR HORIZONTAL ATTACHMENT HOLE



TENSION ASSEMBLY OPGW-TLV
FOR VERTICAL ATTACHMENT HOLE ON LATTICE TYPE TOWERS

F	4-19-11 A7-KKR	ADDED SUPPORT BRACKET ASSEMBLY. ADDED NOTES 12, 13 AND 14.
E	9-20-10 A7-RC	ADDED BNK TO ITEM 8.
D	5-15-09 A7-MK	REVISED FLOATING DEADEND AND NOTE 9.
C	7-2-04 A7-FSC	REVISED TURNBUCKLE FITTINGS, NOTE 7 AND ADDED OPGW-SP
B	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
A	7-1-02 A79-JGW	MINOR REVISIONS.

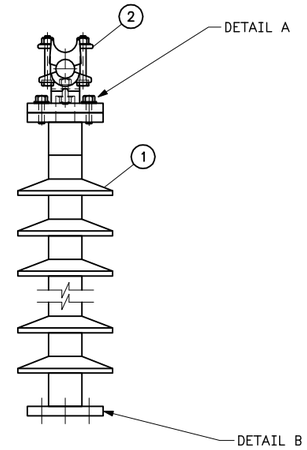
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS

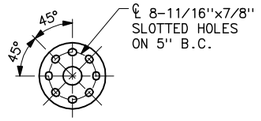
OPTICAL GROUND WIRE ASSEMBLIES

DESIGNED JEFF WILD APPROVED ROSS CLARK
ELECTRICAL ENGINEERING MANAGER

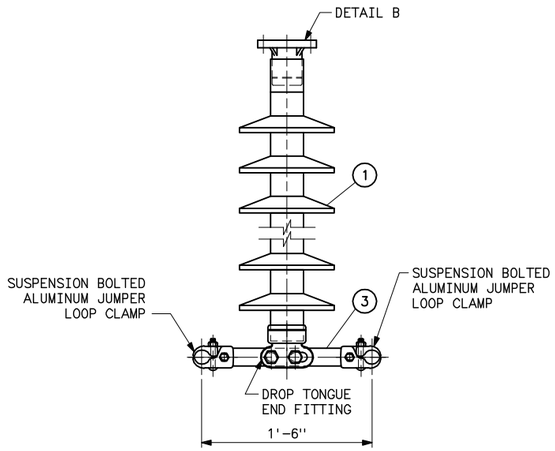
SIZE			
A	MARCH 1, 2000	41	1031



TYPE SP-1
OVERHUNG



DETAIL A
BUS SUPPORT FITTING
END DETAILS

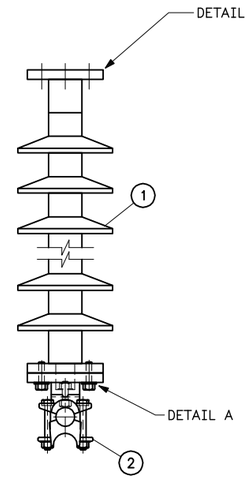


TYPE SP-3
DOUBLE CONDUCTOR,
SINGLE POST INSULATOR

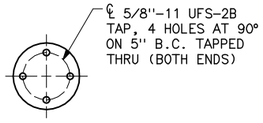
MATERIAL LIST	
ITEM NO.	DESCRIPTION
1	STATION POST INSULATOR, POLYMER FIBERGLASS (COMPOSITE), FLANGE END FITTING (BOTH ENDS)
2	HORIZONTAL BUS SUPPORT FITTING (ANDERSON ACS OR EQUAL)
3	YOKE/CLAMP ASSEMBLY

NOTE

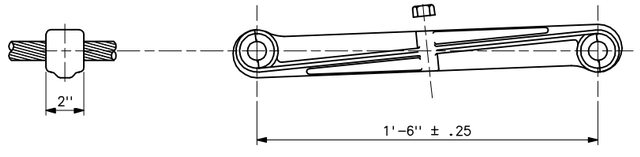
1. SEE SPECIFICATION FOR INSULATOR ELECTRICAL AND MECHANICAL RATINGS.
2. WHERE TWO CONDUCTOR SPACERS ARE REQUIRED, THEY SHALL BE INSTALLED HALF-WAY BETWEEN THE JUMPER PADS AND THE JUMPER INSULATOR ASSEMBLY.



TYPE SP-2
UNDERHUNG



DETAIL B
INSULATOR FLANGE
DRILLING DETAILS



SPACER
TWO BUNDLE CONDUCTOR

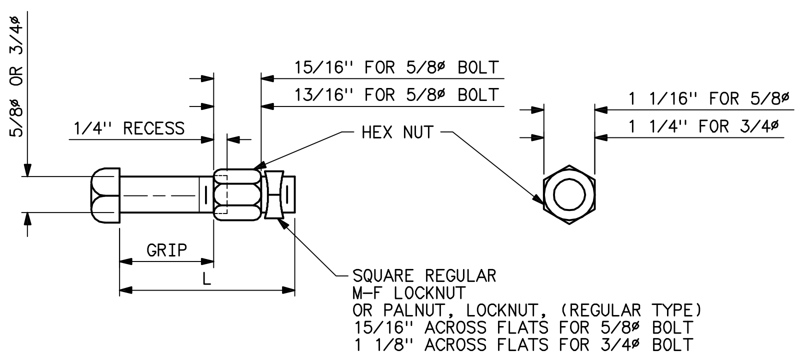
B	6-9-09 A7-MK	ADDED NEW ASSEMBLY AND SPACER.
A	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

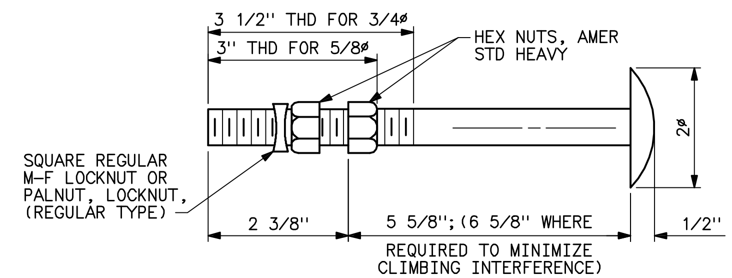
TRANSMISSION LINE STANDARDS
STATION POST
JUMPER INSULATOR ASSEMBLIES

DESIGNED F.S. COOK _____ APPROVED R.M. CLARK _____
ELECTRICAL ENGINEERING MANAGER

CAE	APRIL 15, 2003	41	1033



CONNECTION BOLT



STEP BOLT

NOTE

1. GRIP INCLUDES FILLS AND BEVEL WASHERS WHERE USED.

BOLT LENGTHS REQUIRED FOR VARIOUS GRIPS

L FOR 3/4ø BOLTS	1 3/4"				2"				2 1/4"				2" 1/2"				2 3/4"			
GRIP	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	11/16"	3/4"	13/16"	7/8"	15/16"	1"	1 1/16"	1 1/8"	1 3/16"	1 1/4"	1 5/16"	1 3/8"	1 7/16"
L FOR 5/8ø BOLTS	1 1/2"			1 3/4"				2"				2 1/4"				2" 1/2"				2 3/4"

L FOR 3/4ø BOLTS	3"				3 1/4"				3 1/2"				3 3/4"				4"
GRIP	1 1/2"	1 9/16"	1 5/8"	1 11/16"	1 3/4"	1 13/16"	1 7/8"	1 15/16"	2"	2 1/16"	2 1/8"	2 3/16"	2 1/4"	2 5/16"	2 3/8"	2 7/16"	2" 1/2"
L FOR 5/8ø BOLTS	2 3/4"			3"				3 1/4"				3 1/2"				3 3/4"	

C	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
B	7-13-99 A3-DH	REDRAWN.

SUPERSEDES DWG NO. 40-D-5672

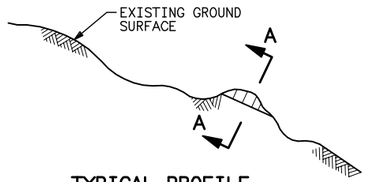
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS

TOWER BOLTS

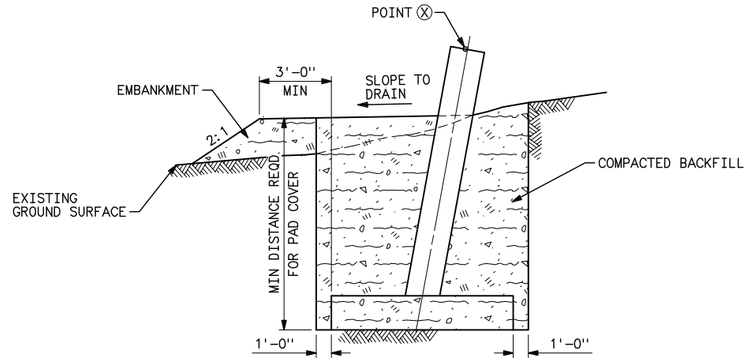
DESIGNED BUREC APPROVED DOUG HANSON CIVIL ENGINEERING MANAGER

CAE APRIL 10, 1979 | 41 | 2001

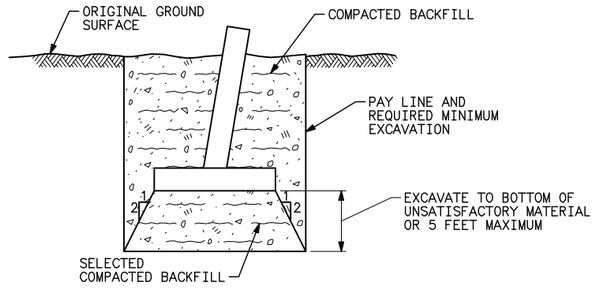


TYPICAL PROFILE ALONG ℄ RIGHT OF WAY

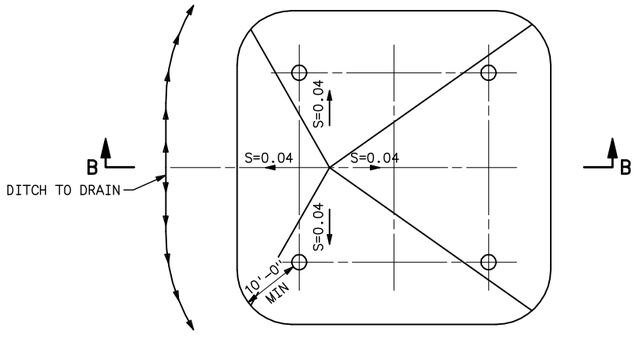
SECTION A–A
TYPICAL LINE CLEARANCE EXCAVATION
LOCATIONS AND DIMENSIONS OF CUT TO BE AS DIRECTED

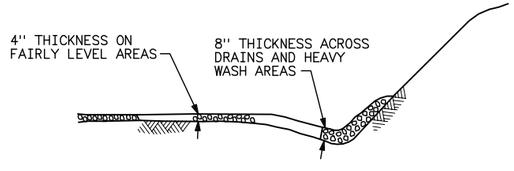


TYPICAL FOOTING COVER EMBANKMENT
FOR USE AS DIRECTED WHEN COMPACTED BACKFILL TO EXISTING GROUND SURFACE DOES NOT PROVIDE REQUIRED FOOTING PAD COVER (NOT TO BE USED ON GROUND SLOPE STEEPER THAN 3 TO 1)

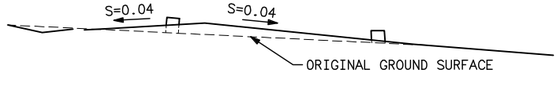


SPECIAL EXCAVATION AND COMPACTED BACKFILL
FOR TYPES D OR F FOOTINGS
FOR USE AS DIRECTED WHERE UNSATISFACTORY MATERIALS, WHICH DO NOT MEET THE REQUIRED BEARING CLASSIFICATION FOR FOUNDATION MATERIALS, ARE ENCOUNTERED AT THE BOTTOM OF NORMAL EXCAVATION





TYPICAL SECTION OF GRAVEL BLANKET PROTECTION FOR TOWER SITES
LOCATIONS AND EXTENT OF PROTECTED AREA TO BE AS DIRECTED



SECTION B–B
EMBANKMENT IN LOESS
FOR USE AS DIRECTED WHEN TYPE "AL" FOOTING IS REQUIRED
NOT REQUIRED WHERE GROUND SLOPE IS ≥ 0.04

D	9-12-12 A7-DH	CORRECTED SPELLING ERRORS.
C	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
B	7-13-99 A3-DH	REDRAWN.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – GOLDEN, COLORADO

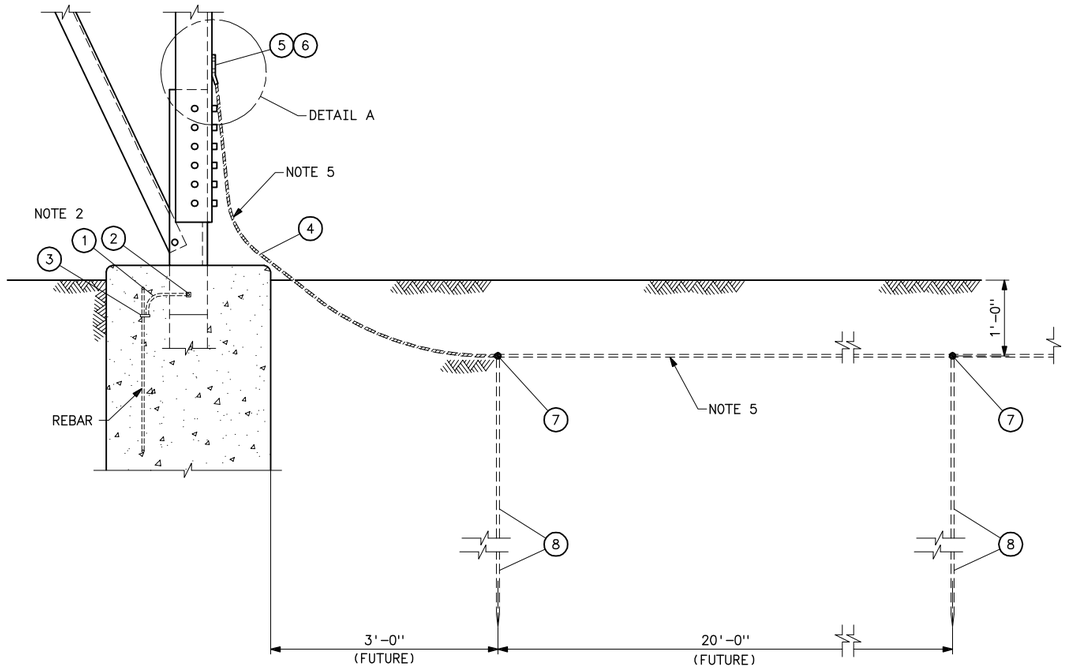
TRANSMISSION LINE STANDARDS

SPECIAL EARTHWORK

DESIGNED BUREC _____ APPROVED DOUG HANSON
CIVIL ENGINEERING MANAGER

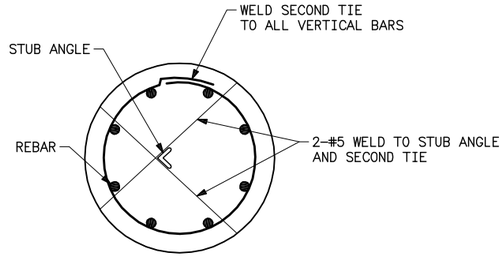
CAE	JANUARY 29, 1982	41	2017

Thu Sep 02 1999 08:20:57 AM G:\users\Cox\41_2017.dwg



SECTION A-A
GROUNDING CONNECTION

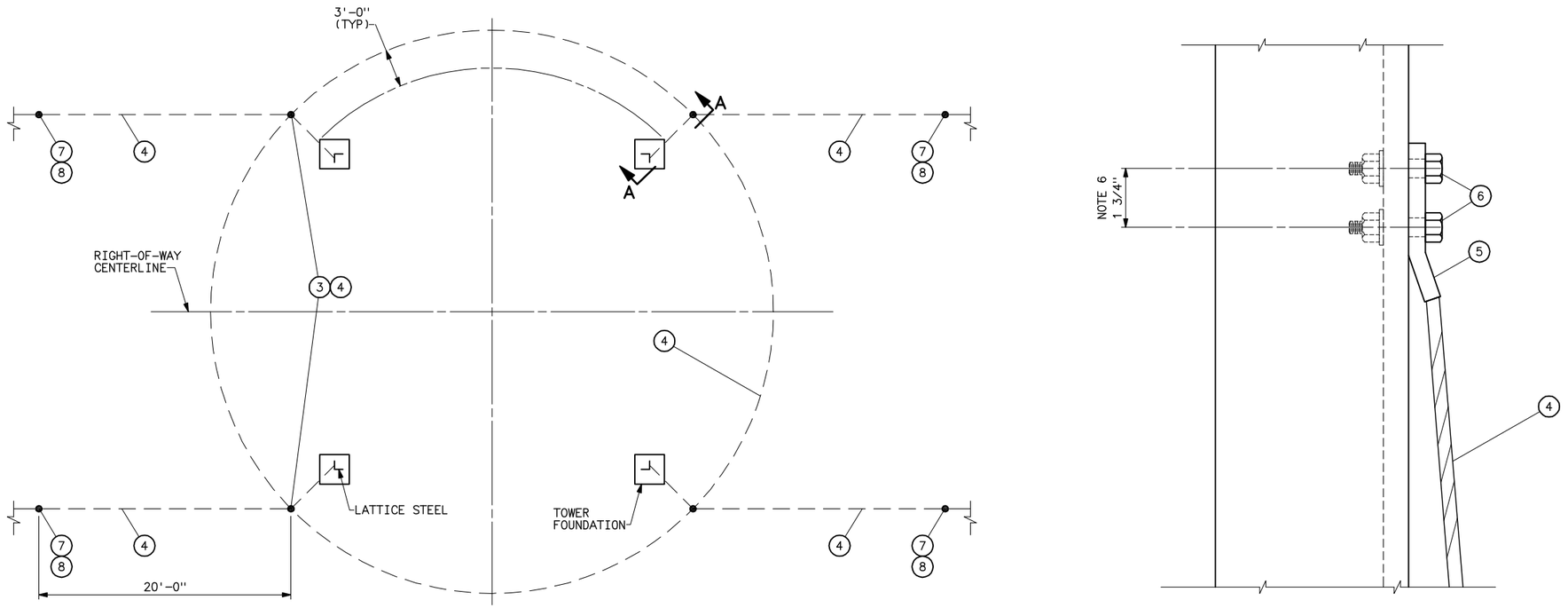
BILL OF MATERIAL		
ITEM NO.	NO. REQD	DESCRIPTION
1	4	4/0 COPPER WIRE, LENGTH AS REQUIRED
2	4	CABLE TO BAR GROUND CONNECTOR SIMILAR TO BURNDY TYPE GB
3	4	CABLE TO ROD GROUND CONNECTOR SIMILAR TO BURNDY TYPE GAR
4	4	COPPER CLAD STEEL WIRE NO. 4/0 AWG, 30% CONDUCTIVITY, LENGTH AS REQUIRED
5	4	NEMA 2 HOLE PAD (NOTE 6)
6	8	BOLT, 1/2 IN GALVANIZED WITH NUT & LOCK WASHER. LENGTH AS REQUIRED
7	4	CABLE TO GROUND ROD CONNECTOR (NOTE 4)
8	4	5/8" x 10'-0" GROUND RODS



WELDING PLAN
(LONGITUDINAL REINFORCEMENT NOT SHOWN)

NOTES

1. GROUND THE TOWER TO THE REBAR IN THE FOUNDATION. IF THE DESIRED RESISTIVITY IS NOT ACHIEVED, INSTALL THE RING WITH GROUND RODS. EXTEND GROUND WIRES WITH GROUND RODS EVERY 20 FEET AS REQUIRED TO ACHIEVE DESIRED RESISTIVITY AS DIRECTED BY THE COR.
2. CONNECT EACH STUB ANGLE TO REBAR BY WELDING OR WITH PAD, WIRE, AND CONNECTOR. ADDITIONAL PADS, WIRE, AND CONNECTORS MAY BE REQUIRED TO ACHIEVE DESIRED RESISTIVITY.
3. DRIVE GROUND RODS TO ACHIEVE DESIRED RESISTIVITY AS DIRECTED BY THE COR. IF ROCK IS ENCOUNTERED BEFORE ACHIEVING DEPTH OF THE GROUND ROD, MUST DRILL A MIN 3 IN. HOLE TO DEPTH AND FILL WITH "GEM" PLACING GROUND ROD IN CENTER OF HOLE.
4. GROUND ROD CONNECTIONS SHALL BE CADWELD, THERMOWELD, TECTOWELD OR EQUIVALENT PROCESS.
5. ALWAYS MAINTAIN A MIN BEND RADIUS OF 8 INCHES FOR ALL GROUND WIRES AND CONNECTIONS.
6. THE TWO 9/16" HOLES FOR THE ATTACHMENT MUST BE ON THE CENTER OF THE EXISTING LEG. SPRAY OVER DRILLED HOLES WITH ZINC PAINT.
7. EXTERNAL PIGTAILS SHALL NOT BE EMBEDDED IN THE CONCRETE.



PLAN VIEW
TOWER CONNECTION DETAIL
(FUTURE)

DETAIL A

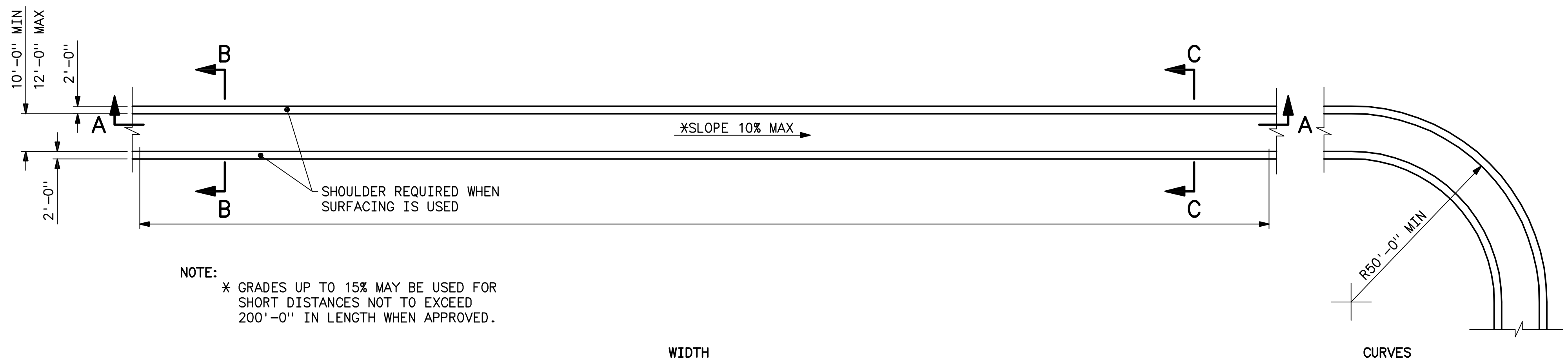
A	10-10-03 A7-RC	REVISED TO SHOW PRIMARY STRUCTURE GROUNDING INSIDE FOUNDATION

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

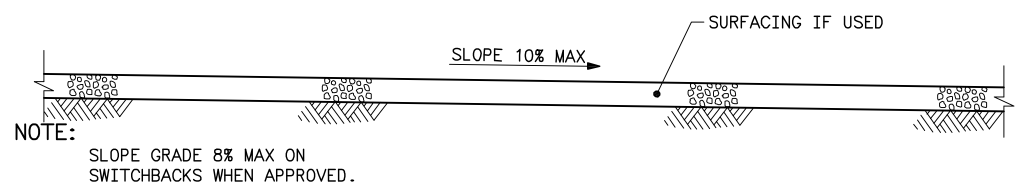
TRANSMISSION LINE STANDARDS
LATTICE STEEL TOWERS
STRUCTURE GROUNDING

DESIGNED J. WILD APPROVED ROSS CLARK
ELECTRICAL ENGINEERING MANAGER

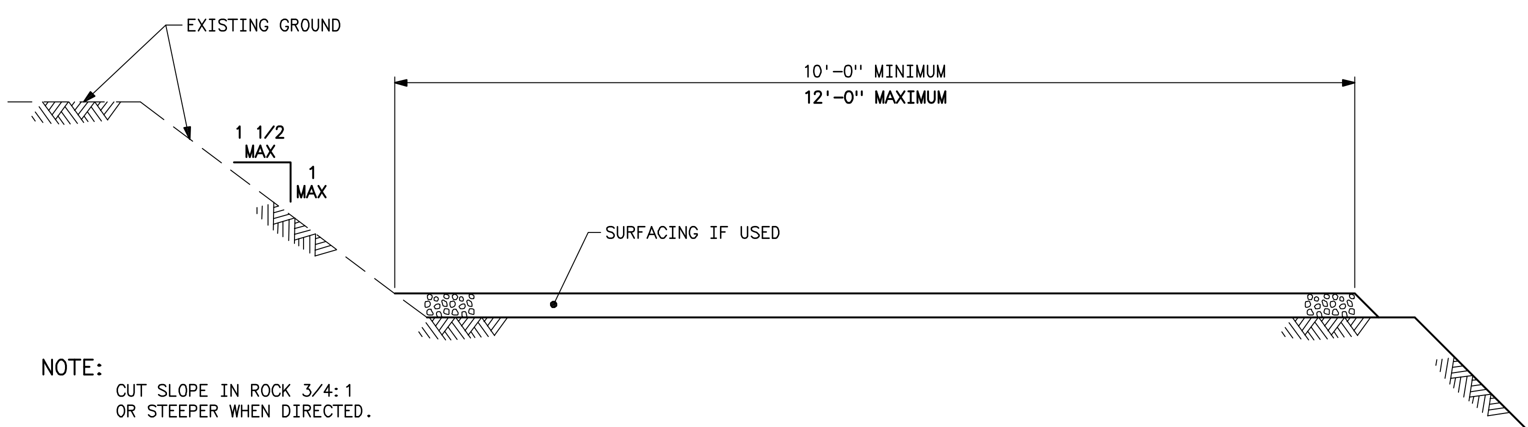
CAD	JULY 15, 2003	41	2034



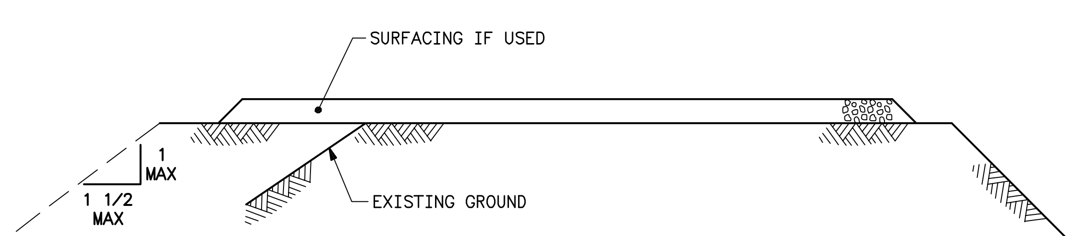
ACCESS ROADS



SECTION A–A



SECTION B–B



SECTION C–C

A	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.

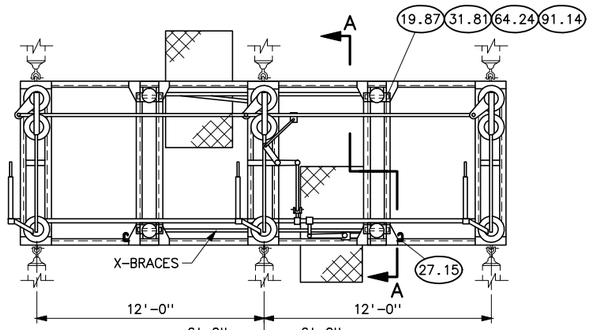
SUPERSEDES DWG NO. 43 2212

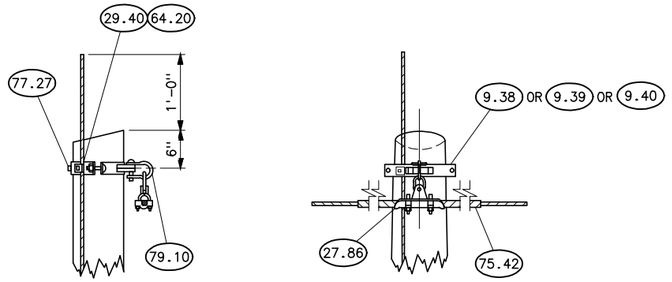
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
ACCESS ROADS
GENERAL REQUIREMENTS

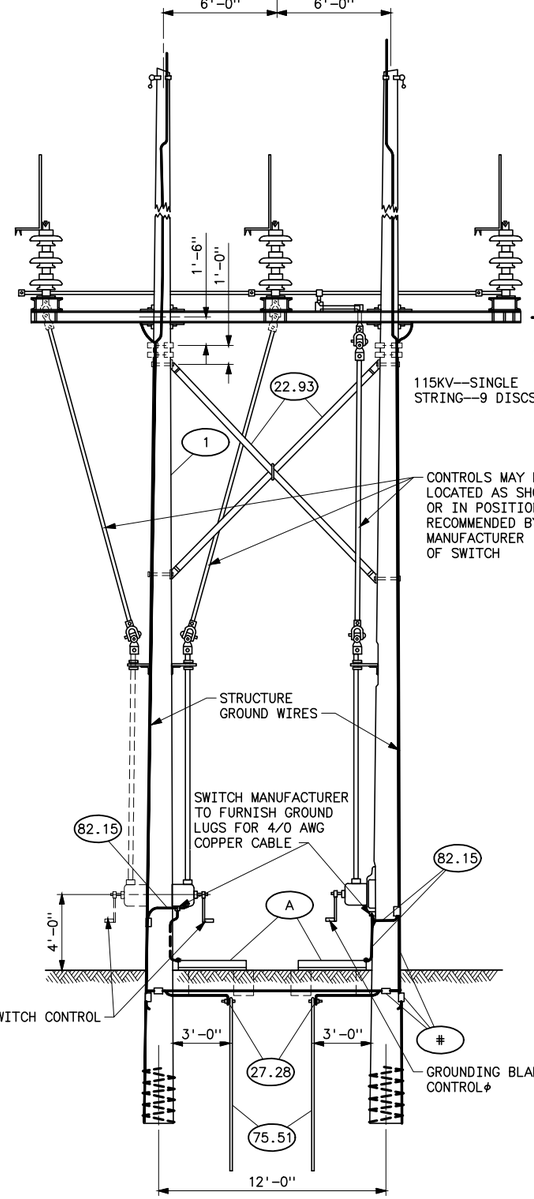
DESIGNED DOUG HANSON APPROVED DOUG HANSON CIVIL ENGINEERING MANAGER

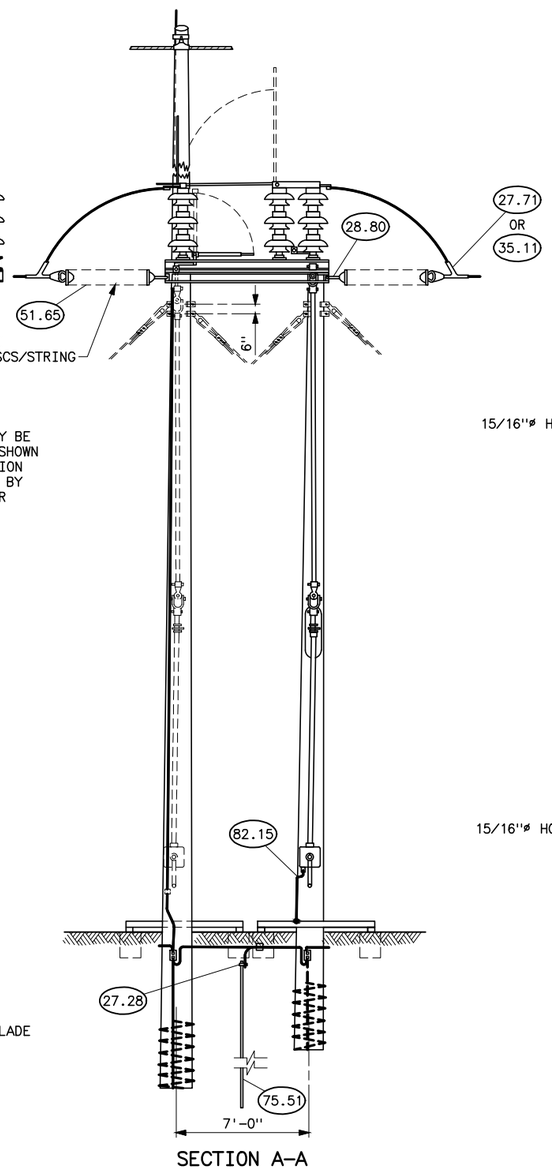
APRIL 28, 2003	41	2035



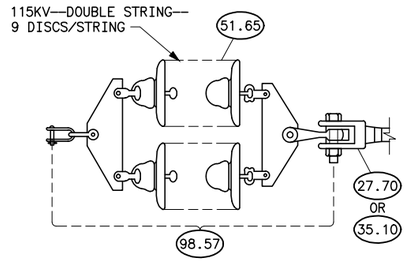


DETAIL OF OVERHEAD GROUND WIRE ATTACHMENT

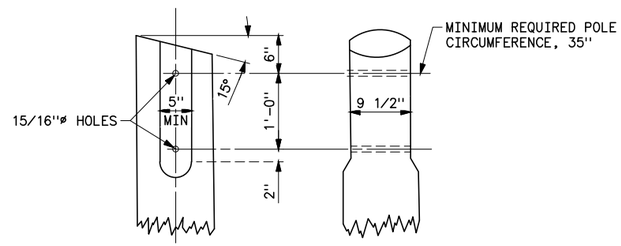




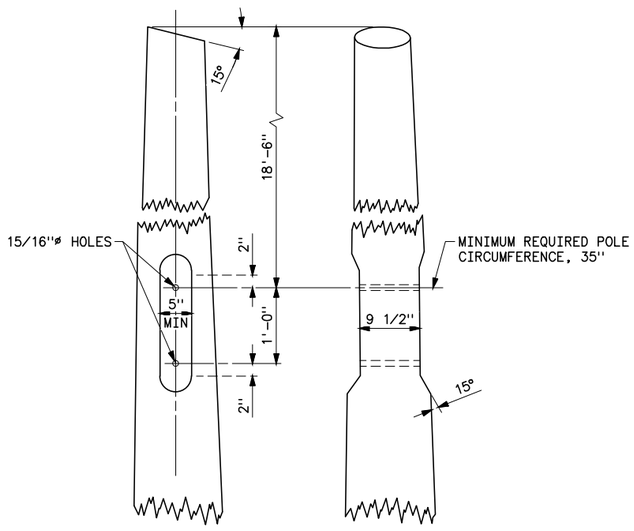
SECTION A-A



DOUBLE INSULATOR STRING ASSEMBLY≠



DETAIL OF SHORT POLE



DETAIL OF LONG POLE

STRUCTURE MATERIAL

PART NO.	QUANTITY 115KV WITH OGW	QUANTITY 115KV W/O OGW	DESCRIPTION	DWG NO. 41
1	4	4	POLE	
19.87	8	8	BOLT, MACHINE 7/8"x14"	
22.93	2	2	X-BRACES, COMPLETE WITH FITTINGS, (3 1/8"x 4 3/8")	6029
27.15	2	2	CLAMP, BELCHER, 15/16" HOLE SPACING, 1/2" J-BOLT	
27.28	2	2	CLAMP, COPPER ALLOY FOR GROUND ROD	
31.81	16	16	CONNECTOR, SHEAR PLATE, 4" DIAMETER FOR 7/8" BOLT (WOOD TO METAL)	
64.24	8	8	LOCKNUT, FOR 7/8" BOLT	
75.51	2	2	GROUND ROD, COPPERWELD 3/4"x10'	
82.15	40 FT.	40 FT.	4/0 AWG 19 STRAND COPPER CABLE	
84.10	1	1	AIR-BREAK SWITCH, COMPLETE WITH MOUNTING BOLTS	
84.15	1	1	BASE, SWITCH	6092
91.14	8	8	LOCK WASHER, SPRING, FOR 7/8" BOLT	
A	2	2	SWITCH OPERATING PLATFORM, DETAIL "A"	31 1075
#	GROUNDING MATERIAL, PART NUMBERS AND DESCRIPTION SHOWN ON 41 1012			

INSULATOR MATERIAL

PART NO.	SINGLE STRING	DOUBLE≠ STRING	DESCRIPTION		DWG NO. 41
27.70 OR 35.10		6	CLAMP, STRAIN WITH CLEVIS FITTING FOR CONDUCTOR		
			DEAD END, COMPRESSION TYPE		
27.71 OR 35.11	6		CLAMP, STRAIN WITH SOCKET FITTING FOR CONDUCTOR		1002
			DEAD END, COMPRESSION TYPE WITH SOCKET FITTING		1002
28.80	6		CLEVIS, Y-BALL		1003
51.65	6	54-DISCS	INSULATOR, ASSEMBLY 5 3/4" SPACING	SINGLE STRING, DEAD END	1002
		108-DISCS		≠ DOUBLE STRING, DEAD END	
98.57		6	DOUBLE YOKE ASSEMBLY, COMPLETE WITH FITTINGS		1004

OVERHEAD GROUND WIRE MATERIAL

PART NO.	QUANTITY	DESCRIPTION	DWG NO. 41
9.38-9.39 OR 9.40	2Δ	BAND, POLE TOP	6035, 6036, 6037
27.86	2Δ	CLAMP, SUSPENSION WITH 2 1/4" LINK FOR OVERHEAD GROUND WIRE	
29.40	2	CLIP, GROUND, WITH 3/8"x1 1/2" CARRIAGE BOLT AND M.F. LOCKNUT	6035, 6036, 6037
64.20	2	LOCKNUT FOR 3/8" BOLT	
75.42	2 SETS	ROD, ARMOR, PREFORMED, FOR 3/8" STEEL STRAND	
77.27	2	LAG SCREW, 1/2"x4", FETTER DRIVE THREAD	
79.10	2	SHACKLE FOR POLE TOP BAND	6036, 6037

REFERENCE DRAWINGS

GROUNDING DETAILS ---------- 41 1012
GUYING DETAILS ---------- 41 6056
STEEL DETAILS ---------- 41 6092

NOTES

1. USE TWO LAG SCREWS AND WASHERS FOR EACH FOUR-WAY STRAIN BAND.
2. Δ ANCHOR TYPE SHACKLE AND 2 1/4" LINK NOT REQUIRED WHEN TYPE B POLE TOP BAND, DWG NO 41 6035 IS USED.
3. ≠ USE ONLY WHEN SPECIFIED.
4. ϕ FOR SWITCH WITH HANDLE OPERATED MECHANISM SEE DETAIL E, DWG. 31 1075 FOR GROUNDING.

B	3-2-11 A7-DDD	REDRAWN AND REVISED TITLE BLOCK TO BE CONSISTENT WITH TRANSMISION LINE STD DWGS.

SUPERSEDES DWG NO. 40-D-5189

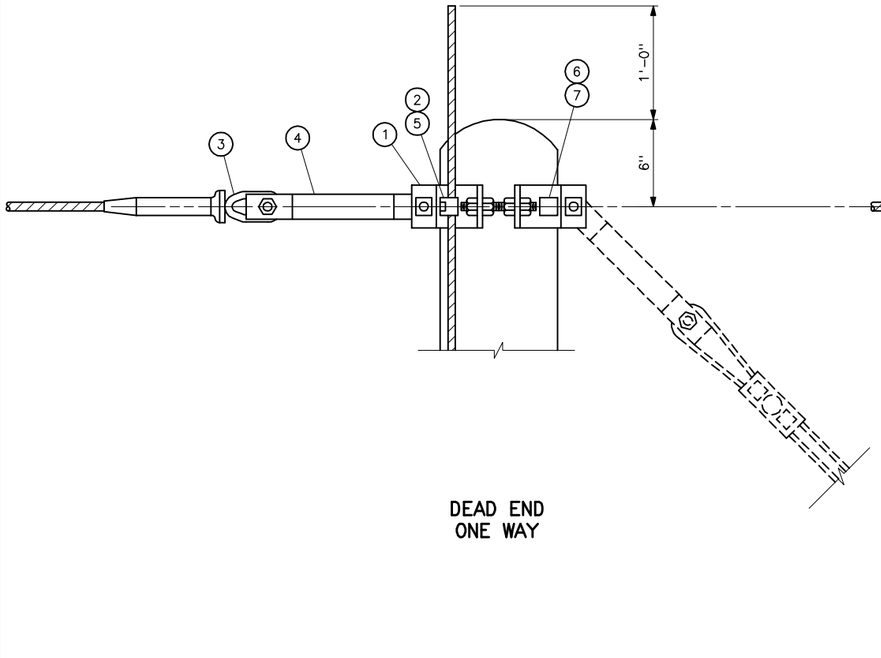
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

STANDARD DESIGNS
TRANSMISSION LINES
TYPE 4SWT 115KV
DISCONNECTING SWITCH STRUCTURE

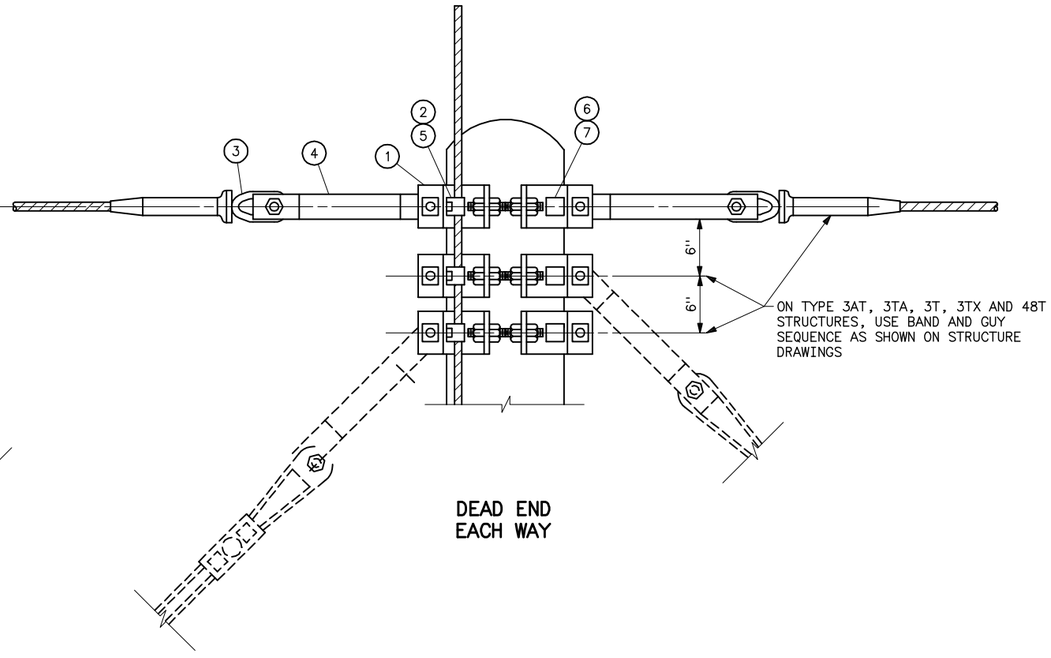
DESIGNED BUREC ---------- APPROVED BUREC ----------

CAD	DATE	41	6005
	SEPTEMBER 29, 1980		

MATERIAL LIST		
ITEM NO.	DESCRIPTION	DWG NO. 41
1	BAND, FOUR-WAY STRAIN	6030
2	CLIP, GROUND, WITH 3/4x2 1/2 CONE HEAD BOLT	6030
3	COMPRESSION DEAD END, EYE-TYPE FOR OGW	
4	LINK, CONNECTING PAIR	6030
5	LOCKNUT FOR 3/4 BOLT	
6	LAG SCREW, 1/2x4, FETTER DRIVE THREAD	
7	WASHER, ROUND FLAT, 1 3/8 OD, 9/16 HOLE	



DEAD END
ONE WAY



DEAD END
EACH WAY

TYPICAL OGW ATTACHMENT USING EYE-TYPE COMPRESSION
DEAD ENDS

REFERENCE DRAWINGS

115KV
TYPE 3DE ____ 41 6004
TYPE HS ____ 41 6010
TYPE HSB ____ 41 6011
TYPE 3TA ____ 41 6018
TYPE 3AT ____ 41 6074
TYPE 3T ____ 41 6075
TYPE 3TX ____ 41 6093
TYPE 4BT ____ 41
TYPE 4S ____ 41 6105
138 & 161KV
TYPE 3DE ____
TYPE HS ____ 41 6006
TYPE HSB ____ 41 6007
TYPE 3TA ____ 41 6018
TYPE 3AT ____ 41
TYPE 3T ____ 41 6017
TYPE 3TX ____
TYPE 4BT ____
TYPE 4S ____

D	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
C	3-20-92 A2-BH	REDRAWN

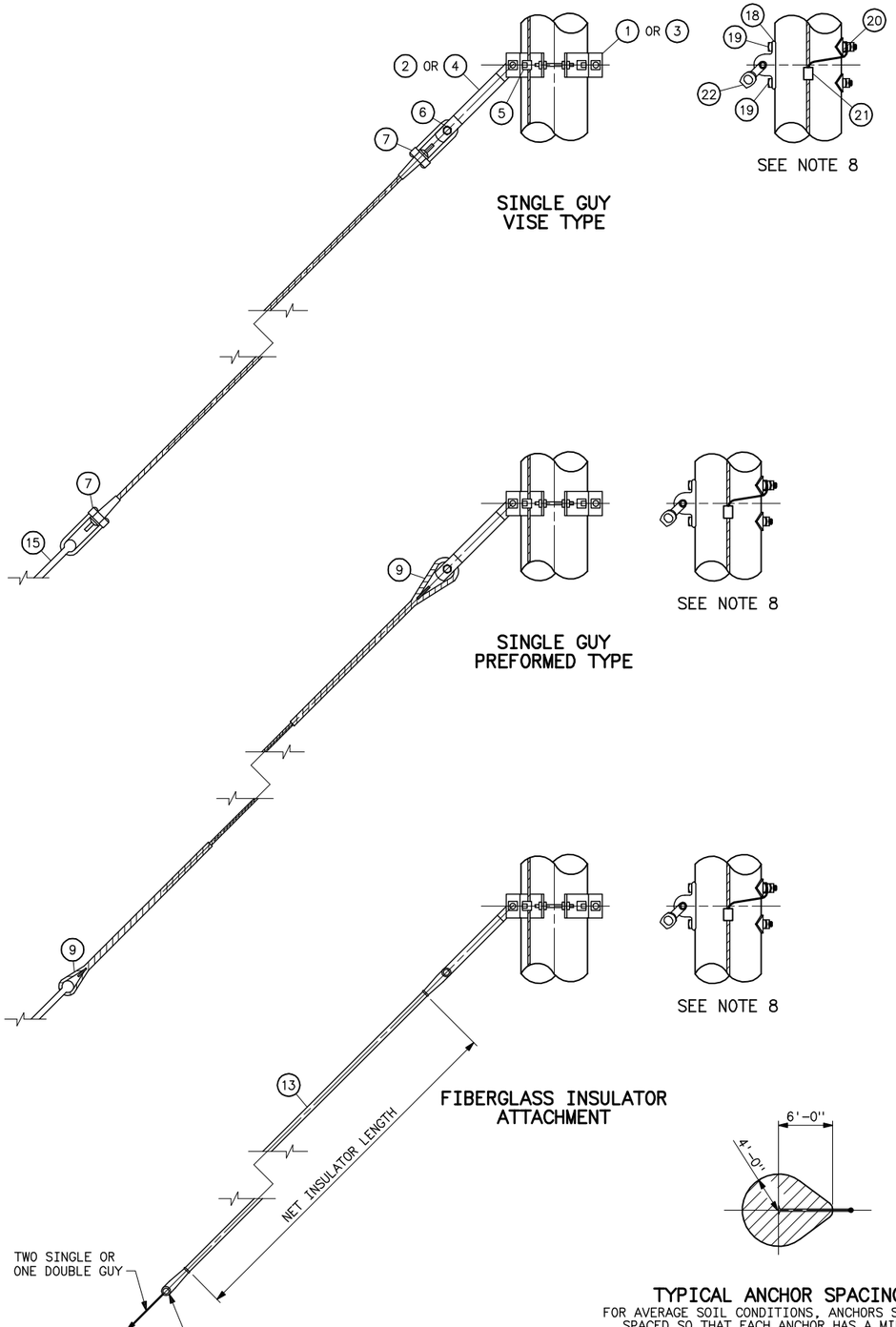
SUPERSEDES DWG NO. 40-D-5764

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
WOOD-POLE DEAD END DETAILS
FOR OVERHEAD GROUND WIRE

DESIGNED BUREC _____ APPROVED DOUG HANSON _____
CIVIL ENGINEERING MANAGER

A_F	AUGUST 6, 1979	41	6042

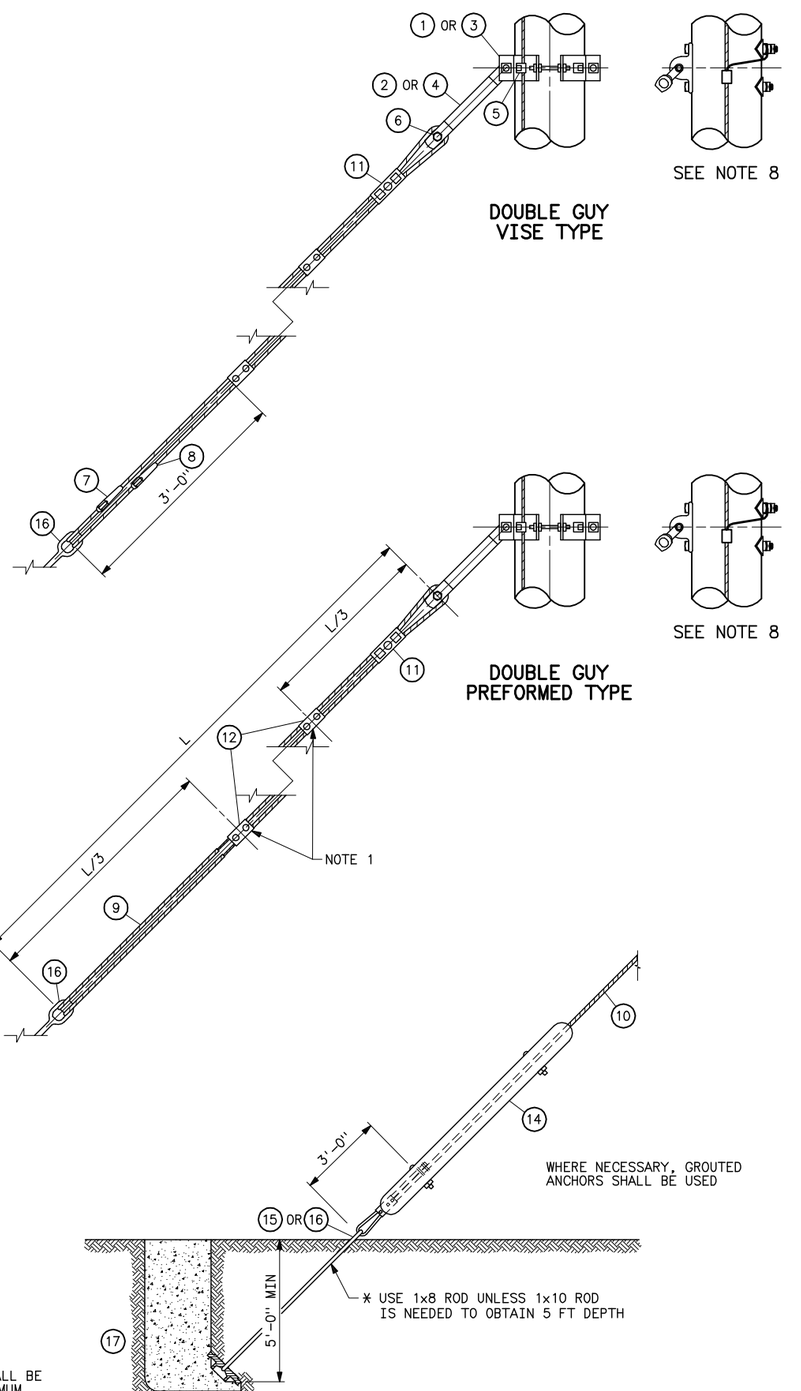


SINGLE GUY
VISE TYPE

SINGLE GUY
PREFORMED TYPE

FIBERGLASS INSULATOR
ATTACHMENT

ON TYPE 3A AND 3AB STRUCTURES WITH SINGLE GUYS EACH SIDE OF POLE, THE GUY STRAIN INSULATOR SHALL BE PROVIDED WITH TWO SHEAVE WHEELS



DOUBLE GUY
VISE TYPE

DOUBLE GUY
PREFORMED TYPE

TYPICAL ANCHOR SPACING

FOR AVERAGE SOIL CONDITIONS, ANCHORS SHALL BE SPACED SO THAT EACH ANCHOR HAS A MINIMUM AREA OF ACTION AS SHOWN BY THE SHADED AREA ABOVE. THESE AREAS SHOULD NOT OVERLAP.

TYPICAL GUY AND ANCHOR ASSEMBLY
WITH CONCRETE ANCHOR

ALL GUYS SHALL FORM A 45° VERTICAL ANGLE WITH THE POLE, INSOFAR AS POSSIBLE

REFERENCE MATERIALS

ITEM NO.	DESCRIPTION
1	FOUR-WAY STRAIN BAND EQUAL TO HUGHES BROS. NO. 3105 WITH TWO 1/2"ø×4" LAG SCREWS AND WASHERS PER BAND
2	LINK, CONNECTING PAIR EQUAL TO HUGHES BROS. 3154
3	FOUR-WAY STRAIN BAND EQUAL TO HUGHES BROS. NO. 3112
4	LINK, CONNECTING PAIR, EQUAL TO HUGHES BROS. 3157
5	1/2"ø GROUNDING CLIP ASSEMBLY (INCLUDES BONDING CLIP, CARRIAGE BOLT, NUT AND LOCKNUT) HUGHES 2718.55 OR EQUAL
6	SHEAVE WHEEL SUITABLE FOR 7/16"ø STRAND
7	DEADEND, AUTOMATIC VISE TYPE FOR GUY STRAND, WITH SHORT BAIL
8	DEADEND, AUTOMATIC VISE TYPE FOR GUY STRAND, WITH EXTRA LONG BAIL
9	DEADEND, PREFORMED TYPE FOR GUY STRAND
10	STRAND, GALVANIZED, 7/16" HIGH STRENGTH STEEL
11	CLAMP, GUY, 3 BOLT, 6" LONG
12	2-BOLT GUY CLAMP
13	INSULATOR, FIBERGLASS GUY STRAIN WITH BNK AND SHEAVE WHEEL. MINIMUM ULTIMATE STRENGTH OF 29,000 LBS. (SEE TABLE)
14	GUY PROTECTOR
15*	ANCHOR ROD, 1"×8'-0", THIMBLEYE
16*	ANCHOR ROD, 1"×8'-0", TWINEYE
17	CONCRETE ANCHOR (DWG NO. 41 6049)
18	DEAD-END TEE EQUAL TO HUGHES BROS. NO. 2817R4.5-15-15C
19	7/8"ø SQUARE HEAD BOLT WITH CURVED WASHER, SQUARE NUT, AND LOCKNUT
20	BOND CLIP EQUAL TO HUGHES BROS. NO. 2727.8
21	PARALLEL GROOVE CLAMP, 2-BOLT COPPER ALLOY
22	DUCTILE DEADEND THIMBLE, EQUAL TO ANDERSON TYPE DDT-07 WITH BNK, 40,000 LBS ULT. STRENGTH

SEE NOTE 8

NOTES

1. INSTALL TWO BOLT CLAMPS ON EACH DOUBLE GUY TO PREVENT THE TWO STRANDS FROM SLAPPING TOGETHER UNDER WIND CONDITIONS.
2. CLAMPS ARE TO BE INSTALLED AFTER DOUBLE GUY HAS BEEN TIGHTENED.
3. FOR LOCATION OF BANDS, SEE INDIVIDUAL STRUCTURE DRAWINGS.
4. ADDITIONAL DETAILS ARE SHOWN ON STANDARD GUY ARRANGEMENT AND ASSEMBLY DRAWINGS.
5. FOR GUY EACH SIDE OF POLE ON TYPE 3A AND 3AB STRUCTURES, SEE DWG NO. 41 6053. FOR TWO SINGLE GUYS, INSULATOR SHALL BE PROVIDED WITH TWO SHEAVE WHEELS.
6. * TO BE USED WHEN SPECIFIED.
7. BNK INDICATES BOLT, NUT, AND STAINLESS STEEL COTTER KEY REQUIRED.
8. DEAD-END TEES MAY BE USED IN LIEU OF POLE BANDS AS SHOWN. DUCTILE DEADEND THIMBLE REPLACES CONNECTING LINKS AND SHEAVE WHEELS THAT ARE USED WITH POLE BAND CONSTRUCTION.

FIBERGLASS INSULATOR DATA

KV	MINIMUM NET LENGTH OF FIBERGLASS	NO ARCING HORNS
138	6'-3"	
161	7'-0"	
230	8'-6"	

F	01-06-05 A7-KKR	ADDED DEAD-END TEE OPTION.
E	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
D	11-30-96 A3-TEC	REVISED AND REDRAWN ON CAE SYSTEM.

SUPERSEDES DWG NO. 40-D-5674

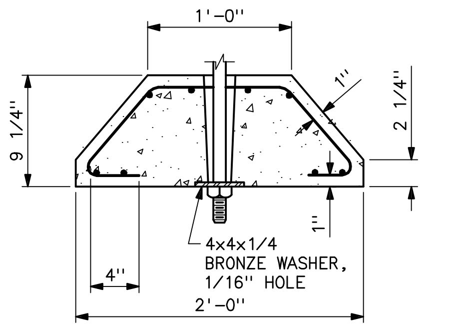
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS

GUY ASSEMBLY AND DETAILS

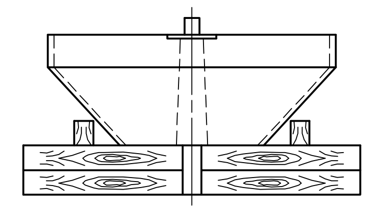
DESIGNED KAREN ROWE APPROVED DOUG HANSON
CIVIL ENGINEERING MANAGER

CAD	AUGUST 6, 1979	41	6047



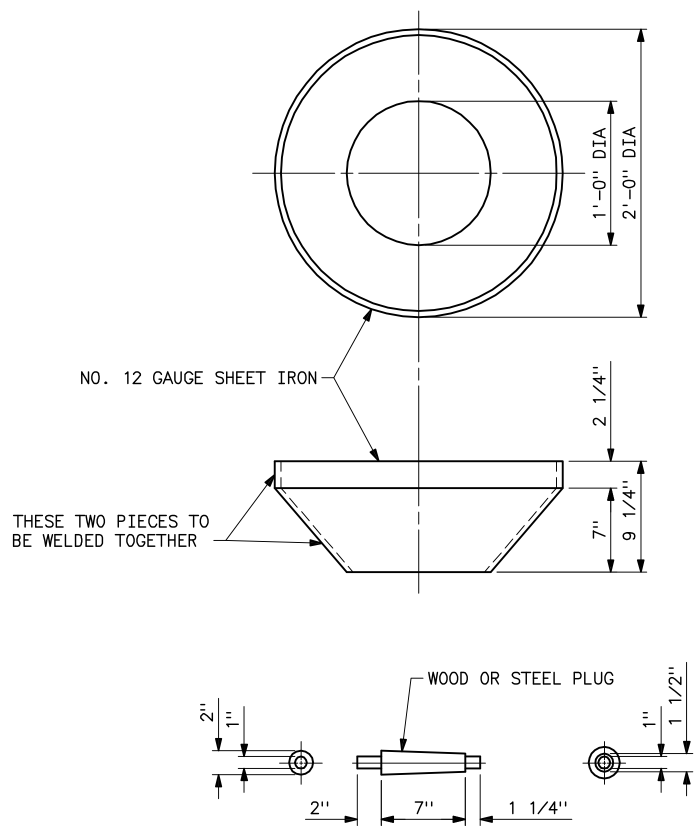
CONCRETE ANCHOR

REINFORCE WITH 12 PIECES OF WIRE TIED TOGETHER WITH WIRE HOOPS AS SHOWN 0.1483 DIA COLD DRAWN STEEL WIRE ASTM SPEC A82

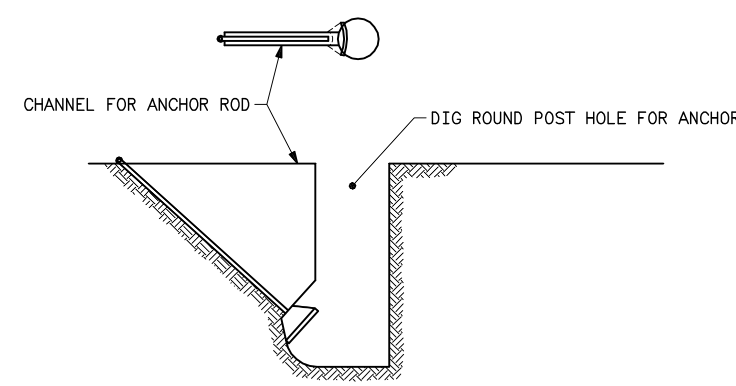


SET UP FOR POURING CONCRETE ANCHOR

CONCRETE SHALL BE 1-2-4 MIX USING "PEA" GRAVEL



DETAILS OF FORM FOR CONCRETE ANCHOR



DETAILS OF INSTALLATION OF CONCRETE ANCHOR

EARTH TO BE WELL TAMPED WHEN BACKFILLED

D	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
C	7-13-99 A3-RMC	REDRAWN.

SUPERSEDES DWG NO. 40-D-3585

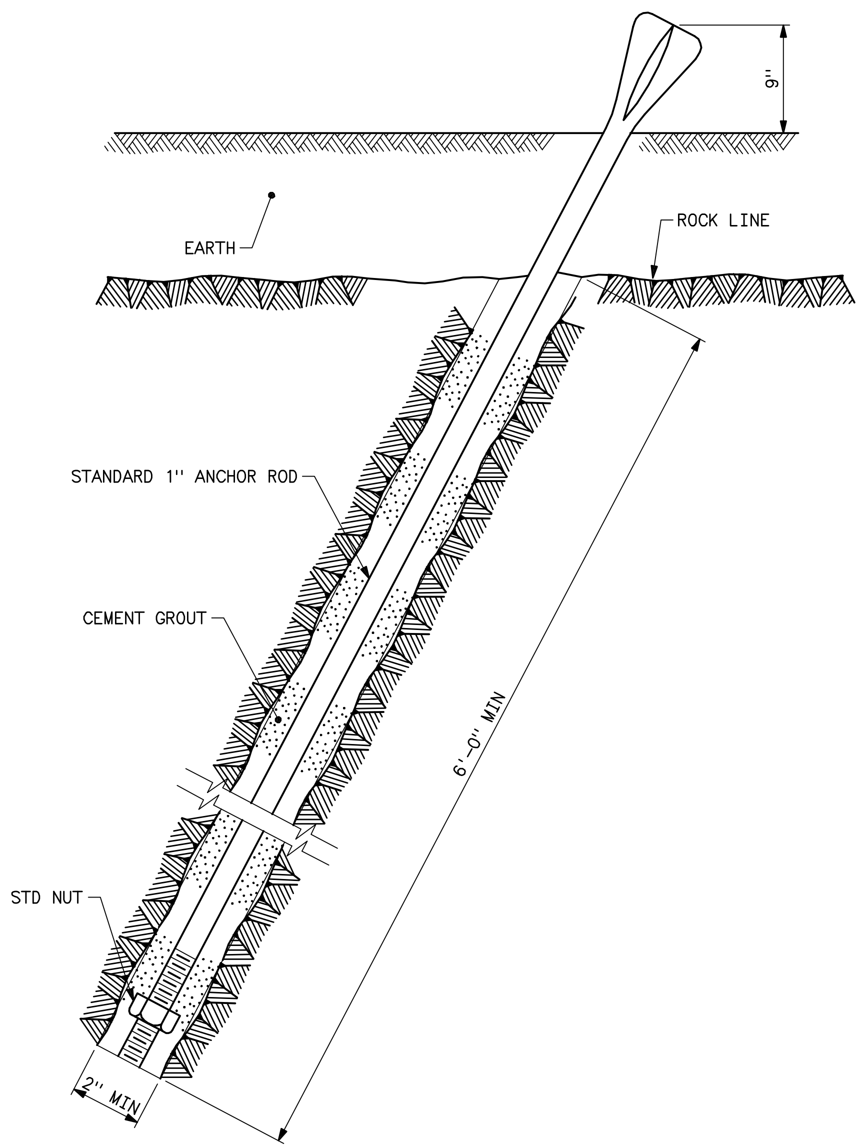
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS

CONCRETE ANCHORS

DESIGNED BUREC   APPROVED ROSS M. CLARK, ELECTRICAL ENGINEERING MANAGER

CAE	AUGUST 6, 1979	41	6049



D	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
C	7-13-99 A3-RMC	REDRAWN.

SUPERSEDES DWG NO. 40-D-3610

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

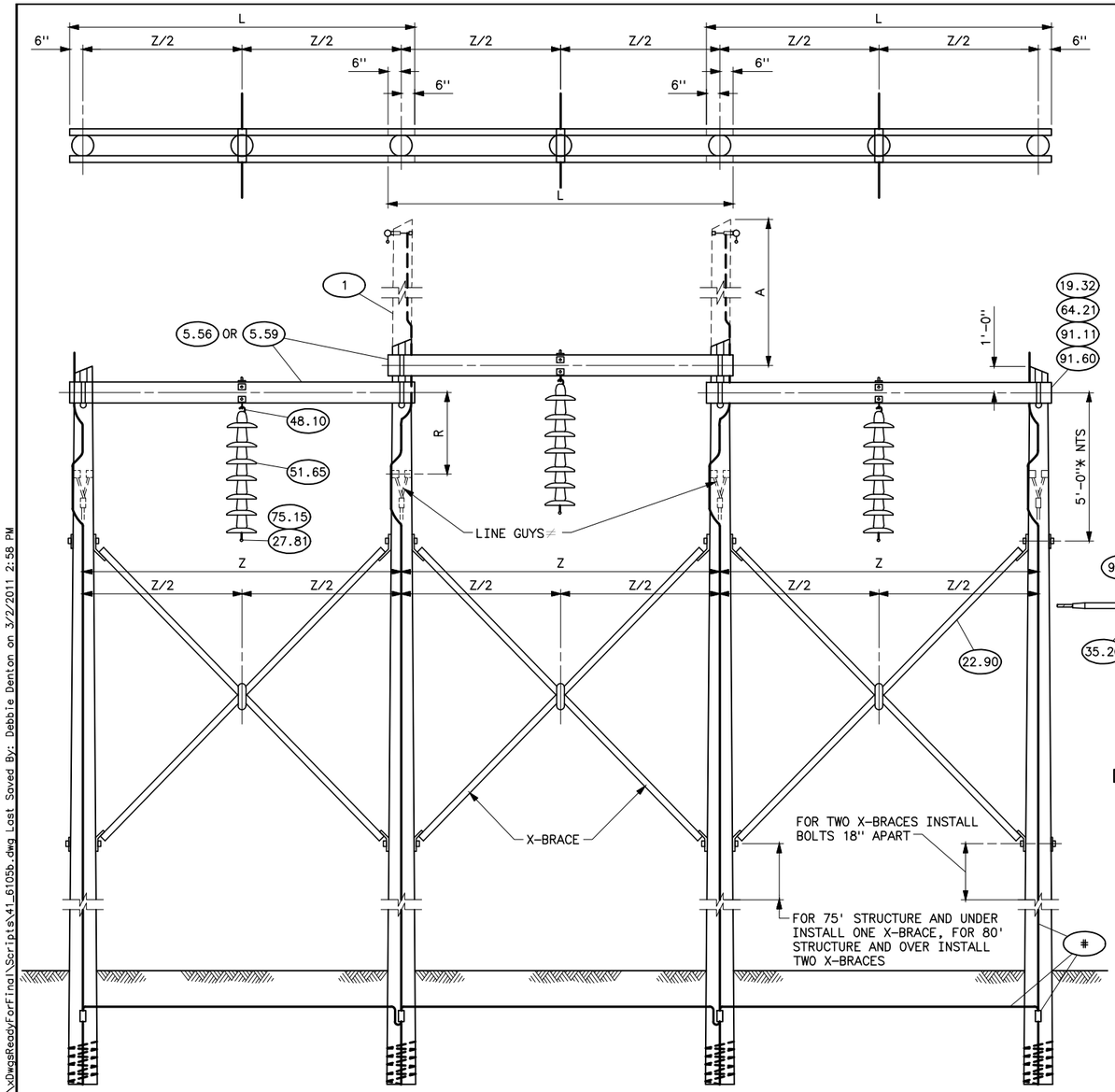
TRANSMISSION LINE STANDARDS

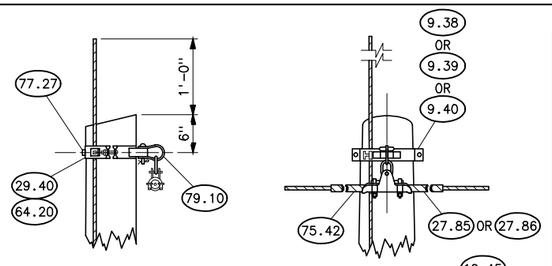
ANCHOR ROD GROUTING DETAILS

DESIGNED BUREC APPROVED ROSS M. CLARK ELECTRICAL ENGINEERING MANAGER

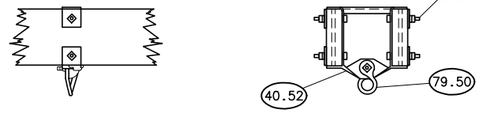
AUGUST 6, 1978 | 41 | 6050

Plotted By: entwistle Nov 04, 2010- 3:30pm

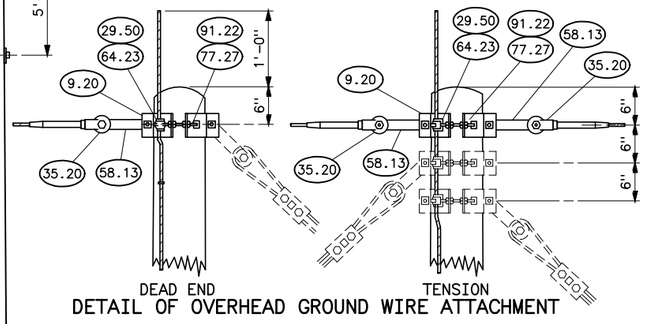




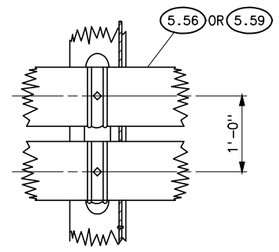
SUSPENSION

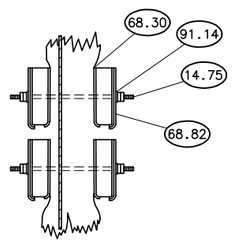


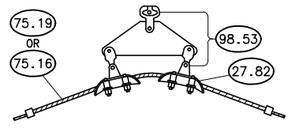
DETAIL OF PHASE FITTING ASSEMBLY



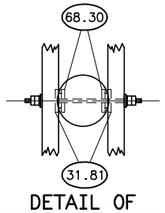
DETAIL OF OVERHEAD GROUND WIRE ATTACHMENT



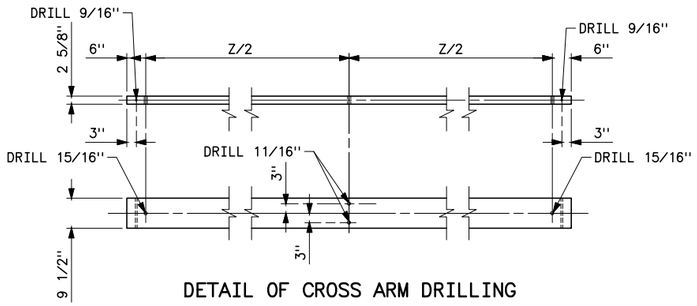




SINGLE STRING WITH YOKE≠



DETAIL OF CROSSARM ATTACHMENT



DETAIL OF CROSS ARM DRILLING

STRUCTURE MATERIAL

PART NO.	QUANTITY WITH OVERHEAD GROUND WIRES 69KV	WITH OVERHEAD GROUND WIRES 115KV	W/OUT OVERHEAD GROUND WIRES 69KV	W/OUT OVERHEAD GROUND WIRES 115KV	DESCRIPTION	DWG NO. 41
1	4	4	4	4	POLE	
5.56	6	6	6	6	CROSSARM, WOOD, 2 5/8''x9 1/2''x13'-0'' (TYPE 4S)	
5.59	6	6	6	6	CROSSARM, WOOD, 2 5/8''x9 1/2''x16'-0'' (TYPE 4S-1)	
14.75	6	6	6	6	BOLT, DOUBLE ARMING, 7/8''x20'' WITH 4 NUTS	
19.32	12	12	12	12	BOLT, MACHINE, 1/2''x12''	
19.45	12	12	12	12	BOLT, MACHINE 5/8''x5''	
31.81	24	24	24	24	CONNECTOR, 4'' SHEAR PLATE, FOR 7/8'' BOLT	
40.52	3	3	3	3	FITTING, PHASE	6038
64.21	12	12	12	12	LOCKNUT, 1/2'' BOLT	
64.22	12	12	12	12	LOCKNUT, 5/8'' BOLT	
68.30	12	12	12	12	PLATE, FLAT GAIN	6038
68.82	12	12	12	12	PLATE, RIBBED TIE	6038
22.90	3 OR 6	3 OR 6	3 OR 6	3 OR 6	X-BRACE, 2-PIECE 4S -- 3 3/8''x4 3/8'' / 4S-1 -- 3 3/8''x5 3/8''	6029
79.50	3	3	3	3	SHACKLE, TWISTED	6038
91.11	12	12	12	12	LOCKWASHER, SPRING, 1/2'' BOLT	
91.12	12	12	12	12	LOCKWASHER, SPRING, 5/8'' BOLT	
91.14	12	12	12	12	LOCKWASHER, SPRING, 7/8'' BOLT	
91.60	24	24	24	24	WASHER, SQUARE FLAT, 2''x2''x1/8'', 9/16'' HOLE	
91.62	12	12	12	12	WASHER, SQUARE FLAT, 2 1/4''x2 1/4''x3/16'', 11/16'' HOLE	
#	GROUNDING MATERIAL, PART NUMBERS AND DESCRIPTION SHOWN ON 41 1012					

INSULATOR MATERIAL

PART NO.	SINGLE STRING 69KV	SINGLE STRING 115KV	SINGLE STRING WITH YOLK≠ 69KV	SINGLE STRING WITH YOLK≠ 115KV	DESCRIPTION	DWG NO. 41
48.10	3	3	3	3	HOOK, SUSPENSION	1003
51.65	12	21	12	21	INSULATOR, SUSPENSION TYPE, 5 3/4'' SPACING	1000
75.15 OR 75.18	3	3	–	–	ROD, ARMOR, TAPERED, SINGLE SUPPORT (FOR ACSR ONLY)	1000
					ROD, ARMOR, PREFORMED, SINGLE SUPPORT (FOR ACSR ONLY)	1000
27.81	3	3	–	–	CLAMP, SUSPENSION WITH SOCKET FITTING (FOR CONDUCTOR)	1000
27.82	–	–	6	6	CLAMP, SUSPENSION WITHOUT CONNECTOR	
75.16 OR 75.19	–	–	3	3	ROD, ARMOR, TAPERED, DOUBLE SUPPORT (FOR ACSR ONLY)	
					ROD, ARMOR, PREFORMED, DOUBLE SUPPORT (FOR ACSR ONLY)	
98.53	–	–	3	3	YOKE, COMPLETE WITH FITTINGS	

OVERHEAD GROUND WIRE MATERIAL

PART NO.	SUSPENSION	DEAD END	TENSION	DESCRIPTION	DWG NO. 41
29.50	–	2	2	CLIP, GROUND WITH 3/4''x2 1/2'' CONE HEAD BOLT	6030
35.20	–	2	4	DEAD END, COMPRESSION TYPE, FOR OGW	
58.13	–	2	4	LINK, CONNECTING, PR.	6030
64.20	2	–	–	LOCKNUT, 3/8'' BOLT	
64.23	–	2	2	LOCKNUT, 3/4'' BOLT	
75.42	2 SETS	–	–	ROD, ARMOR, PREFORMED	
77.27	2	4	4	LAGSCREW, 1/2''x4'', FETTER DRIVE THREAD	
79.10	2Δ	–	–	SHACKLE, ANCHOR TYPE	
91.22	–	4	4	WASHER, ROUND FLAT, 1 3/8'' OD, 9/16'' HOLE	
9.20	–	2	2	BAND, FOUR-WAY STRAIN	6030
9.38, 9.39 OR 9.40	2	–	–	BAND, POLE TOP	6034, 6035, 6036, 6037
27.85 OR 27.86	2Δ	–	–	CLAMP, SUSPENSION, WITH 2 1/4'' LINK	
29.40	2	–	–	CLIP, GROUND WITH 3/8''x1 1/2'' CARRIAGE BOLT	6034

TYPE	VOLTAGE	A WITH OGW 30° PROTECTIVE ANGLE	A WITH OGW 39° PROTECTIVE ANGLE	A WITHOUT OGW	L	Z	Z/2	R
4S	69KV & 115KV	9'-0''	4'-6''	1'-0''	13'-0''	12'-0''	6'-0''	2'-0''
4S-1		9'-0''	4'-6''	1'-0''	16'-0''	15'-0''	7'-6''	3'-0''

NOTES

1. USE TWO LAG SCREWS AND WASHERS FOR EACH FOUR-WAY STRAIN BAND.
2. Δ ANCHOR TYPE SHACKLE AND 2 1/4'' LINK NOT REQUIRED WHEN TYPE B POLE TOP BAND, DWG NO. 41 6035 IS USED. FOR VERTICAL ANGLES GREATER THAN 20°, USE LARGE ANGLE, SUSPENSION CLAMP PART NO. 27.85.
3. * WHEN AN ADDITIONAL DISC IS USED ON ANGLE STRUCTURES, AT RAILROAD OR MAIN HIGHWAY CROSSINGS, THIS DIMENSION SHALL BE INCREASED ONE FOOT.
4. ϕ GREATER LENGTH MAY BE REQUIRED FOR EXTRA LARGE POLES.
5. ≠ USE ONLY WHEN SPECIFIED.

REFERENCE DRAWINGS

DRILLING AND GAINING DETAILS WITH OGW
30° PROTECTIVE ANGLE _____ 41 6021
GUY ARRANGEMENT-ASSEMBLY-H-FRAME ___ 41 6051 & 41 6052
DRILLING AND GAINING DETAILS (WITHOUT OGW) ___ 41 6066
DRILLING AND GAINING DETAILS WITH OGW
39° PROTECTIVE ANGLE _____ 41 6068

B	3-2-11 A7-DDD	REDRAWN.

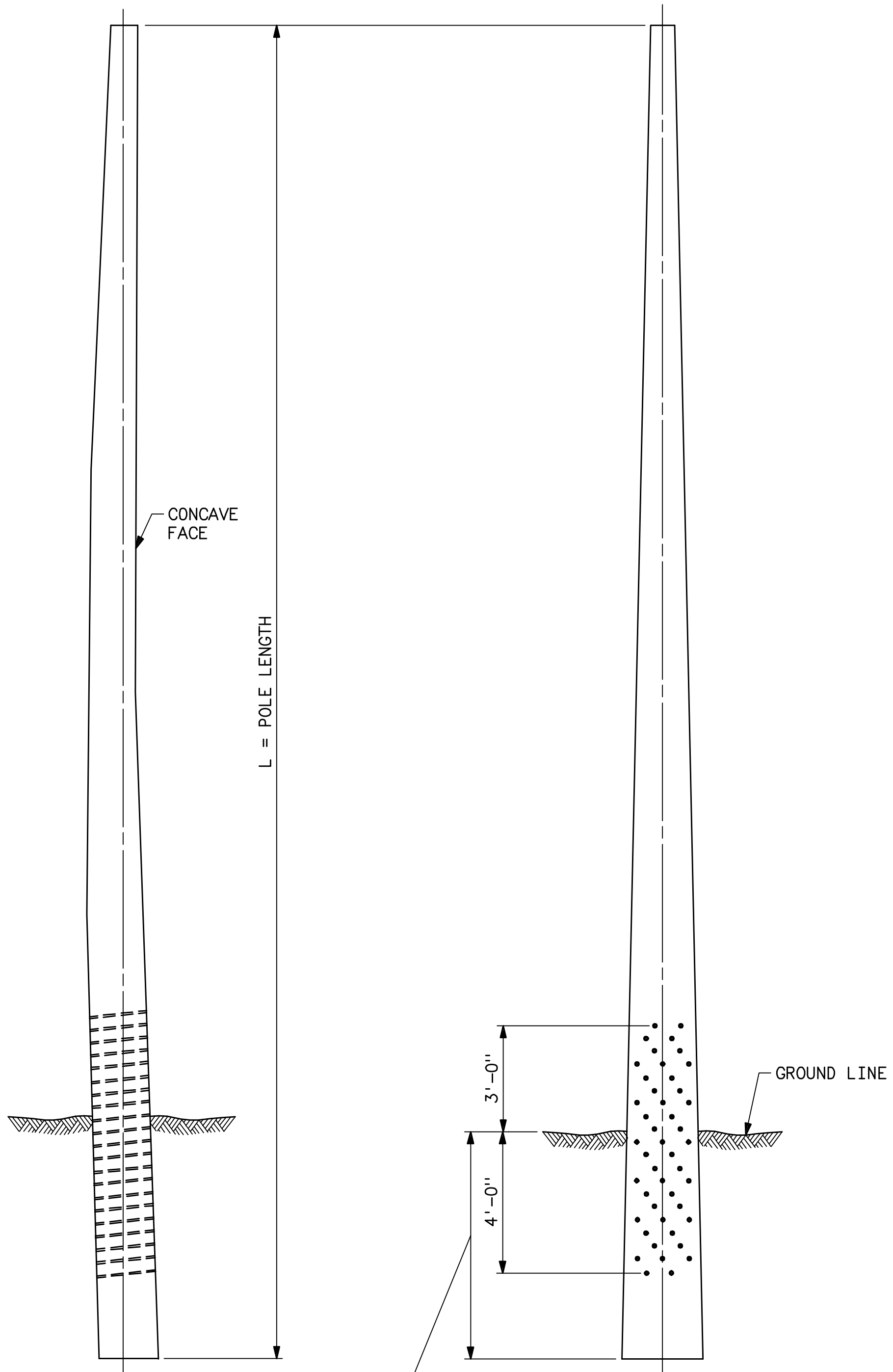
SUPERSEDES DWG NO. 40-D-5425

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

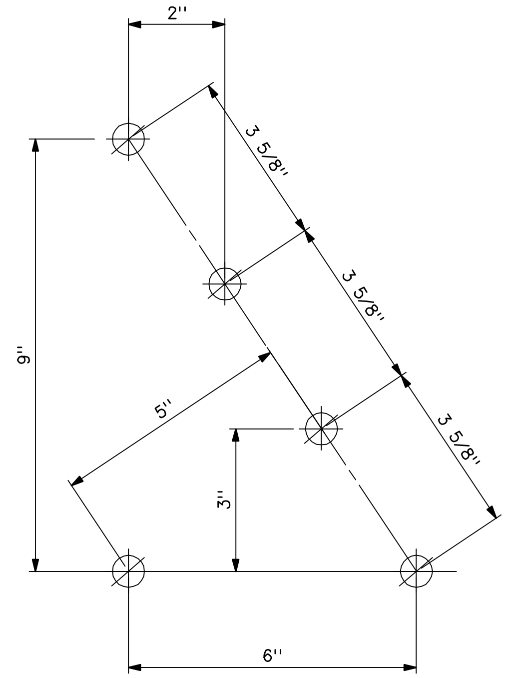
STANDARD DESIGNS
TRANSMISSION LINES
TYPE 4S AND 4S-1, 69 AND 115KV
SUSPENSION STRUCTURE

DESIGNED BUREC _____ APPROVED BUREC _____

CAF	MAY 4, 1988	41	6105

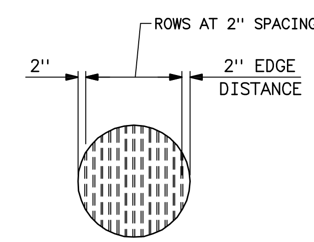


DEPTH OF SET	
POLE LENGTH (FT)	SET
40 TO 90 INCL	10% OF L PLUS 2 FT
90 TO 100	11 FT
105 TO 125 INCL	12 FT

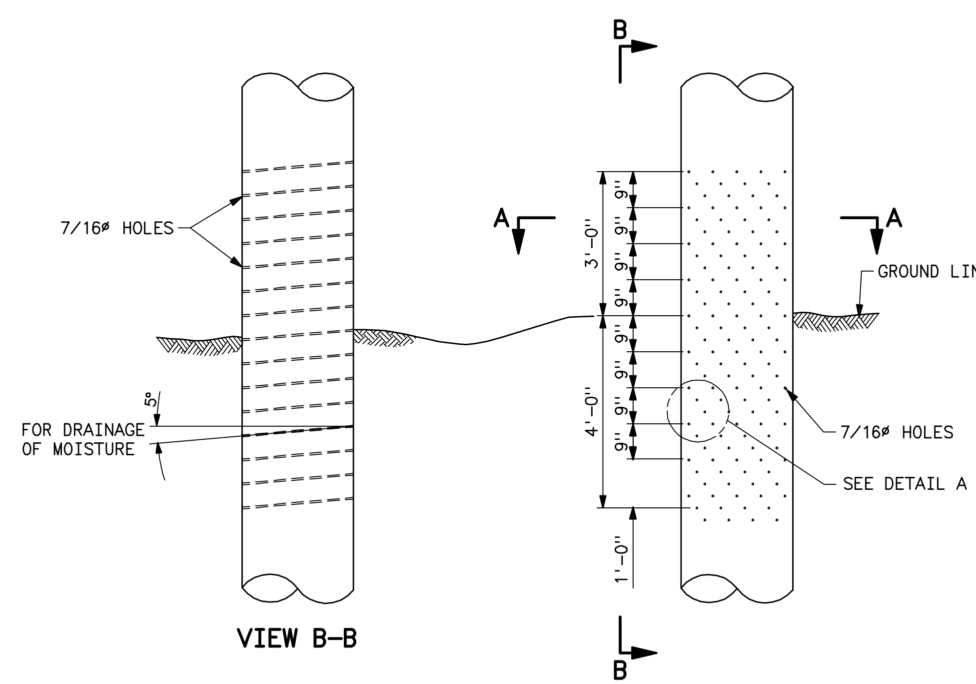


DETAIL A

PATTERN FOR HOLE DRILLING TEMPLATE



SECTION A-A



GROUND LINE HOLE DRILLING

NOTES

1. ALL HOLES TO BE MADE BEFORE TREATMENT
2. ALL HOLES SHALL BE COMPLETELY DRILLED THROUGH THE POLE FROM ONE DIRECTION
3. HOLES SHALL RUN PARALLEL TO CONDUCTOR

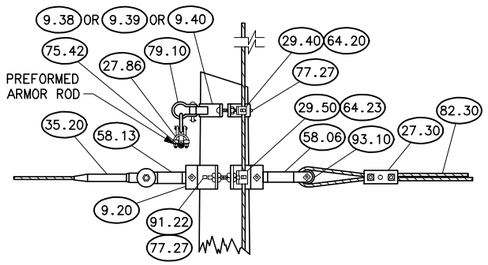
B	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
A	3-27-95 A2-RMC	CHANGED DRILLED ZONE

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

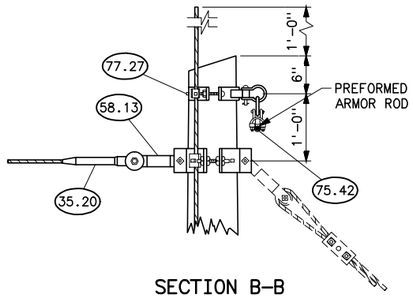
TRANSMISSION LINE STANDARDS
DOUGLAS FIR POLES
DRILLING DETAILS

DESIGNED K. ROWE APPROVED R.M. McCAFFERTY
DIRECTOR, DIVISION OF TRANSMISSION LINE AND BUILDING DESIGN

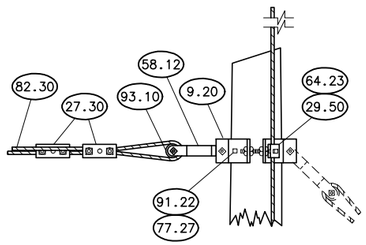
JUNE 10, 1988 | 41 | 6106



SECTION A–A

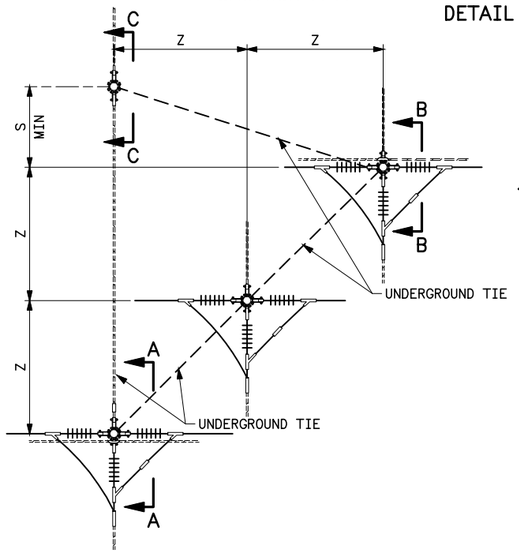


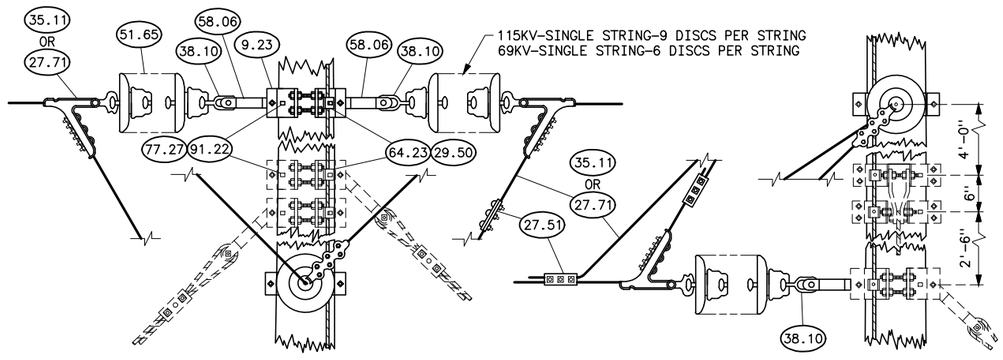
SECTION B–B



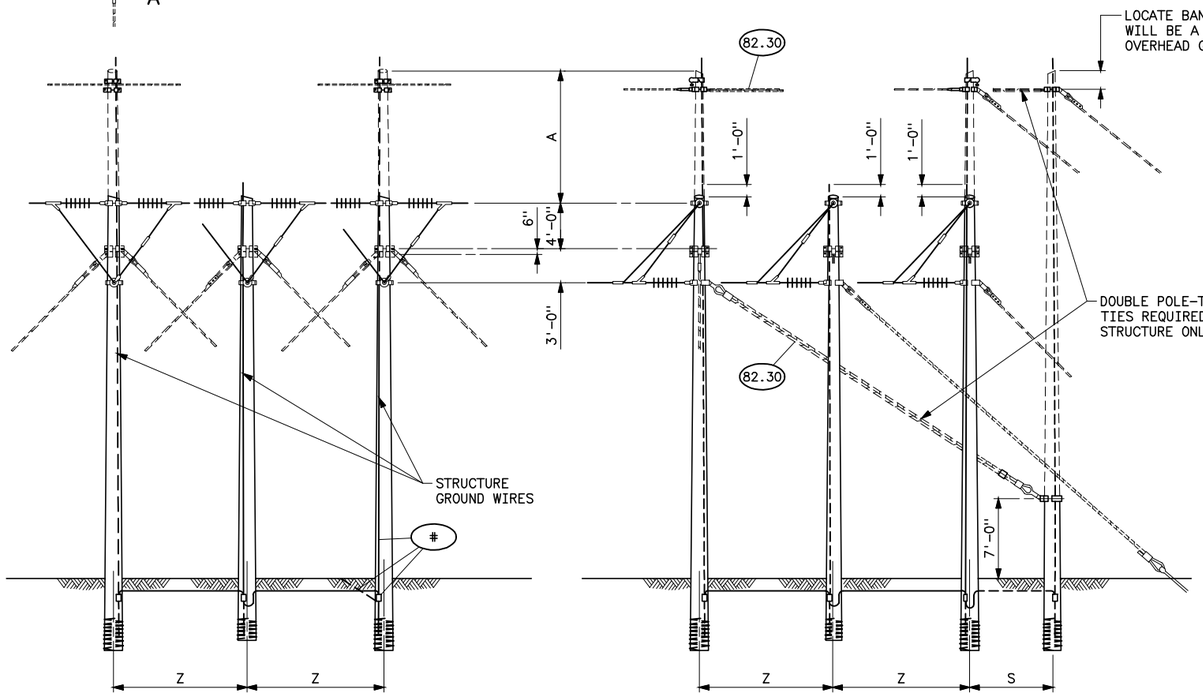
SECTION C–C

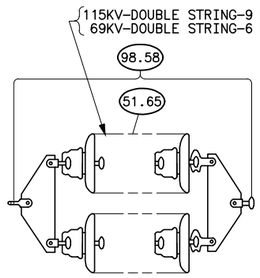
DETAIL OF OVERHEAD GROUND WIRE AND POLE TIE ATTACHMENT





DETAIL OF CONDUCTOR DEAD END AND TENSION ASSEMBLY AND POLE ATTACHMENT





DETAIL OF DOUBLE INSULATOR STRING ASSEMBLY ≠

VOLTAGE	A			S	Z
	WITH OGW		WITHOUT OGW		
	30° PROTECTIVE ANGLE	39° PROTECTIVE ANGLE			
69KV	10'–0"	5'–6"	1'–0"	8'–0" MIN	12'–0"
115KV	10'–0"	5'–6"	1'–0"	8'–0" MIN	12'–0"

STRUCTURE MATERIAL

PART NO.	QUANTITY				DESCRIPTION	DWG NO. 41
	4BT WITH OGW		3BT WITHOUT OGW			
	69KV	115KV	69KV	115KV		
1	4	4	3	3	POLE	
9.23	6	6	6	6	BAND, FOUR–WAY STRAIN, TYPE B	6031
29.50	6	6	6	6	CLIP, GROUND WITH 3/4"x2 1/2" CONEHEAD BOLT	6030
58.06	9	9	9	9	LINK, CONNECTING PAIR	6031
64.23	6	6	6	6	LOCKNUT, FOR 3/4" BOLT	
77.27	12	12	12	12	LAG SCREW, 1/2"x4", FETTER DRIVE THREAD	
91.22	12	12	12	12	WASHER, ROUND FLAT, 1 3/8" OD, 9/16" HOLE	
#	GROUNDING MATERIAL, PART NUMBERS AND DESCRIPTION SHOWN ON 41 1012					

INSULATOR MATERIAL

PART NO.	SINGLE STRING		DOUBLE STRING ≠		DESCRIPTION	DWG NO. 41
	69KV	115KV	69KV	115KV		
27.51	6	6	6	6	CLAMP, PARALLEL GROOVE, 3–BOLT, FOR CONDUCTOR	
27.71 OR 35.11	9	9	9	9	CLAMP, STRAIN SOCKET FITTING, FOR CONDUCTOR	1002
					DEAD END, COMPRESSION TYPE WITH SOCKET FITTING, FOR CONDUCTOR	1002
38.10	9	9	–	–	CONNECTOR, BALL EYE	
51.65	54	81	108	162	INSULATORS, SUSPENSION TYPE, 10" DIAMETER, 5 3/4" SPACING	1002
98.58	–	–	18	18	DOUBLE YOKE ASSEMBLY, COMPLETE WITH FITTINGS	1004

OVERHEAD GROUND WIRE MATERIAL

PART NO.	QUANTITY	DESCRIPTION	DWG NO. 41
9.20	4	BAND, FOUR–WAY STRAIN	6030
9.38, 9.39, 9.40	2	BAND, POLE TOP	6034, 6035, 6036, 6037
27.30	6	CLAMP, GUY, 3–BOLT, 6" LONG	
27.86	2	CLAMP, SUSPENSION, WITH 2 1/4" LINK	
29.40	2	CLIP, GROUND, WITH 3/8"x1 1/2" CARRIAGE BOLT	6034, 6035, 6036, 6037
29.50	4	CLIP, GROUND, WITH 3/4"x2 1/2" CONEHEAD BOLT	6030
35.20	2	DEAD END, COMPRESSION TYPE	
58.11	2	LINK, CONNECTING, PAIR	6030
58.12	2	LINK, CONNECTING, PAIR	
58.13	2	LINK, CONNECTING, PAIR	
64.20	2	LOCKNUT, FOR 3/8" BOLT	
64.23	4	LOCKNUT, FOR 3/4" BOLT	
77.27	8	LAG SCREW, 1/2"x4", FETTER DRIVE THREAD	
79.10	2Δ	SHACKLE, ANCHOR TYPE	6034, 6036, OR 6037
82.30	170 FT	STEEL STRAND, 7–WIRE, 7/16" SIEMENS–MARTIN (POLE–TO–POLE TIES)	
91.22	8	WASHER, ROUND, FLAT, 1 3/8" OD, 9/16" HOLE	
93.10	6	SHEAVE WHEEL, FOR 7/16" SIEMENS–MARTIN STRAND	6030
75.42	2 SETS	ROD, ARMOR, PREFORMED	

NOTES

1. USE TWO LAG SCREWS AND WASHERS FOR EACH FOUR–WAY STRAIN BAND.
2. Δ ANCHOR TYPE SHACKLE AND 2 1/4" LINK NOT REQUIRED WHEN TYPE B POLE TOP BAND, DWG NO 41 6035 IS USED.
3. ≠ USE ONLY WHEN SPECIFIED.

REFERENCE DRAWINGS

GROUNDING DETAILS ——— 41 1012
GUY ARRANGEMENT ——— 41 6095

B	3–2–11 A7–DDD	REDRAWN.

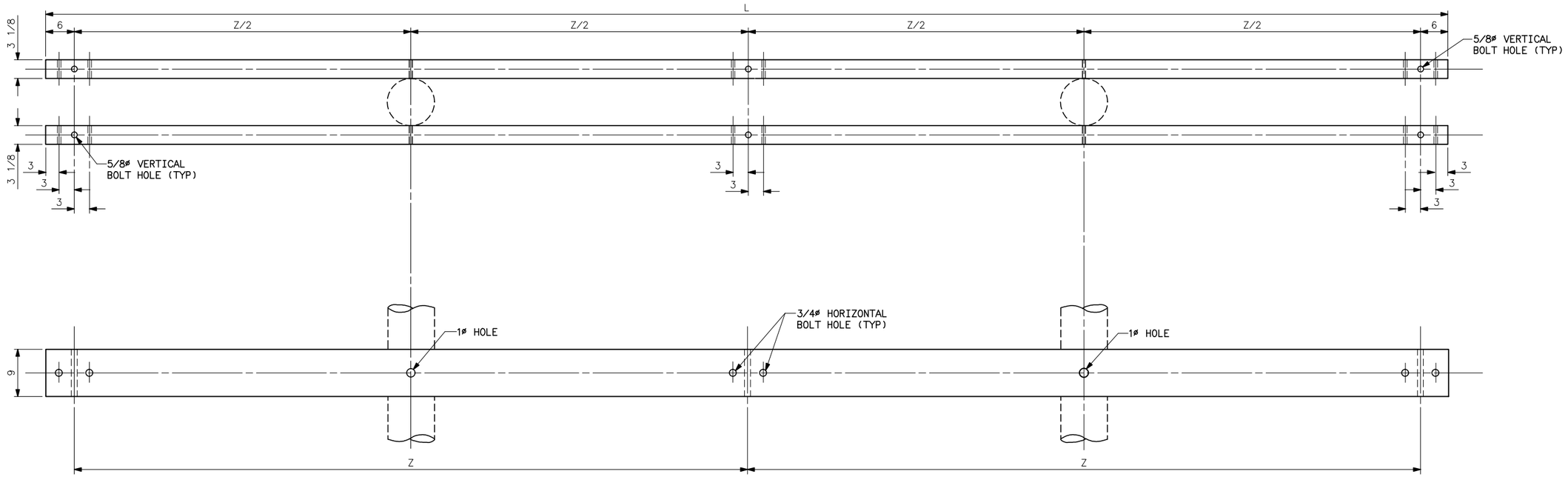
SUPERSEDES DWG NO. 40–D–4814

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

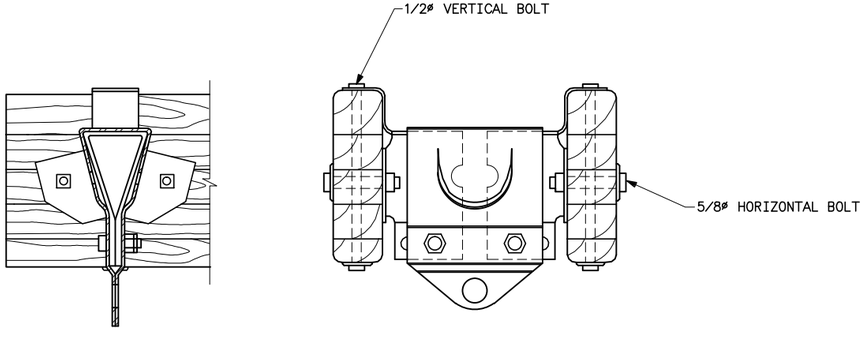
STANDARD DESIGNS
TRANSMISSION LINES
TYPE 3BT/4BT 69 AND 115KV BRANCH LINE STRUCTURE

DESIGNED BUREC ——— APPROVED BUREC ———

CAD	MARCH 20, 1991	41	6109



CROSSARM DRILLING DETAILS



DETAIL OF ADJUSTABLE SPACER FITTING

VOLTAGE	STRUCTURE TYPE	L	Z	Z/2	HUGHES BROS. SPACER FITTING (OR EQUAL) PART NO.
69KV	HS-1	21-0	10-0	5-0	3414.2
69KV	HSB-1	25-0	12-0	6-0	3414.2
115KV	HS-1 AND HSB-1	25-0	12-0	6-0	3414.2
138KV	HS-1 AND HSB-1	29-0	14-0	7-0	3415.13
161KV	HS-1 AND HSB-1	35-0	17-0	8-6	3415.13
230KV	HSB-1	45-0	22-0	11-0	3415.13

NOTES

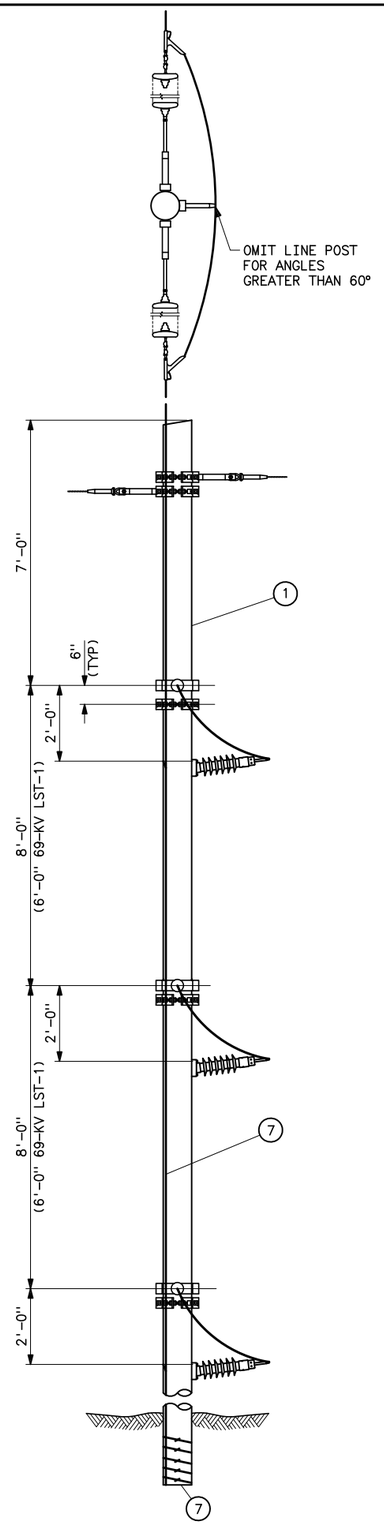
1. CROSSARMS SHALL BE GLUED LAMINATED.
2. ALL HOLES IN WOOD SHALL BE BORED 1/8 INCH LARGER THAN THEIR RESPECTIVE BOLT DIAMETERS

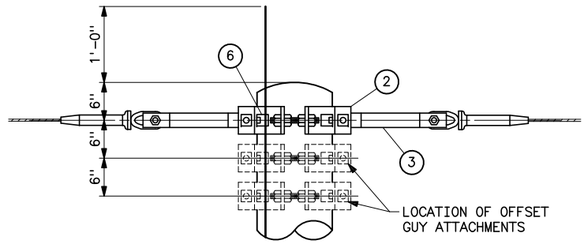
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - GOLDEN, COLORADO

STANDARD DESIGNS
TRANSMISSION LINES
CROSSARM DRILLING DETAILS
HS-1 AND HSB-1 STRUCTURES
WITH ADJUSTABLE SPACER FITTINGS

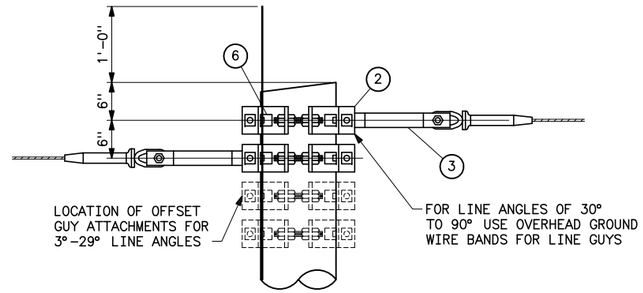
DESIGNED KAREN ROWE APPROVED DOUG HANSON
CIVIL ENGINEERING MANAGER

CAD	AUGUST 30, 1996	41	6113

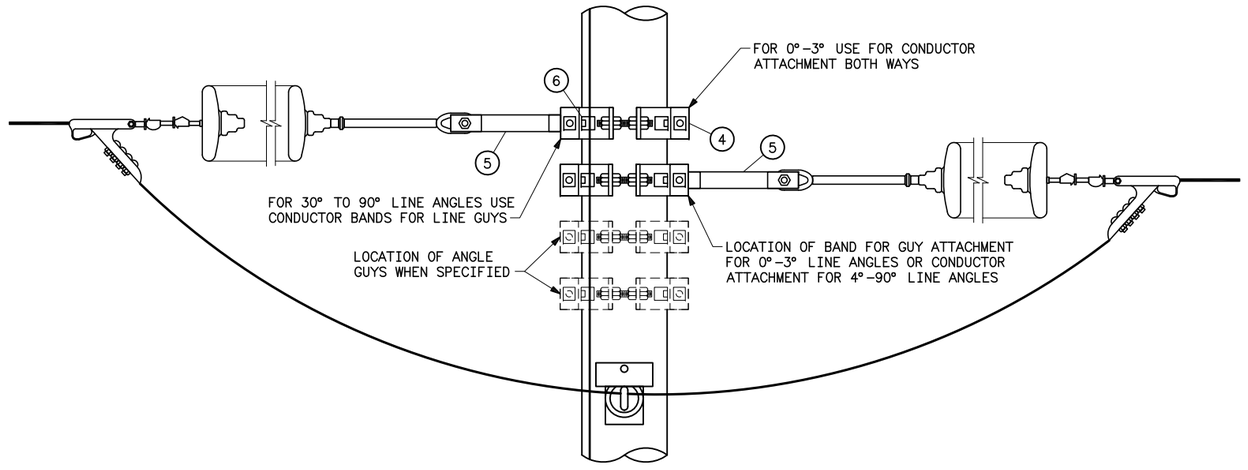




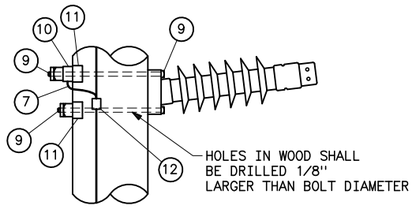
TANGENT TENSION ASSEMBLY (0°-3°)
FOR OVERHEAD GROUND WIRE



ANGLE TENSION ASSEMBLY (4°-90°)
FOR OVERHEAD GROUND WIRE



DETAIL OF INSULATOR ATTACHMENT
FOR CONDUCTOR



POST INSULATOR ASSEMBLY

STRUCTURE MATERIAL

PART NO.	QUANTITY STRUCTURE TYPE ST-1 AND LST-1		DESCRIPTION
	TANGENT TENSION	ANGLE TENSION	
1	1	1	POLE, SEE STRUCTURE LIST FOR HEIGHT
2	1	2	FOUR-WAY STRAIN BAND; HUGHES 3105 SERIES, OR APPROVED EQUAL WITH 2-1/2x4 LAG SCREWS & WASHERS PER BAND
3	2	2	CONNECTING LINK; PAIR WITH BNK HUGHES 3154, OR APPROVED EQUAL
4	3	6	FOUR-WAY STRAIN BAND: HUGHES 3112 SERIES OR APPROVED EQUAL
5	6	6	CONNECTING LINK; PAIR WITH BNK HUGHES 3157, OR APPROVED EQUAL
6	4	8	1/2ø GROUNDING CLIP ASSEMBLY (INCLUDES BONDING CLIP, CARRIAGE BOLT, NUT AND LOCKNUT) HUGHES 2718.55 OR EQUAL
7	AS REQ'D	AS REQ'D	NO. 2 AWG 30% CONDUCTIVITY, COPPER CLAD WIRE ATTACHED WITH 2" STAPLES
8	1	1	POLE BOTTOM PLATE (BLACKBURN NO. GP 110 OR EQUAL) ATTACHED TO POLE
9	-	-	MACHINE BOLT WITH NUT AND LOCKNUT (SUPPLIED WITH INSULATOR BRACKET)
10	3	3	BONDING CLIP (EQUAL TO BROOKS MANUFACTURER BC SERIES OR HUGHES NO. 2727) WITH NUT
11	6	6	3x3x1/4 CURVED SQUARE WASHER WITH BOLT HOLE
12	3	3	PARALLEL GROOVE CLAMP, 2-BOLT COPPER ALLOY

NOTES

1. POLES SHALL BE GIVEN RAKE OF 1/4" FOR EACH FOOT OF POLE LENGTH AGAINST THE STRAIN FOR LINE ANGLES GREATER THAN 5°.
2. BNK INDICATES BOLT, NUT, AND STAINLESS STEEL COTTER KEY REQUIRED.
3. ALL POLE BANDS SHALL BE BONDED WITH PART NUMBER 5.
4. EXTRA BANDS, LINKS. GROUNDING ASSEMBLIES, AND LAG SCREWS NEEDED FOR GUYING ARE NOT INCLUDED IN THIS QUANTITY.
5. HOLES IN WOOD SHALL BE DRILLED 1/8" LARGER THAN BOLT DIAMETER.
6. MEASUREMENTS FOR HORIZONTAL LINE POST MOUNTING ARE TO CENTERLINE OF TOP MOUNTING BOLT.
7. ALL HARDWARE WILL BE OF THE SIZE RECOMMENDED BY THE INSULATOR MANUFACTURER.
8. DEAD END TEES MAY BE USED IN LIEU OF POLE BANDS. CONNECTING LINKS, SHEAVE WHEELS AND GROUNDING CLIP ASSEMBLIES ARE NOT REQUIRED WITH DEAD END TEES, SEE STANDARD DRAWING 41 6138.

REFERENCE DRAWINGS

GUY ASSEMBLIES AND DETAILS_____41 6047
GUYING REQUIREMENTS FOR SINGLE POLE
CONSTRUCTION WITH OVERHEAD GROUND WIRE___41 6071
WOOD POLE STRUCTURES
GROUNDING DETAILS_____41 1012
WOOD POLE STRUCTURES
OVERHEAD GROUND WIRE ASSEMBLY_____41 1019
TENSION INSULATOR ASSEMBLIES -
SINGLE STRING_____41 1022
TENSION INSULATOR ASSEMBLIES -
DOUBLE STRING_____41 1023
HORIZONTAL POST - INSULATOR ASSEMBLIES___41 1024
OPTICAL GROUND WIRE ASSEMBLIES_____41 1031

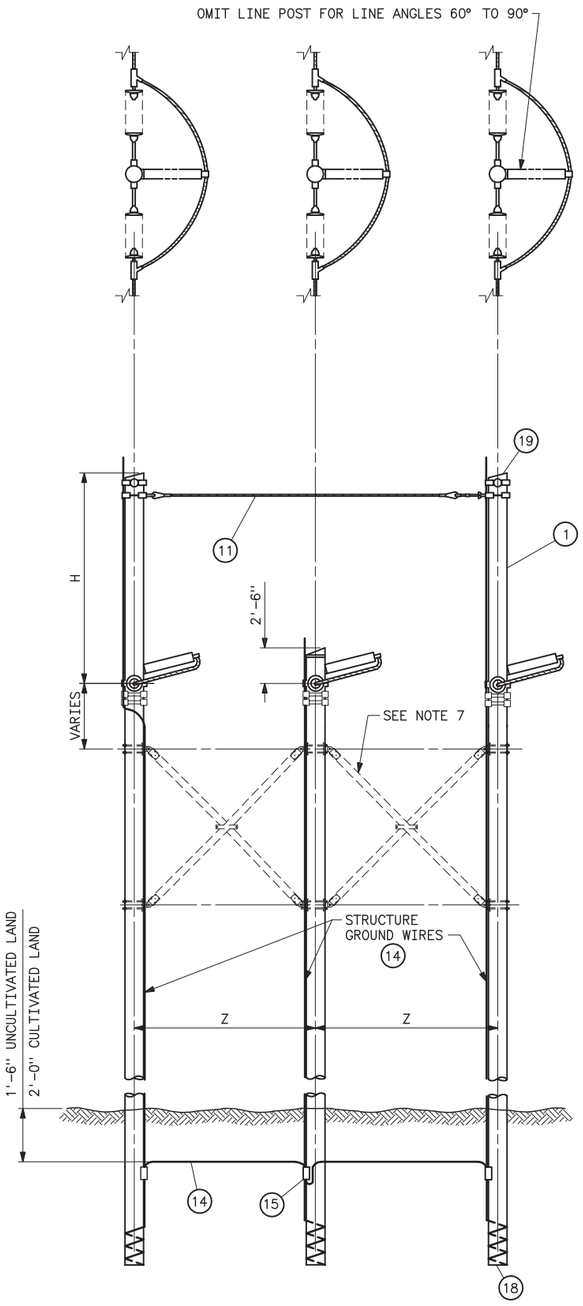
B	10-17-05 A7-KKR	ADDED LST-1 AND DRAWING REFERENCES.
A	01-25-05 A7-KKR	MINOR REVISIONS.

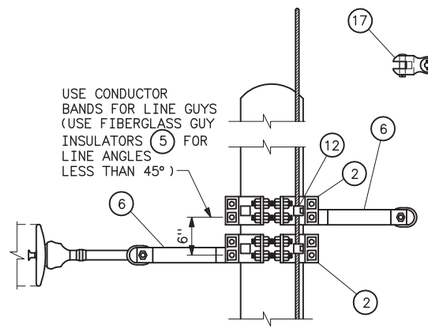
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - GOLDEN, COLORADO

STANDARD DESIGNS
TRANSMISSION LINES
TYPE ST-1 AND LST-1 69 AND 115KV TANGENT AND ANGLE TENSION STRUCTURES

DESIGNED KAREN ROWE APPROVED DOUG HANSON
CIVIL ENGINEERING MANAGER

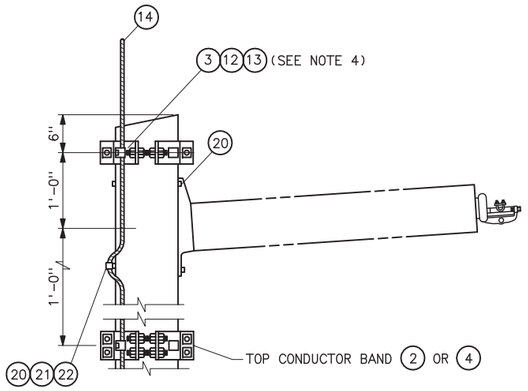
SIZE			
A/E	AUGUST 30, 1996	41	6116



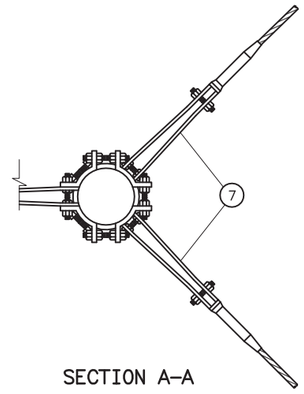


DETAIL OF INSULATOR ATTACHMENT
(FOR LINE ANGLES 5° TO 90°)

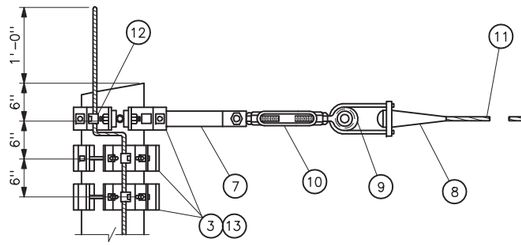
DETAIL OF INSULATOR ATTACHMENT 4
(FOR LINE ANGLES 0°–5°)



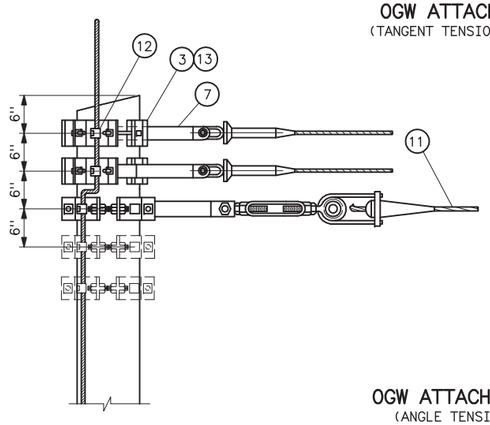
POST INSUSLATOR ASSEMBLY

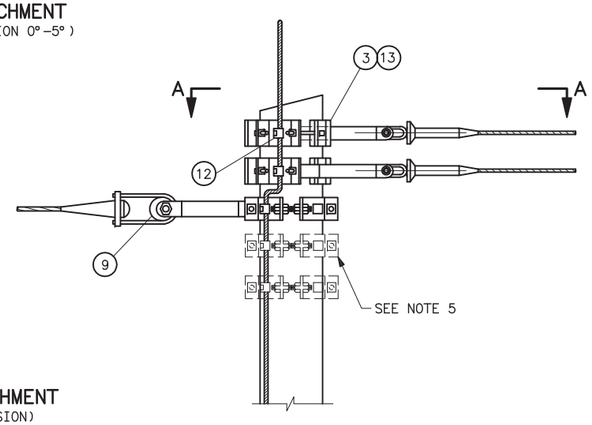


SECTION A–A



OGW ATTACHMENT
(TANGENT TENSION 0°–5°)





OGW ATTACHMENT
(ANGLE TENSION)

VOLTAGE	Z				H	
	ANGLE TURNED IN DEGREES					
	0°–30°	30°–45°	45°–60°	60°–90°	0°–60°	60°–90°
115KV	15'-0"	21'-0"	27'-0"	35'-0"	16'-0"	14'-0"
69KV	14'-0"	19'-0"	25'-0"	33'-0"	16'-0"	14'-0"

STRUCTURE MATERIAL

PART NO.	ANGLE 0°–5°	ANGLE 5°–30°	ANGLE 30°–60°	ANGLE 60°–90°	DESCRIPTION
1	3	3	3	3	POLE, SEE STRUCTURE LIST FOR LENGTH
2	———	6	6	6	FOUR-WAY STRAIN POLE BAND; HUGHES 3112 SERIES,JOSLYN J25969 SERIES; OR, APPROVED EQUAL (SEE NOTE 6)
3	7	11	7	6	FOUR-WAY STRAIN POLE BAND; HUGHES 3103 SERIES, JOSLYN J25967 SERIES; OR, APPROVED EQUAL (SEE NOTE 6)
4	3	———	———	———	POLE BAND ASSEMBLY, HUGHES B1784-VV OR APPROVED EQUAL (SEE NOTE 6)
5	6	6	6	———	FIBERGLASS GUY INSULATOR, 10 FT LENGTH
6	———	6	6	6	CONNECTING LINK; PAIR W/BNK HUGHES 3157, JOSLYN J26035; OR, APPROVED EQUAL
7	6	6	6	6	CONNECTING LINK PAIR W/BNK; HUGHES 3154; JOSLYN J6650; OR, APPROVED EQUAL CONNECTING LINK WITH BNK
8	2	2	2	2	DEAD-END AUTOMATIC VISE TYPE FOR GUY STRAND
9	2	2	2	2	SHEAVE WHEEL, 2 1/2 DIA MINIMUM
10	1	1	1	1	TURNBUCKLE, CLEVIS-EYE, 7/8x12
11	AS REQD	AS REQD	AS REQD	AS REQD	STEEL STRAND 7/16'', 7-WIRE, HIGH STRENGTH
12	7	17	13	12	1/2ø GROUNDING CLIP ASSEMBLY (INCLUDES BONDING CLIP, CARRIAGE BOLT, NUT AND LOCKNUT). HUGHES 2718.55 OR EQUAL
13	14	22	14	12	LAG SCREWS, 1/2x4 WITH FLAT WASHERS (2 EACH PER BAND)
14	AS REQD	AS REQD	AS REQD	AS REQD	NO. 2 AWG 30% CONDUCTIVITY, COPPER CLAD WIRE ATTACHED WITH 2-INCH STAPLES
15	3	3	3	3	PARALLEL GROOVE CLAMP, 2-BOLT COPPER ALLOY
17	6	———	———	———	CLEVIS-CLEVIS 90° W/BNK, 40,000 LBS
18	3	3	3	3	POLE BOTTOM PLATE (BLACKBURN NO. GP 110 OR EQUAL) ATTACHED TO POLE
19	3	3	3	3	POLE ANTISPLITTING DEVICE EQUAL TO STAR-LOCK MANUFACTURED BY THE BAYNE COMPANY

POST INSULATOR ASSEMBLY MATERIAL
(OMIT FOR 60° TO 90° ANGLES)

PART NO.	QUANTITY 0°–60°	DESCRIPTION
20	6	7/8''ø x REQD LENGTH MACHINE BOLT WITH LOCKNUT AND LOCK WASHER
21	6	4x4x1/4 CURVED SQUARE WASHER WITH 15/16''ø HOLE
22	3	BONDING CLIP (EQUAL TO BROOKS MANU BC SERIES OR HUGHES BROS NO. 2727)

NOTES

1. FITTINGS SHALL INCLUDE BOLTS, NUTS, AND WASHERS.
2. ALL HOLES SHALL BE BORED 1/8 INCH LARGER IN WOOD POLE THAN THEIR RESPECTIVE BOLT DIAMETERS.
3. MATERIAL REQUIRED WHERE HORIZONTAL LINE POST INSULATORS ARE USED ARE BASED ON BOLT SIZES SHOWN. INSULATOR MAY REQUIRE BOLTS, LOCKNUTS, AND WASHERS OF DIFFERENT SIZES.
4. ADDITIONAL POLE BAND IS NOT REQUIRED ON CENTER POLE FOR LINE ANGLES 60°–90° .
5. FOR 5°–30° LINE ANGLES ADD TWO ADDITIONAL BANDS (PART 3) FOR GUYING ON EACH OUTSIDE POLE.
6. DEADEND TEES MAY BE USED IN LIEU OF POLE BANDS. CONNECTING LINKS, SHEAVE WHEELS AND GROUNDING CLIP ASSEMBLIES ARE NOT REQUIRED WITH DEADEND TEES. SEE STANDARD DRAWING 41 6138.
7. USE X-BRACE EQUAL TO HUGHES BROS NO. 2121 WHEN SPECIFIED.

REFERENCE DRAWINGS

TYPE 3TA-1 AND STRUCTURES
STANDARD GUY STRUCTURES_____41 6125
TENSION INSULATOR ASSEMBLIES
SINGLE STRING_____41 1022
DOUBLE STRING_____41 1023
WOOD POLE STRUCTURES
GROUNDING DETAIL_____41 1012
OVERHEAD GROUND WIRE ASSEMBLY
DETAILS FOR WOOD POLES STRUCTURES_____41 1019
OPTICAL GROUND WIRE ASSEMBLIES_____41 1031
TYPICAL DETAILS FOR DEAD END TEES_____41 6138

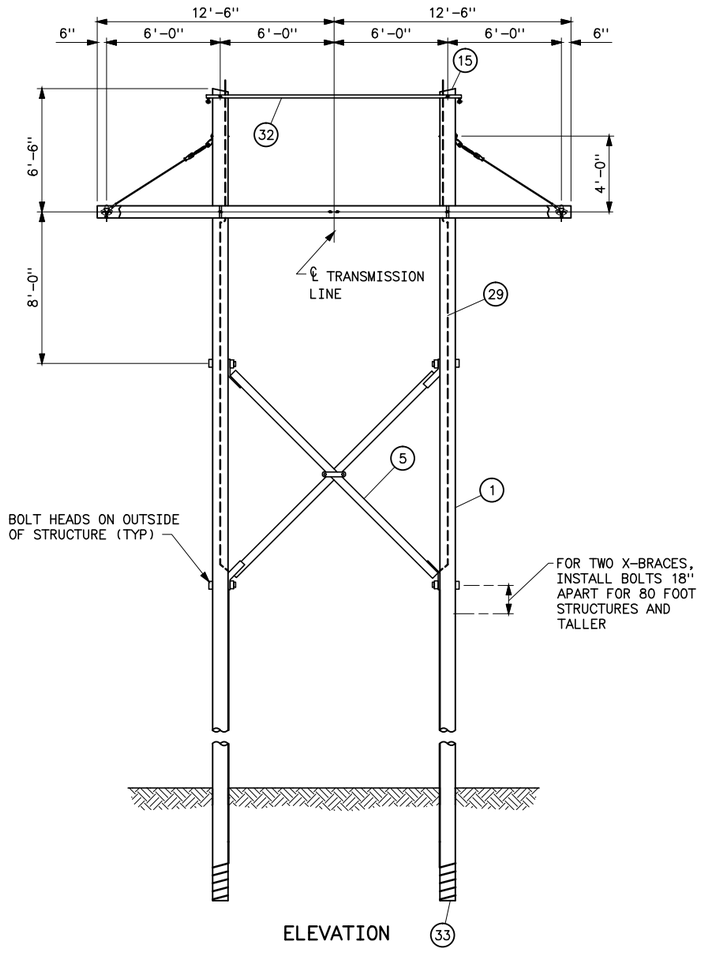
B	5-8-06 A7-KKR	ADDED X-BRACE OPTION
A	01-06-05 A7-KKR	REVISED REFERENCE DRAWINGS. ADDED STAR-LOCK AND NOTE 6.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

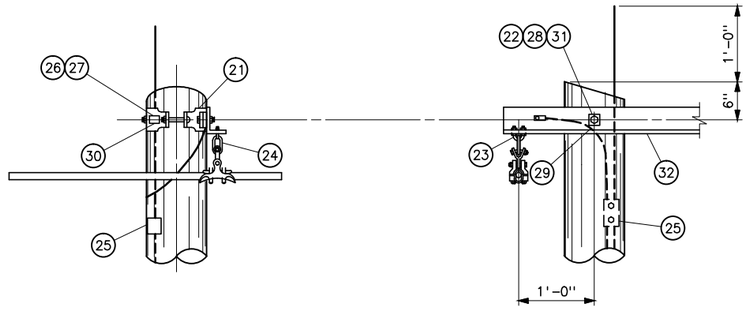
STANDARD DESIGNS
TRANSMISSION LINES
TYPE 3TA-1 69 AND 115KV
3-POLE TENSION STRUCTURE

DESIGNED KAREN ROWE APPROVED DOUG HANSON
CIVIL ENGINEERING MANAGER

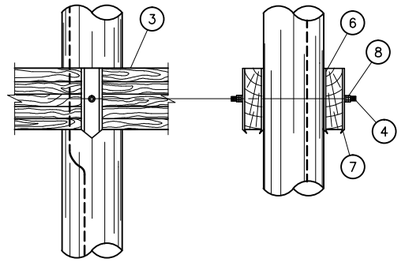
CAE	DECEMBER 31, 1996	41	6118



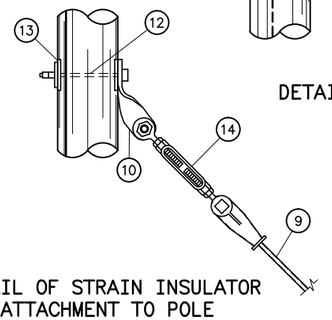
ELEVATION



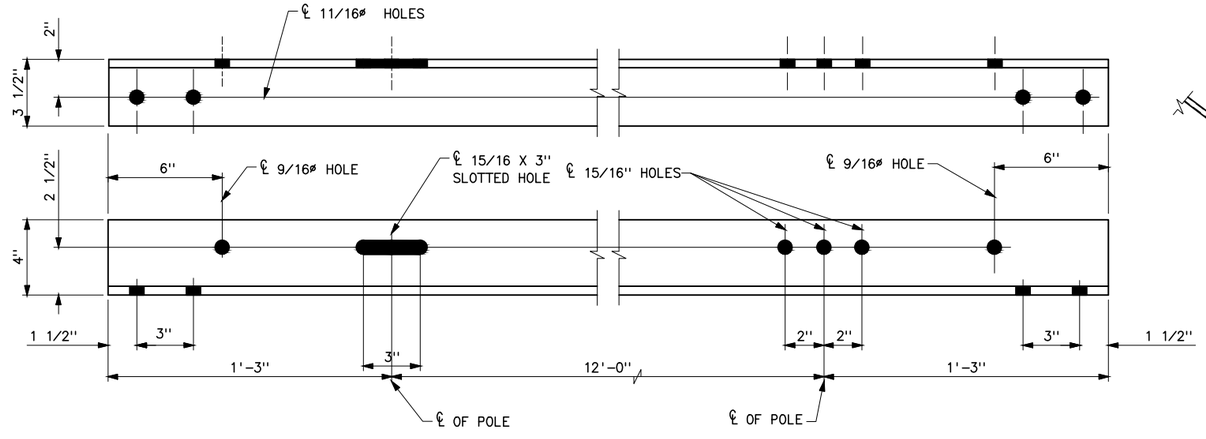
DETAIL OF OVERHEAD GROUND WIRE SUSPENSION ATTACHMENT



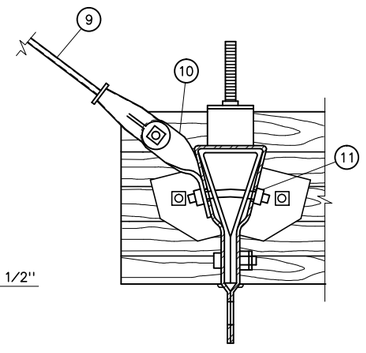
DETAIL OF WOOD ATTACHMENT

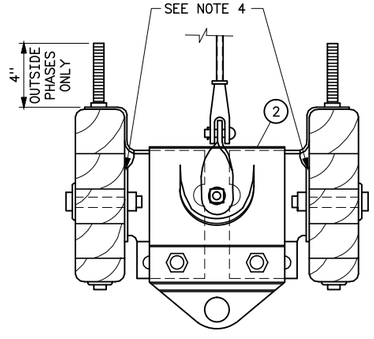


DETAIL OF STRAIN INSULATOR ATTACHMENT TO POLE



STEEL ANGLE (32)





DETAIL OF PHASE FITTING ASSEMBLY

STRUCTURE MATERIAL

PART NO.	QUANTITY	DESCRIPTION
1	2	POLE, SEE STRUCTURE LIST FOR HEIGHT
2	3	ADJUSTABLE SPACER FITTINGS COMPLETE WITH BOLTS, NUTS, & WASHERS (HUGHES BROS. TYPE 3414.2 OR EQUAL) (SEE NOTE 4)
3	2	GLUED LAMINATED WOOD CROSSARM, 3 1/8"x9"x25'-0"
4	2	DOUBLE ARMING BOLT, 7/8"øx REQD LENGTH WUTH 4 NUTS, USE EXTRA NUTS AS LOCKNUTS
5	1	X-BRACE, COMPLETE WITH FITTINGS, 3 3/8"x4 3/8" (HUGHES BROS. NO. 1042 OR EQUAL)
6	4	FLAT GAIN PLATE
7	4	RIBBED TIE PLATE
8	4	SPRING LOCK WASHER FOR 7/8"ø BOLT
9	2	CLEVIS-CLEVIS FIBERGLASS GUY STRAIN, 25,000 LB MINIMUM ULTIMATE STRENGTH COMPLETE WITH BNK
10	4	TWISTED CLIP (EQUAL TO HUGHES BROS NO. AS2276)
11	2	7/8"øx REQD LENGTH BENT BOLT WITH LOCK WASHERS AND LOCKNUTS
12	2	7/8"øx REQD LENGTH BOLT WITH LOCK WASHER AND LOCKNUT
13	2	4"x4"x1/4" CURVED WASHER, 15/16"ø HOLE
14	2	TURNBUCKLE (HUGHES BROS NO. AS2545-B OR EQUAL)
15	2	POLE ANTISPLITTING DEVICE EQUAL TO STAR-LOCK MANUFACTURED BY THE BAYNE COMPANY

OVERHEAD GROUND WIRE AND GROUNDING MATERIAL

PART NO.	QUANTITY	DESCRIPTION
21	2	POLE TOP BAND (HUGHES BROS. NO. 2845-B OR EQUAL)
22	2	MACHINE BOLT, 7/8"øx1'-0"
23	2	"U" BOLT, 5/8"øx3" WITH 4 HEX NUTS AND 2 LOCKNUTS
24	2	CHAIN LINK 1/2"ø (HUGHES BROS NO. 1329-B1 OR EQUAL)
25	2	PARALLEL GROOVE CLAMP, 2-BOLT COPPER ALLOY OR COPPER CRIMPIT (BURNDY TYPE YC-C OR EQUAL)
26	2	1/2"øx4" LAG SCREW WITH FETTER DRIVE THREAD (ONE PER BAND)
27	2	1 3/8"ø FLAT ROUND WASHER WITH 9/16"ø HOLE (ONE PER BAND)
28	2	LOCKNUT FOR 7/8"ø BOLT
29	AS REQUIRED	NO. 2 AWG 30% CONDUCTIVITY, COPPER CLAD WIRE ATTACHED WITH 2" STAPLES
30	4	1/2"ø GROUNDING CLIP ASSEMBLY (INCLUDES BONDING CLIP, CARRIAGE BOLT, NUT AND LOCKNUT).
31	2	SPRING LOCK WASHER FOR 7/8"ø BOLT
32	1	STEEL ANGLE, 4"x3 1/2"x5/16"x 14'-6" LONG
33	2	POLE BOTTOM PLATE (BLACKBURN NO. GP 110 OR EQUAL) ATTACHED TO POLE

NOTES

1. STEEL FOR STEEL ANGLES AND FOR BENT PLATES SHALL CONFORM TO ASTM A36. PIECES SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH ASTM A123.
2. ALL HOLES IN WOOD SHALL BE BORED 1/8" LARGER THAN THEIR RESPECTIVE BOLT DIAMETERS.
3. GAINING IS NOT REQUIRED IF ADJUSTABLE SPACER FITTING IS USED.
4. HOLE IN PLATE SHALL BE UNTAPPED AND MEASURE 1/16" LARGER THAN BOLT. ADD EXTRA LOCKNUT AND SPRING WASHER FOR EACH CONNECTION.
5. BNK INDICATES BOLT, NUT, AND STAINLESS STEEL COTTER KEY REQUIRED.

REFERENCE DRAWINGS

WOOD POLES STRUCTURES
GROUNDING DETAILS ____ 41 1012
OVERHEAD GROUND WIRE ASSEMBLY
DETAILS FOR WOOD POLES STRUCTURES ____ 41 1019
CROSSARM DRILLING DETAILS HS-1 AND HSB-1 STRUCTURES ____ 41 6113
OPTICAL GROUNDWIRE ASSEMBLIES ____ 41 1031
SUSPENSION INSULATOR ASSEMBLIES
SINGLE STRING ____ 41 1020

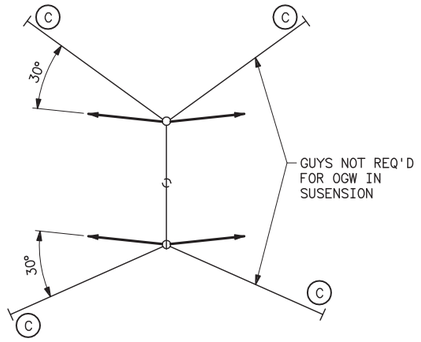
B	3-6-06 A7-KKR	MINOR REVISIONS
A	01-06-05 A7-KKR	MINOR CHANGES. ADDED STAR-LOCK.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

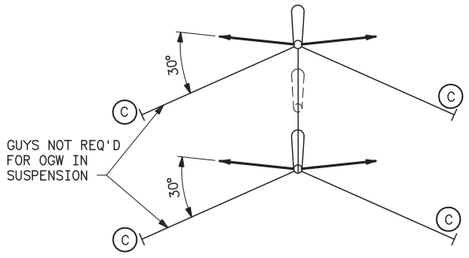
STANDARD DESIGNS
TRANSMISSION LINES
TYPE HS-1 115KV SUSPENSION STRUCTURE

DESIGNED KAREN ROWE APPROVED DOUG HANSON, CIVIL ENGINEERING MANAGER

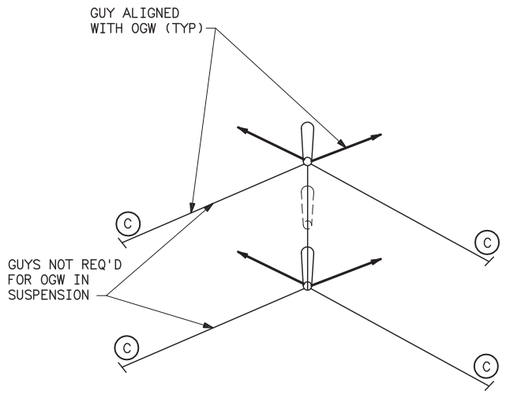
CAE	AUGUST 30, 1996	41	6122



SECTION A–A



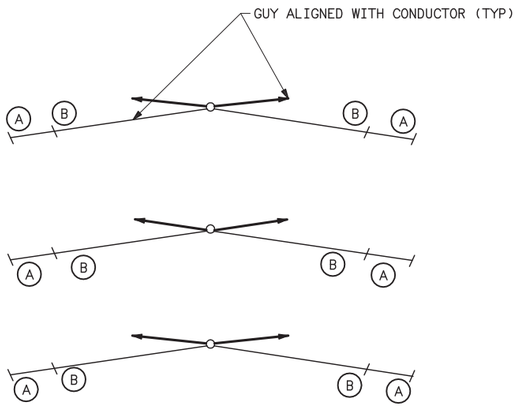
SECTION C–C



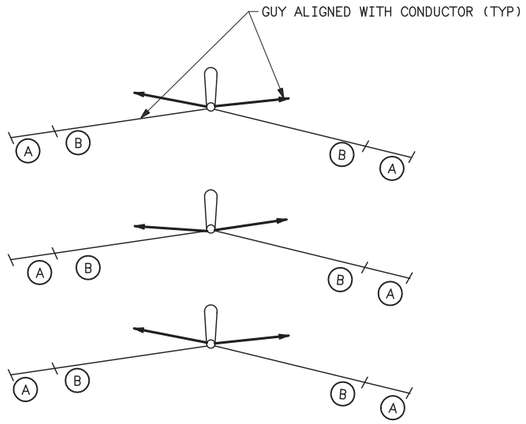
SECTION E–E

GUY AND ANCHOR REFERENCE CHART			
LINE GUYING			
CONDUCTOR GUYS	OGW GUYS	ANCHOR REF	NO. OF ANCHORS
3LSGEW	2LSGEW	(A) (C)	10
3LSGEW	2LDGEW	(A) (C)	10
3LDGEW	2LSGEW	(A) (C)	10
3LDGEW	2LDGEW	(A) (C)	10
3LSGEW–3LDGEW	2LDGEW	(A) (B) (C)	16
6LDGEW	2LDGEW	(A) (B) (C)	16

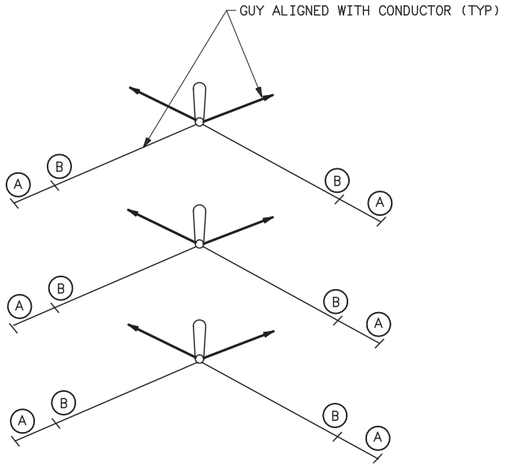
OGW — OVERHEAD GROUND WIRE
COND — CONDUCTOR
LSGEW — LINE SINGLE GUY EACH WAY
LDGEW — LINE DOUBLE GUY EACH WAY
——► — OGW AND CONDUCTOR
◯ — ANCHOR IDENTIFICATION REFERENCE



SECTION B–B



SECTION D–D



SECTION F–F

NOTES

1. RAKE POLES AS FOLLOWS:
   OGW: SUSPENSION 5°–60°
   OGW: TENSION 10°–90°
2. POLE RAKE SHALL BE 1/4–INCH FOR EACH FOOT OF POLE ABOVE GROUND. RAKE SHALL BE AGAINST THE STRAIN.
3. REFER TO DRAWING NO. 41 6047 FOR ANCHOR SPACING.
4. REFER TO PLAN AND PROFILE DRAWINGS FOR ACTUAL GUY QUANTITIES AND TYPES AT EACH SITE.

REFERENCE DRAWING

GUY ASSEMBLIES AND DETAILS _____ 41 6047

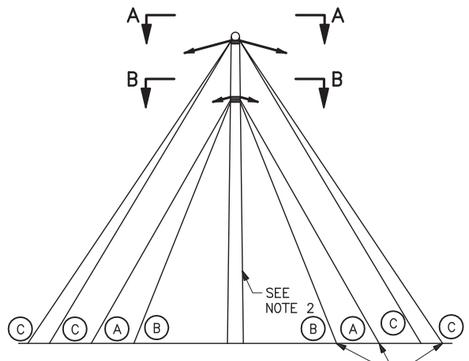


FIGURE 1
OGW AND CONDUCTOR LINE GUYING FOR LINE ANGLES 0° TO 10°

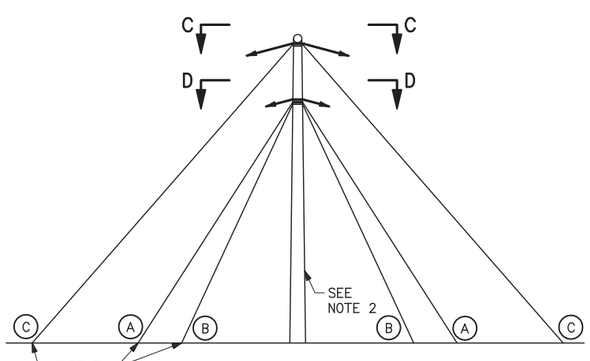


FIGURE 2
OGW AND CONDUCTOR LINE GUYING FOR LINE ANGLES 10° TO 30°

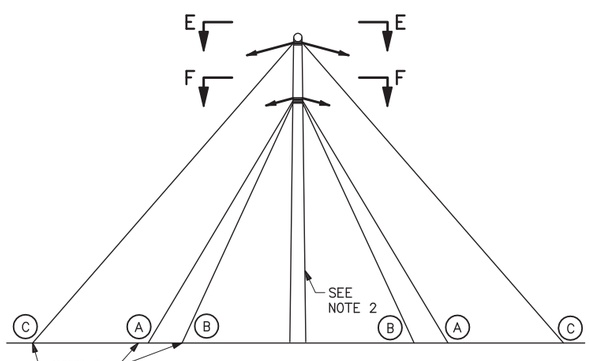


FIGURE 3
OGW AND CONDUCTOR LINE GUYING FOR LINE ANGLES 30° TO 90°

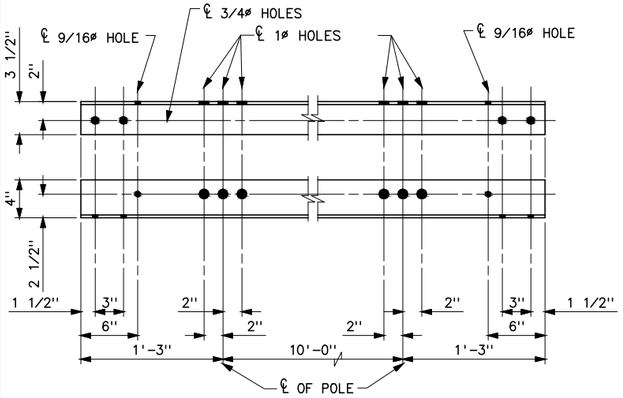
A	03–02–05 A7–KKR	REMOVED NOTE 4. NO LONGER OFFSETTING MIDDLE POLE GUYING.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

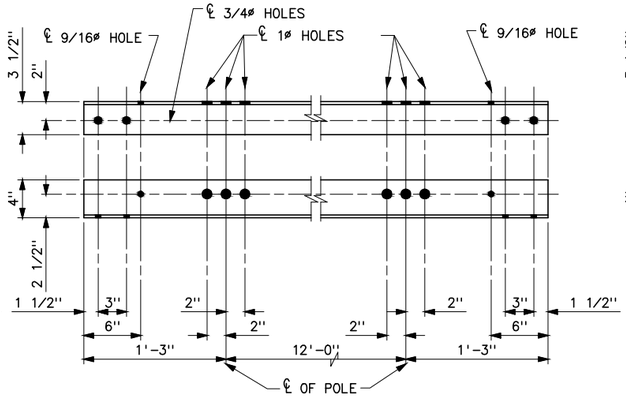
STANDARD DESIGNS
TRANSMISSION LINES
TYPE 3TA–1 STRUCTURES
STANDARD GUY ARRANGEMENT

DESIGNED KAREN ROWE _____ APPROVED DOUG HANSON _____
CIVIL ENGINEERING MANAGER

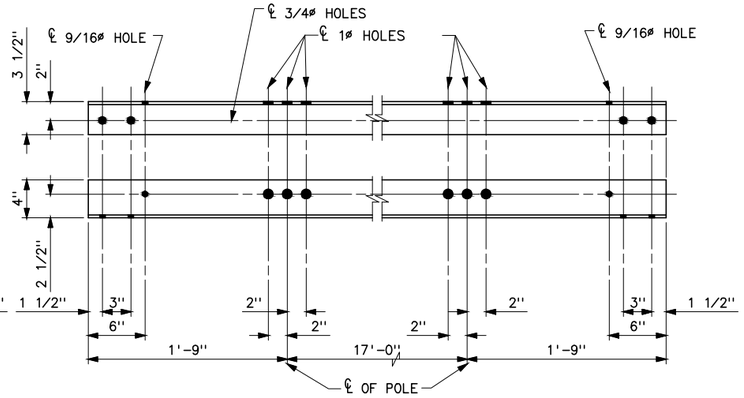
SIZE A/E	DECEMBER 31, 1996	41	6125



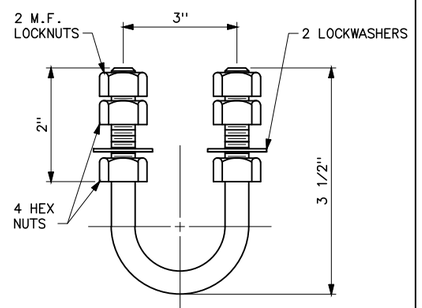
MARK B1
L 4x3 1/2x5/16x12'-6"
WT=97 LBS
(TYPE HS-1 69KV)



MARK B2
L 4x3 1/2x5/16x14'-6"
WT=112 LBS
(TYPE HSB-1 69 AND 115KV)
(TYPE HS-1 115KV)



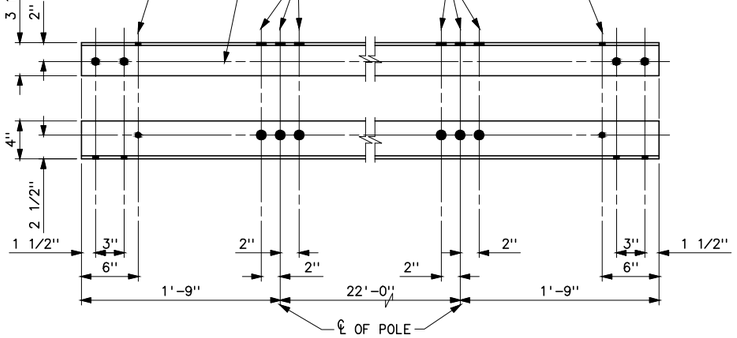
MARK B3
L 4x3 1/2x3/8x20'-6"
WT=187 LBS
(TYPE HSB-1 161KV)



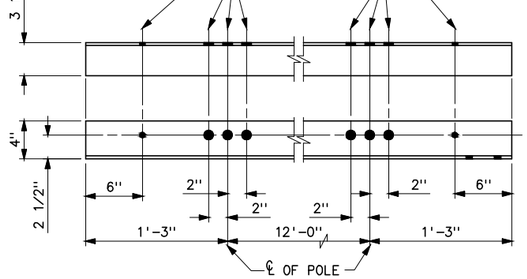
5/8ø U-BOLT
WT=2 LBS

NOTES

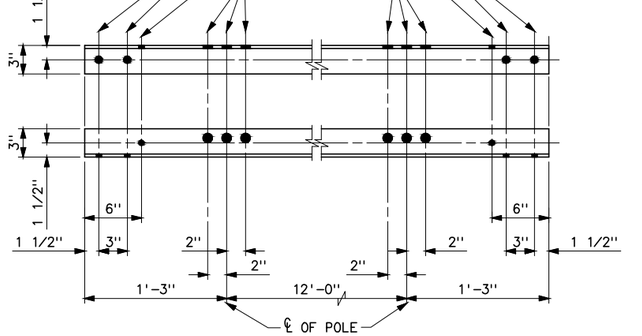
1. STEEL SHALL CONFORM TO ASTM A36. PIECES SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH ASTM A123.
2. STEEL U-BOLTS SHALL MEET IFI 136.
3. NUTS, LOCKWASHERS AND LOCKNUTS SHALL MEET ANSI C135.1.
4. THIS ANGLE IS NOT RECOMMENDED. IT WAS NOT ADEQUATE FOR FALL PROTECTION.



MARK B4
L 4x3 1/2x3/8x25'-6"
WT=232 LBS
(TYPE HSB-1 230KV)



MARK B5
L 4x3 1/2x5/16x14'-6"
WT=112 LBS
(TYPE HA-1 69 AND 115KV)



MARK B6
L 3x3x1/4x14'-6"
WT=67 LBS
(TYPES HS-1, HS-2, HS-4 AND HSB-1
69 AND 115KV; SEE NOTE 4)

REFERENCE DRAWINGS

TYPE HSB-1 161KV SUSPENSION STRUCTURE	41 6129
TYPE HSB-1 69 AND 115KV SUSPENSION STRUCTURE	41 6123
TYPE HS-1 69KV SUSPENSION STRUCTURE	41 6117
TYPE HSB-1 230KV SUSPENSION STRUCTURE	41 6128
TYPE HS-1 115KV SUSPENSION STRUCTURE	41 6122
TYPE HA-1 69 AND 115KV SUSPENSION STRUCTURE	41 6124

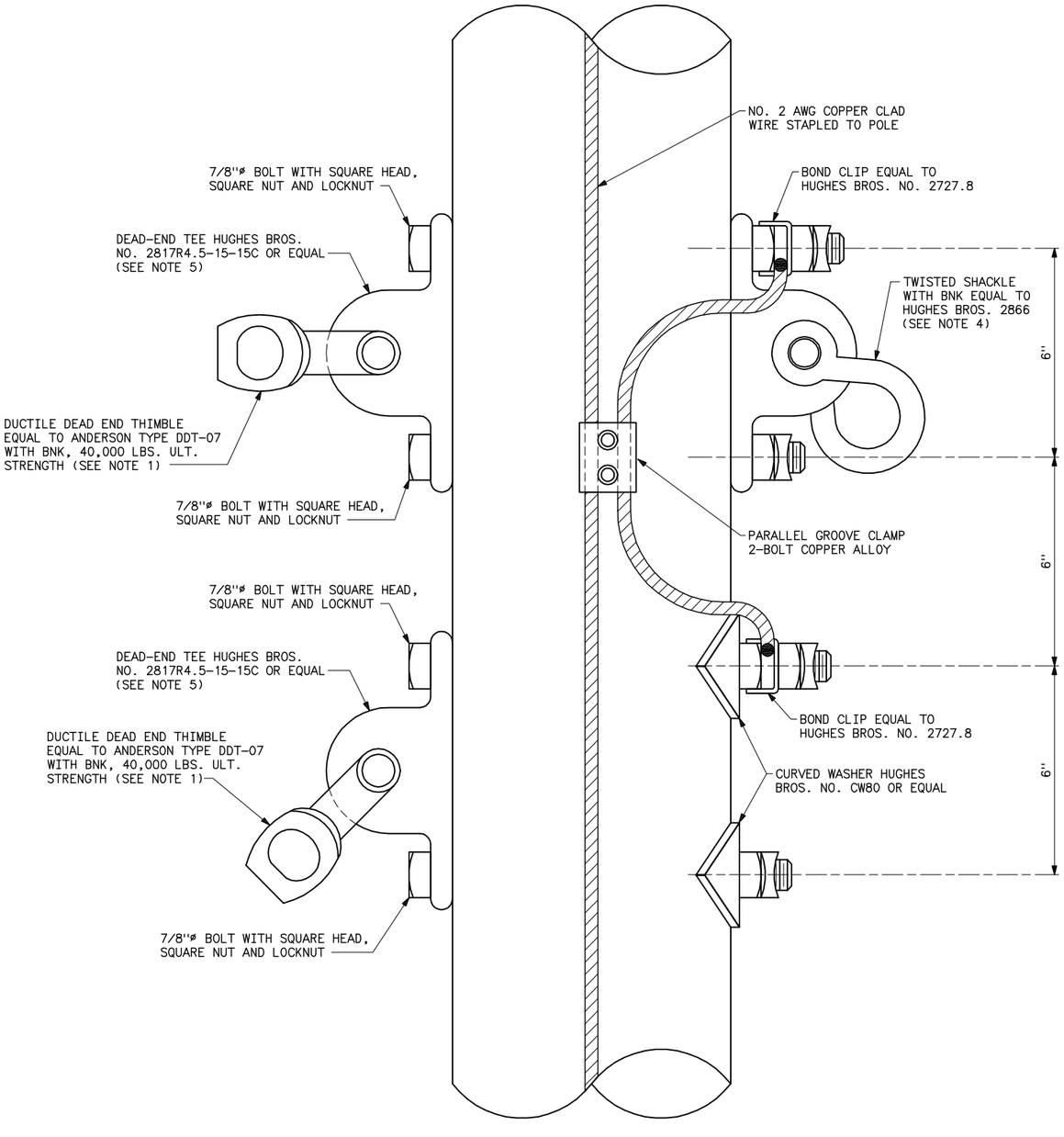
B	02-05-09 A7-CG	REVISED HOLES IN STEEL
A	04-01-03 A7-CG	ADDED DIMENSION TO 9/16ø HOLES ON MARK B6 EACH END.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

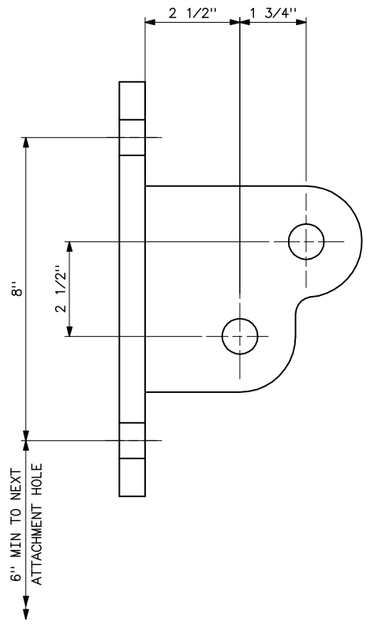
STANDARD DESIGNS
TRANSMISSION LINES
STEEL ANGLE DETAILS FOR WOOD POLE STRUCTURES

DESIGNED CHARLIE GARCIA APPROVED DOUG HANSON
CIVIL ENGINEERING MANAGER

CAE	SEPTEMBER 01, 2000	41	6133



TYPICAL DETAILS FOR DEAD END TEES



DOUBLE GUYING DEAD-END TEE
HUGHES BROS NO. AS2720
OR EQUAL (SEE NOTE 6)

NOTES

1. DUCTILE DEAD END THIMBLE REPLACES CONNECTING LINKS AND SHEAVE WHEELS THAT ARE USED WITH POLE BAND CONSTRUCTION.
2. ALL HOLES IN WOOD SHALL BE BORED 1/8" LARGER THAN THEIR RESPECTIVE BOLT DIAMETERS.
3. BNK INDICATES BOLT, NUT, AND STAINLESS STEEL COTTER KEY REQUIRED.
4. FOR ANGLES LESS THAN 20 DEGREES REPLACE SHACKLE WITH CLEVIS-CLEVIS FITTING AND 16" EXTENSION LINK WITH BNK, 40,000 LBS. ULT. STRENGTH.
5. THE ULTIMATE STRENGTH OF DEAD-END TEE HUGHES BROS NO. 2817R4.5-15-15C IS 60,000 POUNDS. THIS DEAD-END TEE CAN ACCOMMODATE UP TO TWO DOUBLE GUYS WITH TWO EXTENSION LINKS AND TWO SHEAVE WHEELS.
6. THE DOUBLE GUYING DEAD-END TEE OPTION CAN BE USED IN PLACE OF TWO SINGLE DEAD-END TEES. THE ULTIMATE STRENGTH OF THE DOUBLE GUYING DEAD-END TEE HUGHES BROS NO. AS2720 IS 35,000 POUNDS PER ATTACHMENT. EACH ATTACHMENT CAN ACCOMMODATE UP TO ONE DOUBLE GUY.
7. OTHER DEAD-END TEES MAY BE USED AS LONG AS THE ULTIMATE STRENGTH PER ATTACHMENT IS AT LEAST 29,000 POUNDS.

REFERENCE DRAWING

GUY ASSEMBLY AND DETAILS _____ 41 6047

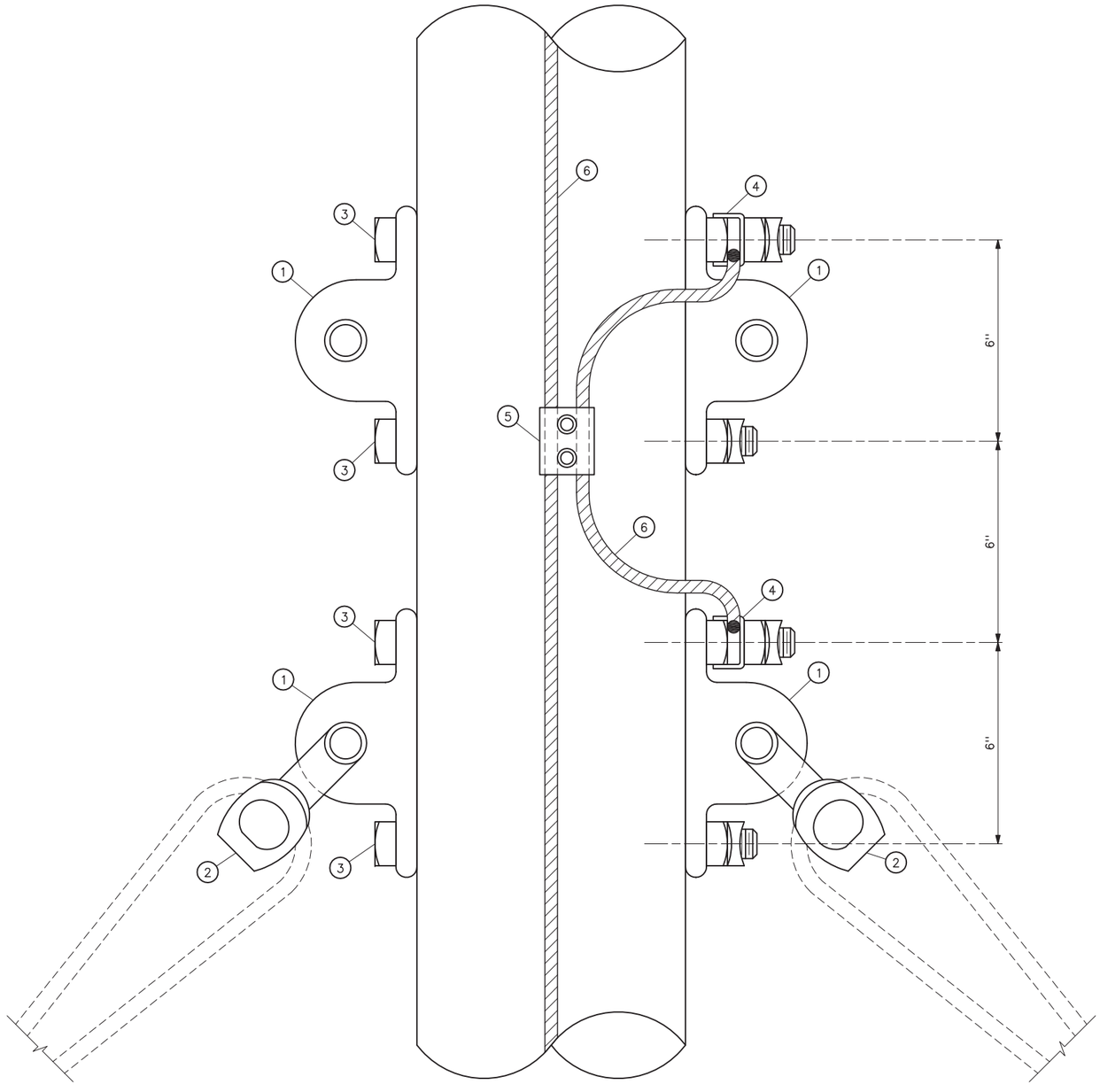
B	6-9-10 A7-KKR	ADDED DOUBLE GUYING DEAD-END TEE OPTION AND NOTES 5, 6, AND 7.
A	02-28-06 A7-KKR	ADDED NOTE 4.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

STANDARD DESIGNS
TRANSMISSION LINES
TYPICAL DETAILS FOR DEAD END TEES

DESIGNED KAREN ROWE APPROVED DOUG HANSON, CIVIL ENGINEERING MANAGER

CAE	JANUARY 24, 2005	41	6138



OPTICAL GROUND WIRE SPLICE STRUCTURE MATERIALS		
PART NO.	QUANTITY	DESCRIPTION
1	4	DEAD-END TEE, HUGHES BROS. NO. 2817R4.5-15-15C OR EQUAL
2	2	DUCTILE DEAD END THIMBLE EQUAL TO ANDERSON TYPE DDT-07 WITH BNK, 40,000 LBS. ULT. STRENGTH
3	4	7/8"ø BOLT WITH SQUARE HEAD, SQUARE NUT AND LOCKNUT
4	2	BOND CLIP EQUAL TO HUGHES BROS. NO. 2727.8
5	1	PARALLEL GROOVE CLAMP 2-BOLT COPPER ALLOY
6	AS REQ'D	NO. 2 AWG COPPER CLAD WIRE

NOTES

1. ALL HOLES IN WOOD SHALL BE BORED 1/8" LARGER THAN THEIR RESPECTIVE BOLT DIAMETERS.
2. BNK INDICATES BOLT, NUT, AND STAINLESS STEEL COTTER KEY REQUIRED.
3. FOR INSTALLATION ON TANGENT H-FRAME OR TENSION STRUCTURES ONLY.

REFERENCE DRAWINGS

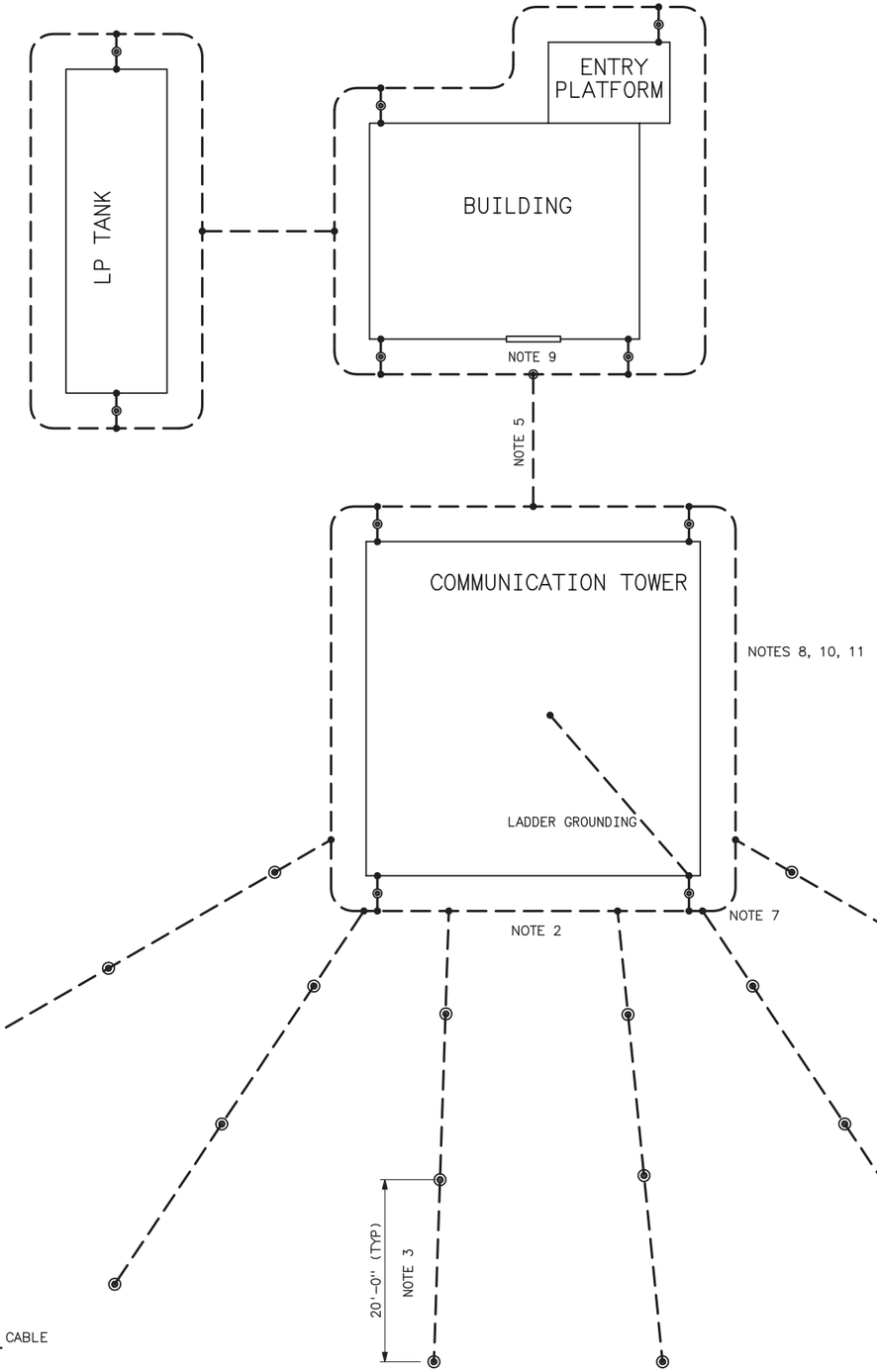
OPTICAL GROUND WIRE ASSEMBLIES_____41 1031
GUY ASSEMBLIES AND DETAILS_____41 6047

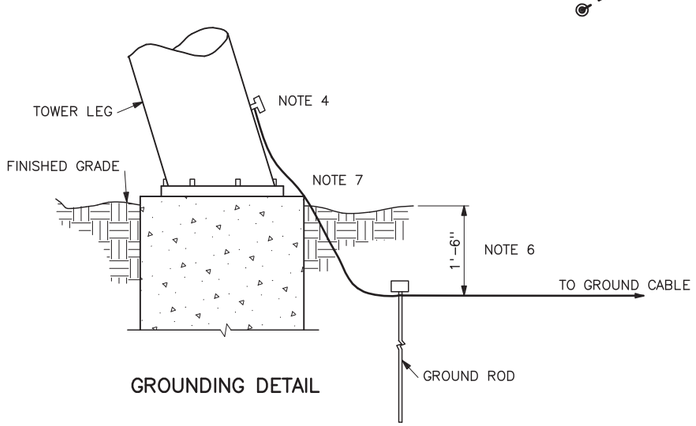
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

STANDARD DESIGNS
TRANSMISSION LINES
TYPICAL DETAILS FOR OPTICAL GROUND WIRE SPLICE STRUCTURES

DESIGNED KAREN ROWE APPROVED DOUG HANSON
CIVIL ENGINEERING MANAGER

CAE	FEBRUARY 28, 2006	41	6153





GROUNDING DETAIL

NOTES

1. THIS DRAWING SHOWS TYPICAL ELEMENTS AND ATTACHMENT LOCATIONS TO COMPLETE THE GROUNDING SYSTEM FOR A COMMUNICATION SITE.
2. SIX 45-FOOT GROUNDING RADIALS SHALL BE CONNECTED TO THE TOWER GROUNDING RING. THE RADIALS SHALL BE DIRECTED AWAY FROM THE TOWER AT EVEN INTERVALS.
3. THE 10-FOOT GROUND RODS SHALL BE SPACED 20 FEET APART ALONG EVERY RADIAL.
4. ALL ELECTRICAL CONNECTIONS SHALL BE MADE USING BURNDY THERMOWELD, CADWELD, OR EQUIVALENT PROCESS AS SHOWN ON DRAWING 31 1060.
5. 30-FOOT SPACING BETWEEN THE BUILDING AND THE MICROWAVE TOWER IS RECOMMENDED. IF THIS SPACING IS GREATER THAN 30-FEET, INSTALL A GROUND ROD IN THE MIDDLE OF THIS GROUNDING CONDUCTOR SECTION.
6. GROUNDING RINGS AND RADIALS SHALL BE BURIED 18-INCHES BELOW THE SURFACE OF THE GROUND.
7. ALWAYS MAINTAIN A MINIMUM BEND RADIUS OF 8-INCHES FOR ALL GROUND WIRES AND CONNECTIONS.
8. GROUNDING RING AROUND THE MICROWAVE TOWER SHALL HAVE A MINIMUM DIAMETER OF 10-FEET.
9. INSTALL A GROUND ROD BELOW WAVEGUIDE ENTRY PANEL OUTSIDE OF THE EQUIPMENT BUILDING.
10. GROUNDING RING AROUND MONOPOLES SHALL HAVE A MINIMUM OF FOUR GROUND RODS.
11. GROUNDING RINGS AND RODS SHALL BE INSTALLED A MINIMUM OF TWO FEET OUTSIDE OF TOWER FOUNDATIONS.
12. FENCE GROUNDS ARE NOT REQUIRED UNLESS IN THE VICINITY OF HIGH VOLTAGE POWER LINES. FENCE GROUNDS SHALL NOT BE BONDED TO THE BUILDING GROUND RING. SEE STANDARD DRAWING 31-1060.
13. FOR SITES WITH GEOLOGY CONSISTING OF ROCK OR LARGELY ROCK, TOWER GROUNDING RADIALS SHALL BE BURIED IN CONDUCTIVE CONCRETE.

LEGEND

◉ = 5/8" X 10' GROUND ROD
— — = NO. 4/0 AWG STRANDED BARE COPPER GROUND CABLE
• = ELECTRICAL CONNECTION TO THE GROUND WIRE

REFERENCE DRAWINGS

SUBSTATION STANDARDS-GROUNDING DETAILS	31 1060
MICROWAVE TOWER GROUNDING	41 7001
GROUNDING-SUBSTATION DETAILS	41 7002
GROUNDING-REMOTE DETAILS	41 7003

A	9-30-04 A79-SEJ	LP TANK GROUNDING AND MINOR REVISIONS

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

COMMUNICATIONS
STANDARD
MICROWAVE SITE GROUNDING
TYPICAL PLAN

DESIGNED J. WILD APPROVED C.L.CLEMANS
SYSTEM CONTROL MANAGER

CAE	JUNE 1, 2003	41	7000

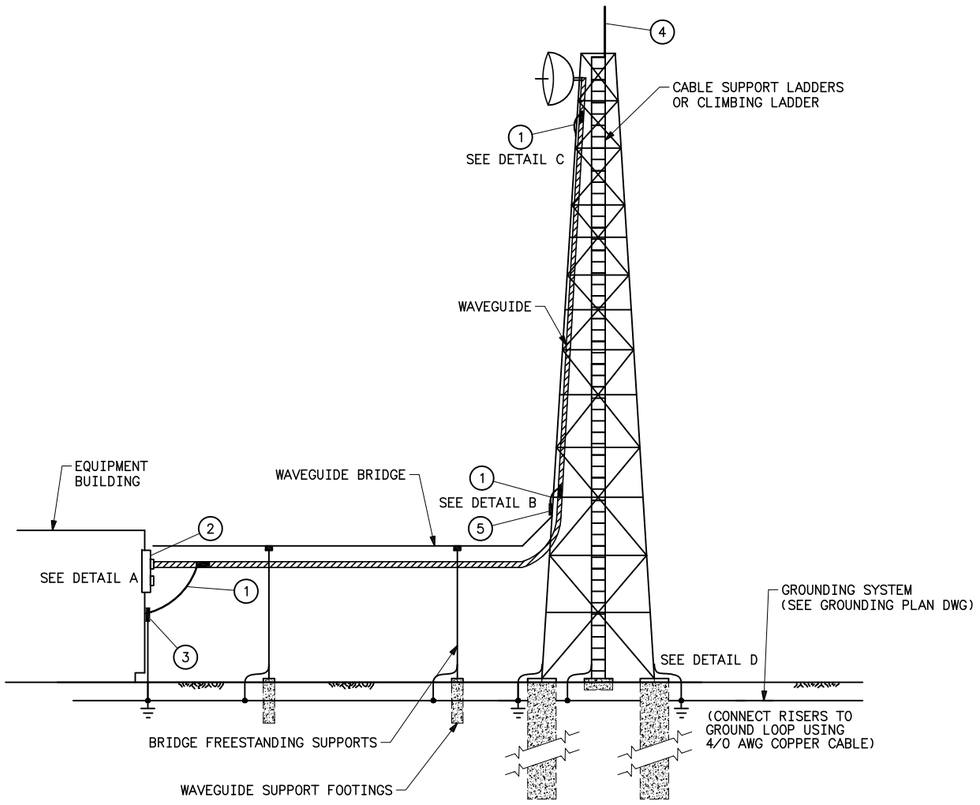
REFERENCE MATERIALS	
ITEM NO.	DESCRIPTION
1	WAVEGUIDE GROUNDING KIT
2	WAVEGUIDE ENTRY PANEL
3	COPPER GROUND BAR WITH INSULATED WALL MOUNT
4	LIGHTNING ROD WITH TOWER BONDING KIT
5	COPPER GROUND BAR WITH TOWER MOUNTING BRACKET

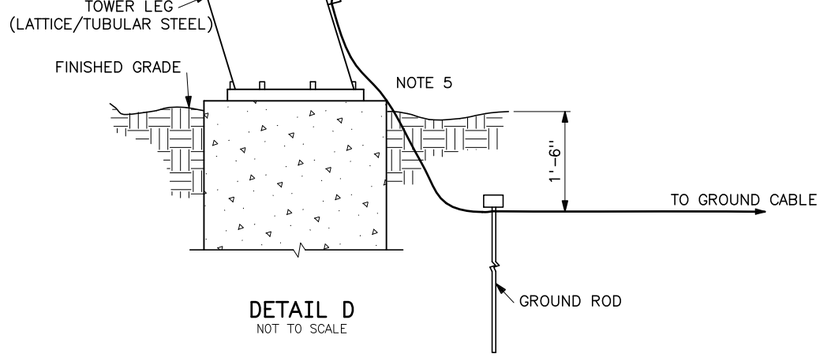
NOTES

1. GROUNDING KITS SHALL BE INSTALLED IN A DOWNWARD DIRECTION TOWARD THE EARTH.
2. WAVEGUIDE SHALL BE GROUNDED EVERY 75-FEET DOWN THE TOWER IN ADDITION TO THE LOCATIONS SHOWN ON THE DRAWING.
3. LOCATE ONE WAVEGUIDE GROUND WITHIN 18-INCHES OF THE VERTICAL TRANSITION FROM THE ANTENNA.
4. ALL GROUNDING CONDUCTORS SHALL MAINTAIN AN 8-INCH MINIMUM BEND RADIUS.
5. ALL ELECTRICAL CONNECTIONS TO THE GROUND RODS, GROUNDING RING, AND TOWER STEEL SHALL BE MADE USING CADWELD EXOTHERMIC WELD OR EQUIVALENT.

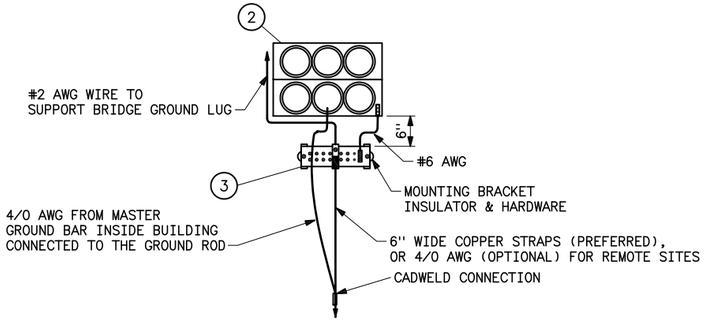
REFERENCE DRAWINGS

SUBSTATION STANDARDS-GROUNDING DETAILS_____31 1060
GROUNDING PLAN_____41 7000
GROUNDING-SUBSTATION DETAILS_____41 7002
GROUNDING-REMOTE SITE DETAILS_____41 7003

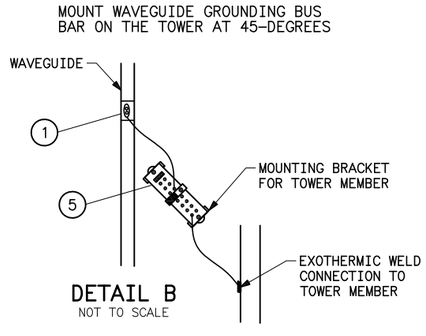




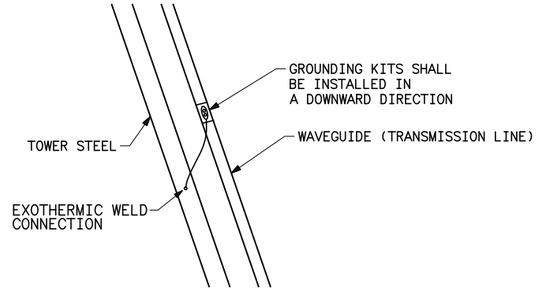
DETAIL D
NOT TO SCALE



DETAIL A
NOT TO SCALE



DETAIL B
NOT TO SCALE



DETAIL C
NOT TO SCALE

B	9-30-04 A79-SEJ	REVISED GROUNDING STRAP IN DETAIL A.
A	4-22-03 A79-JGW	ADDED TOWER BASE DETAIL.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

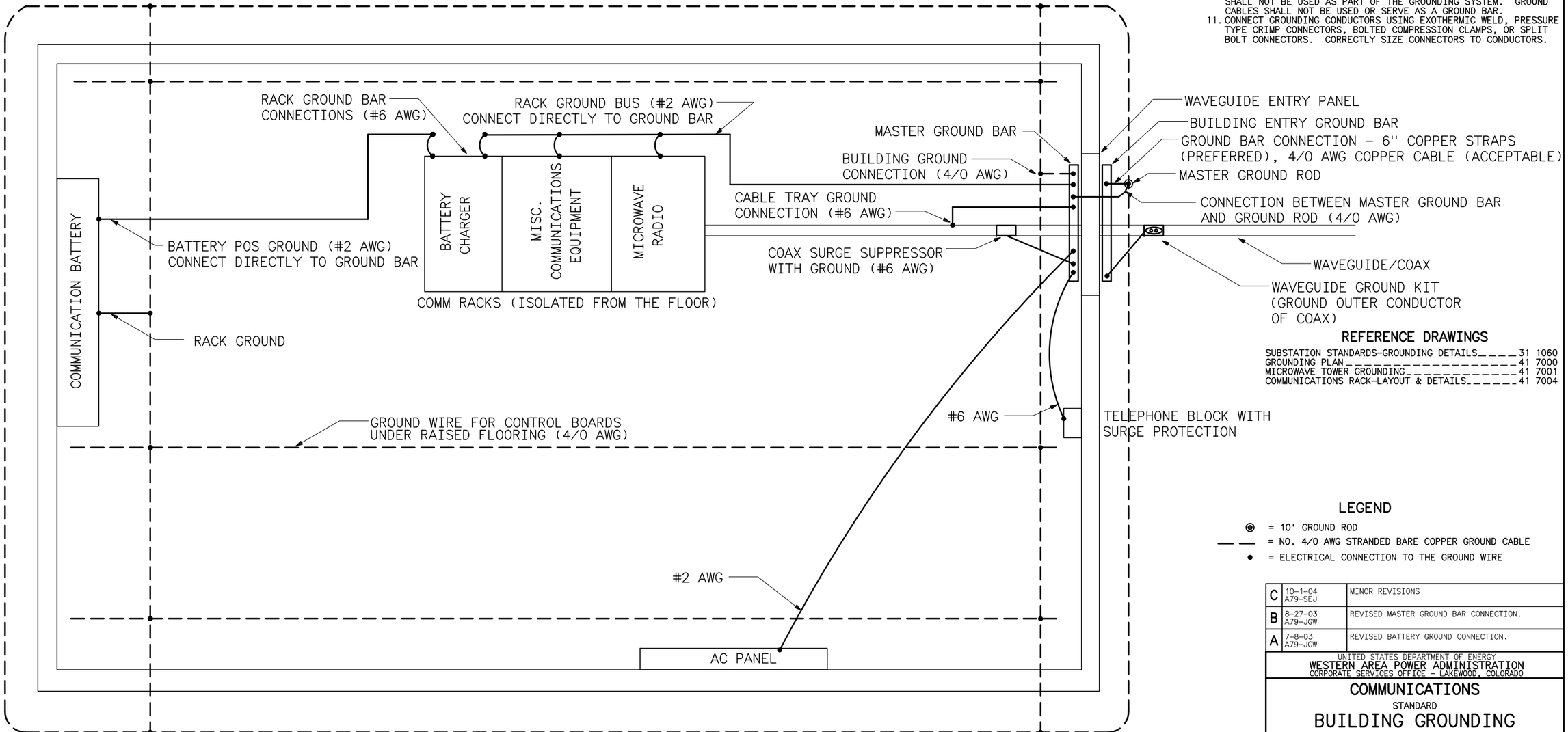
COMMUNICATIONS
STANDARD
MICROWAVE TOWER GROUNDING DETAILS

DESIGNED JEFF WILD APPROVED C.L. CLEMANS, SYSTEM CONTROL MANAGER

CAD	APRIL 1, 2002	41	7001

NOTES

1. GROUNDING PROCEDURES SHALL BE IN ACCORDANCE WITH STANDARD TIA/EIA 607.
2. EQUIPMENT GROUNDS SHALL BE CONNECTED TO THE GROUND BAR ON THE RACK. REFER TO DRAWING 41 7004.
3. USE TWO-HOLE COMPRESSION CONNECTORS TO BOND MASTER GROUND BAR TO THE UNDER FLOOR GROUND WIRE.
4. THE GROUND BARS SHALL BE AT LEAST 1/4-INCH THICK AND AND 2.5-INCH WIDE. INSULATED MOUNTING SUPPORTS SHALL BE USED TO ATTACH GROUND BARS TO THE WALL.
5. EACH ROW OF COMMUNICATIONS EQUIPMENT SHALL HAVE AN INDIVIDUAL GROUND BUS THAT IS ATTACHED TO THE MASTER GROUND BAR.
6. DO NOT INSTALL BARE GROUND WIRES IN METALLIC CONDUITS, RACEWAYS, OR CABLE TRAYS. USE ONLY INSULATED WIRES.
7. THE BUILDING ENTRY GROUND BAR, WAVEGUIDE ENTRY PORT, AND THE MASTER GROUND BAR CAN BE REPLACED BY A COMPLETE COPPER ENTRY PORT, POLYPHASER ENTRANCE PANEL OR EQUAL.
8. CONNECT GROUND WIRES FROM COAXIAL CABLE SURGE SUPPRESSORS TO THE MASTER GROUND BAR, IF PRESENT.
9. LOCATE THE GROUND BARS 6-INCHES BELOW THE WAVEGUIDE ENTRY PORT.
10. MAINTAIN AT LEAST 6-INCHES BETWEEN ALL GROUND CONDUCTORS AND DUCTS, I-BEAMS, AND STRUCTURAL STEEL. SUCH METALLIC OBJECTS SHALL NOT BE USED AS PART OF THE GROUNDING SYSTEM. GROUND CABLES SHALL NOT BE USED OR SERVE AS A GROUND BAR.
11. CONNECT GROUNDING CONDUCTORS USING EXOTHERMIC WELD, PRESSURE TYPE CRIMP CONNECTORS, BOLTED COMPRESSION CLAMPS, OR SPLIT BOLT CONNECTORS. CORRECTLY SIZE CONNECTORS TO CONDUCTORS.



REFERENCE DRAWINGS

SUBSTATION STANDARDS-GROUNDING DETAILS ____ 31 1060
GROUNDING PLAN ____ 41 7000
MICROWAVE TOWER GROUNDING ____ 41 7001
COMMUNICATIONS RACK-LAYOUT & DETAILS ____ 41 7004

LEGEND

- ◉ = 10' GROUND ROD
- — — = NO. 4/0 AWG STRANDED BARE COPPER GROUND CABLE
- • = ELECTRICAL CONNECTION TO THE GROUND WIRE

C	10-1-04 A79-SEJ	MINOR REVISIONS
B	8-27-03 A79-JGW	REVISED MASTER GROUND BAR CONNECTION.
A	7-8-03 A79-JGW	REVISED BATTERY GROUND CONNECTION.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

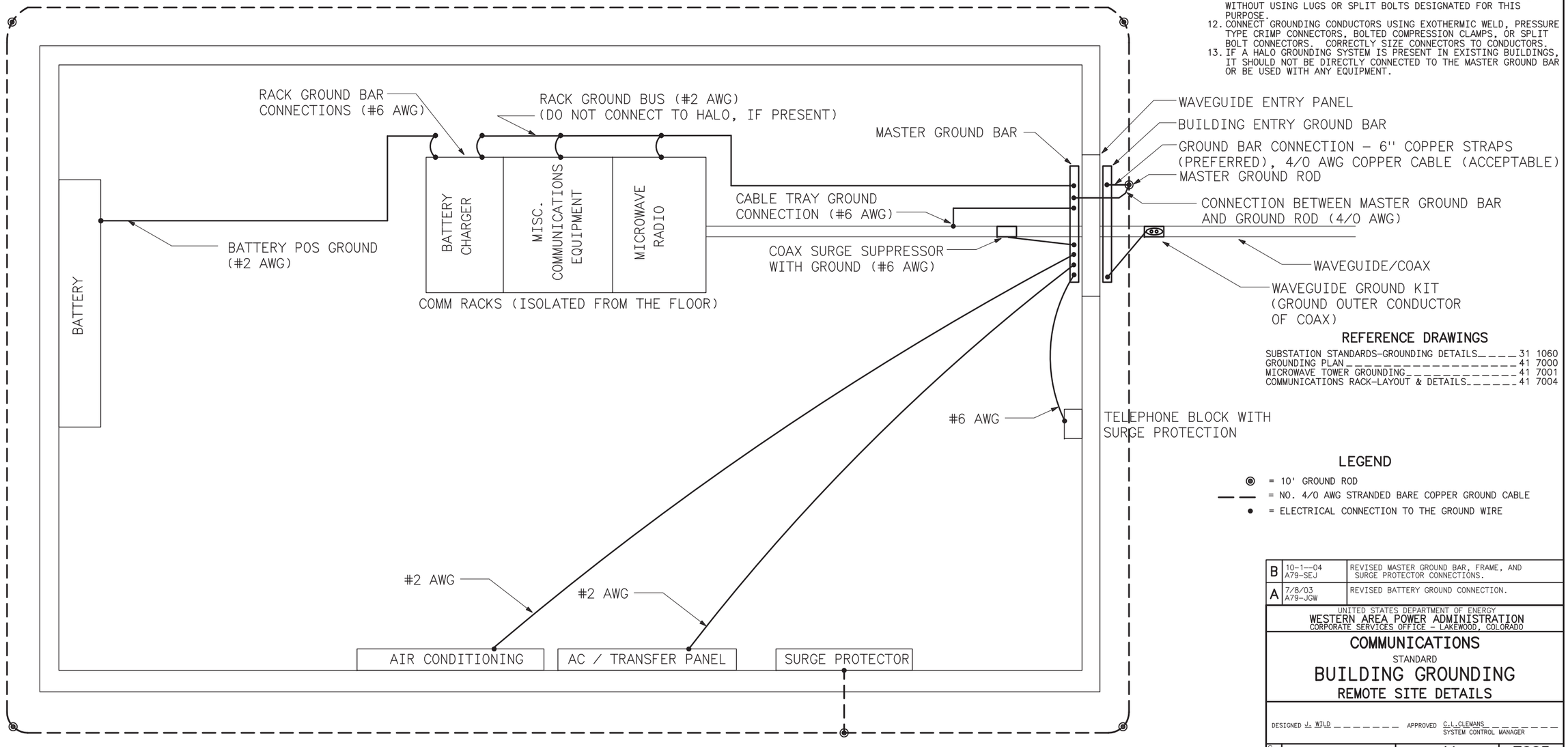
COMMUNICATIONS
STANDARD
BUILDING GROUNDING
SUBSTATION DETAILS

DESIGNED J. WILD APPROVED C.L. CLEMANS, SYSTEM CONTROL MANAGER

CAE	JUNE 1, 2003	41	7002

NOTES

1. GROUNDING PROCEDURES SHALL BE IN ACCORDANCE WITH STANDARD TIA/EIA 607.
2. EQUIPMENT GROUNDS SHALL BE CONNECTED TO THE GROUND BAR ON THE RACK. REFER TO DRAWING 41 7004.
3. THE GROUND BARS SHALL BE AT LEAST 1/4-INCH THICK AND AND 2.5-INCH WIDE. INSULATED MOUNTING SUPPORTS SHALL BE USED TO ATTACH GROUND BARS TO THE WALL.
4. EACH ROW OF COMMUNICATIONS EQUIPMENT SHALL HAVE AN INDIVIDUAL GROUND BUS THAT IS ATTACHED TO THE MASTER GROUND BAR.
5. DO NOT INSTALL BARE GROUND WIRES IN METALLIC CONDUITS, RACEWAYS, OR CABLE TRAYS. USE ONLY INSULATED WIRES.
6. THE BUILDING ENTRY GROUND BAR, WAVEGUIDE ENTRY PORT, AND THE MASTER GROUND BAR CAN BE REPLACED BY A COMPLETE COPPER ENTRY PORT, POLYPHASER ENTRANCE PANEL OR EQUAL.
7. CONNECT GROUND WIRES FROM COAXIAL CABLE SURGE SUPPRESSORS TO THE MASTER GROUND BAR IF PRESENT.
8. LOCATE THE GROUND BARS 6-INCHES BELOW THE WAVEGUIDE ENTRY PORT.
9. MAINTAIN AT LEAST 6-INCHES BETWEEN ALL GROUND CONDUCTORS AND DUCTS, I-BEAMS, AND STRUCTURAL STEEL. SUCH METALLIC OBJECTS SHALL NOT BE USED AS PART OF THE GROUNDING SYSTEM. GROUND CABLES SHALL NOT BE USED OR SERVE AS A GROUND BAR.
10. CONNECT DOORS, DOORFRAMES, LOUVERS, ELECTRICAL PANELS, HVAC EQUIPMENT, TRANSFER SWITCHES, CONDUIT, CABLE TRAYS, AND BATTERY RACKS TO MASTER GROUND BAR OR CHASSIS/FRAME GROUND BAR THAT IS CONNECTED TO THE MASTER GROUND BAR.
11. ENSURE THAT DISSIMILAR METALS ARE NOT CONNECTED TOGETHER WITHOUT USING LUGS OR SPLIT BOLTS DESIGNATED FOR THIS PURPOSE.
12. CONNECT GROUNDING CONDUCTORS USING EXOTHERMIC WELD, PRESSURE TYPE CRIMP CONNECTORS, BOLTED COMPRESSION CLAMPS, OR SPLIT BOLT CONNECTORS. CORRECTLY SIZE CONNECTORS TO CONDUCTORS.
13. IF A HALO GROUNDING SYSTEM IS PRESENT IN EXISTING BUILDINGS, IT SHOULD NOT BE DIRECTLY CONNECTED TO THE MASTER GROUND BAR OR BE USED WITH ANY EQUIPMENT.



REFERENCE DRAWINGS

SUBSTATION STANDARDS-GROUNDING DETAILS	31 1060
GROUNDING PLAN	41 7000
MICROWAVE TOWER GROUNDING	41 7001
COMMUNICATIONS RACK-LAYOUT & DETAILS	41 7004

LEGEND

- ◉ = 10' GROUND ROD
- — — = NO. 4/0 AWG STRANDED BARE COPPER GROUND CABLE
- • = ELECTRICAL CONNECTION TO THE GROUND WIRE

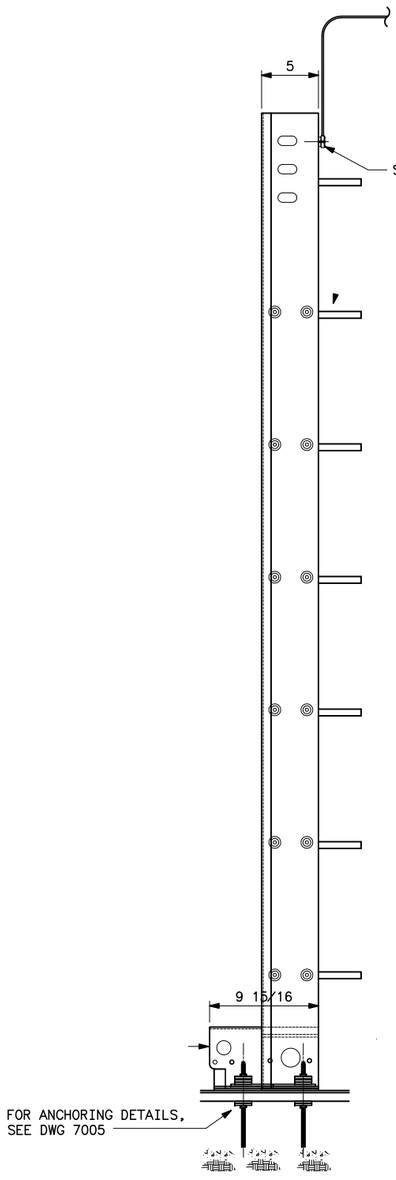
B	10-1-04 A79-SEJ	REVISED MASTER GROUND BAR, FRAME, AND SURGE PROTECTOR CONNECTIONS.
A	7/8/03 A79-JGW	REVISED BATTERY GROUND CONNECTION.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

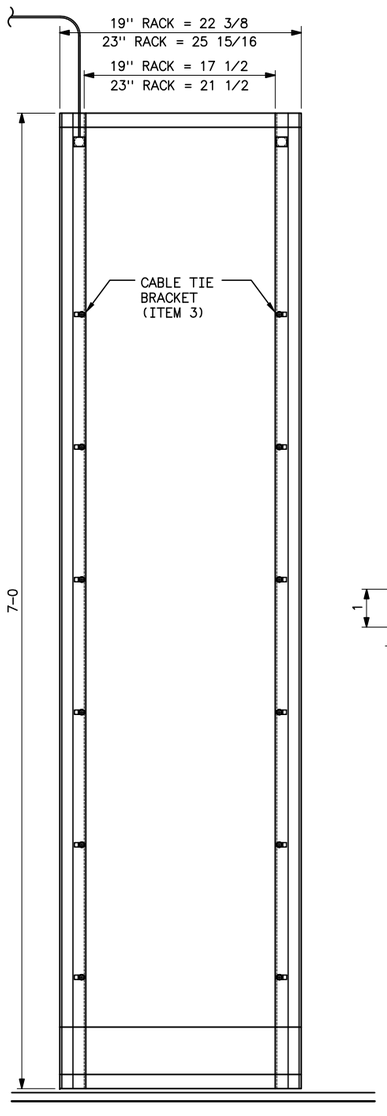
COMMUNICATIONS
STANDARD
BUILDING GROUNDING
REMOTE SITE DETAILS

DESIGNED J. WILD APPROVED C.L.CLEMANS SYSTEM CONTROL MANAGER

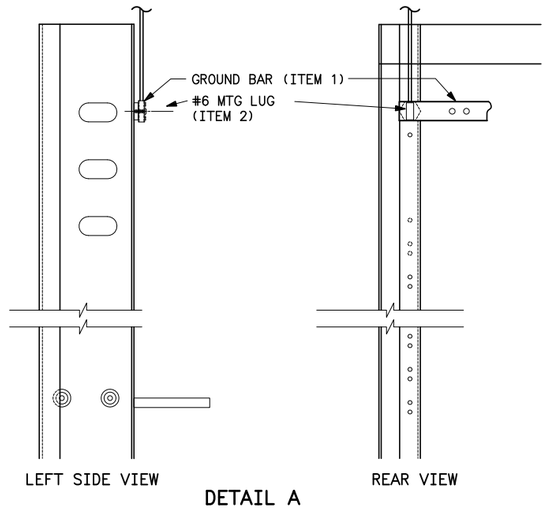
CAE	JUNE 1, 2003	41	7003



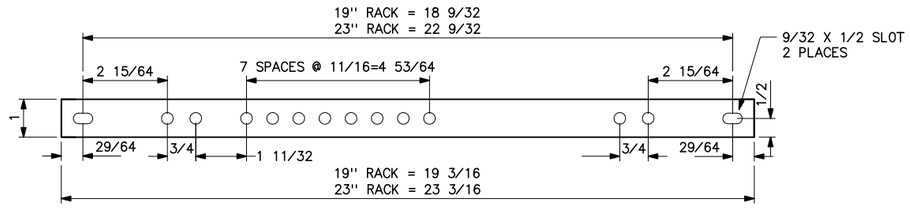
SIDE VIEW



REAR VIEW

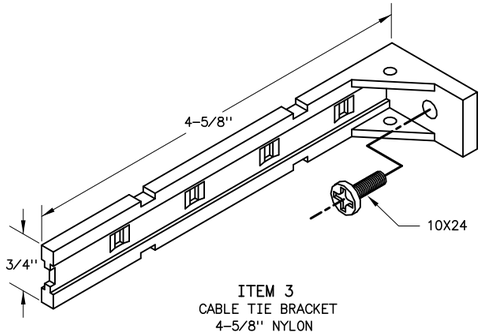


DETAIL A



ITEM 1
1/4 X 1 COPPER GROUND BAR

ITEM 2
#6 MTG LUG



ITEM 3
CABLE TIE BRACKET
4-5/8'' NYLON

REFERENCE DRAWINGS

EQUIPMENT RACK
ANCHORING & GROUNDING DETAILS 41 7005

NOTES

1. UNLESS NOTED, ALL RACKS ARE 7'-0'' HIGH AND 19'' WIDE.
2. RACK FLANGES ARE DRILLED FRONT AND REAR WITH EIA STANDARD 1.75'' RACK UNIT (RU) HOLE PATTERNS.
3. ALL RACKS HAVE FRONT MOUNTED COVERED BASE GUARD RAIL.
4. SEE BUILDING DRAWINGS FOR FLOOR LAYOUT AND RACK LOCATION AND DESIGNATION.
5. EQUIPMENT RACKS FROM OTHER MANUFACTURERS CAN BE USED WITH ACCEPTANCE FROM COR.

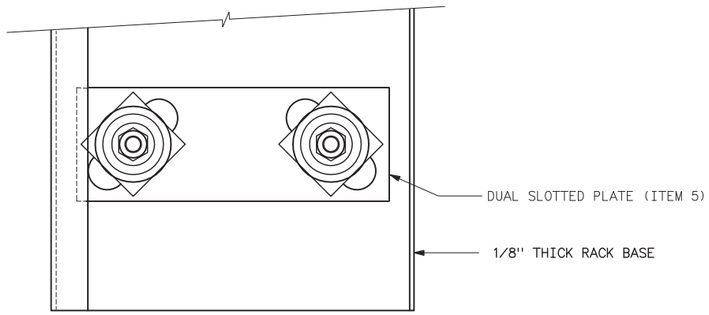
A	9-22-11 A7-SEJ	UPDATED MODIFICATIONS

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

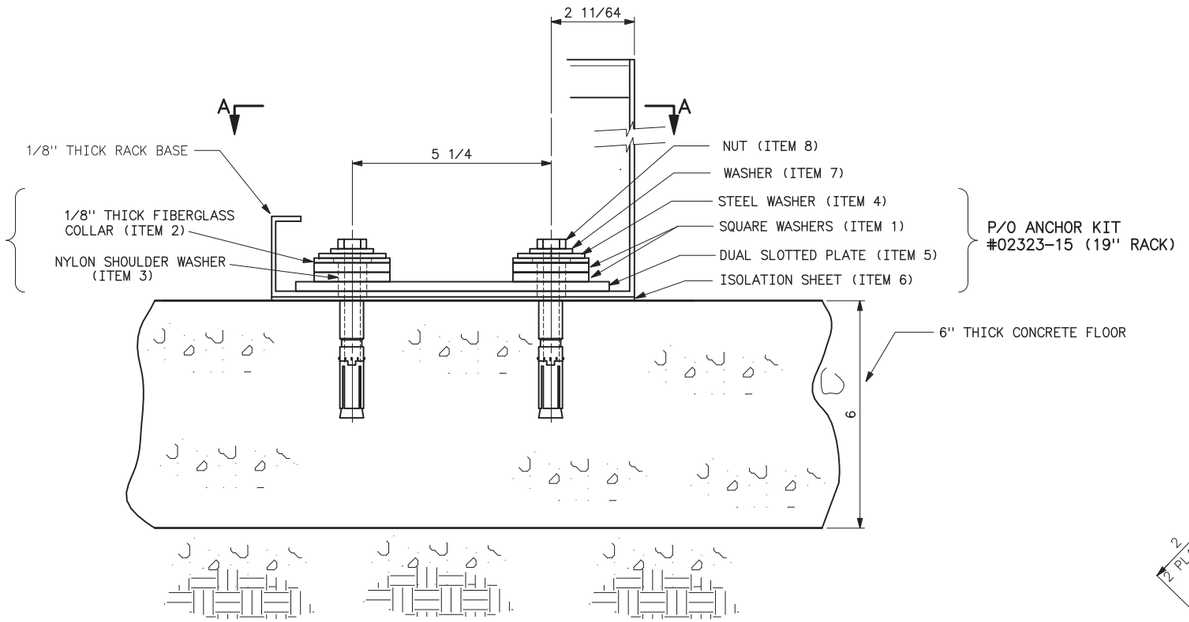
COMMUNICATIONS
STANDARD
EQUIPMENT RACK
LAYOUT & DETAILS

DESIGNED J. WILD APPROVED C.L. CLEMANS, SYSTEM CONTROL MANAGER

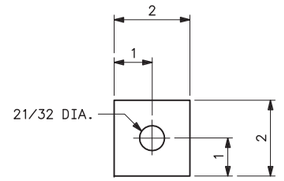
CAD	JUNE 1, 2003	41	7004



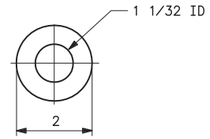
VIEW A–A



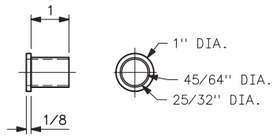
0 1 2 3 4 5 6
SCALE OF INCHES



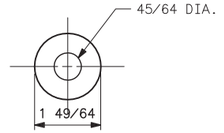
1/4'' THICK SQUARE WASHER
ITEM 1



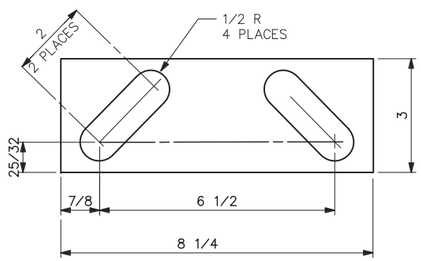
1/8'' THICK FIBER WASHER
ITEM 2



NYLON SHOULDER WASHER
ITEM 3

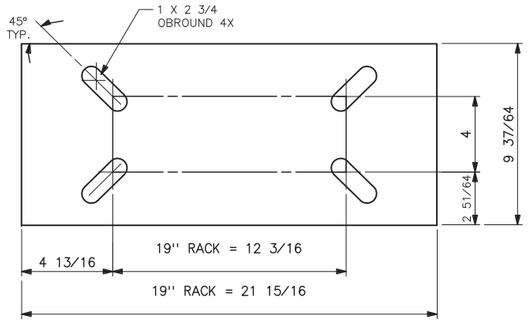


1/8 '' THICK STEEL WASHER
ITEM 4



1/4'' THICK DUAL SLOTTED PLATE
ITEM 5

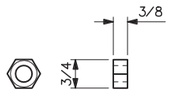
0 1 2 3 4 5 6
SCALE OF INCHES



ISOLATION SHEET FULL BASE
1/16'' THICK FIBERGLASS
ITEM 6

0 3 6 9 12
SCALE OF INCHES

1/8'' THICK HILTI WASHER
ITEM 7



12mm HILTI NUT
ITEM 8

0 1 2 3 4 5 6
SCALE OF INCHES

REFERENCE DRAWINGS

EQUIPMENT RACK – LAYOUT & DETAILS_ _ _ _ _ _ 41 7004

NOTES

1. ANCHOR KIT #02323–15 COMES WITH ANCHOR BOLTS USED TO MOUNT RACKS ON CONCRETE FLOORS.
2. RACKS MOUNTED ON RAISED FLOORS, USE ISOLATED KIT #01464–01, HILTI ANCHOR #HSL–I–12M, AND 12MM THREADED ROD.
3. EQUIVALENT RACKS FROM DIFFERENT MANUFACTURERS CAN BE USED WITH ACCEPTANCE FROM COR.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
SIERRA NEVADA REGION – FOLSOM, CALIFORNIA

COMMUNICATIONS

STANDARD

EQUIPMENT RACK

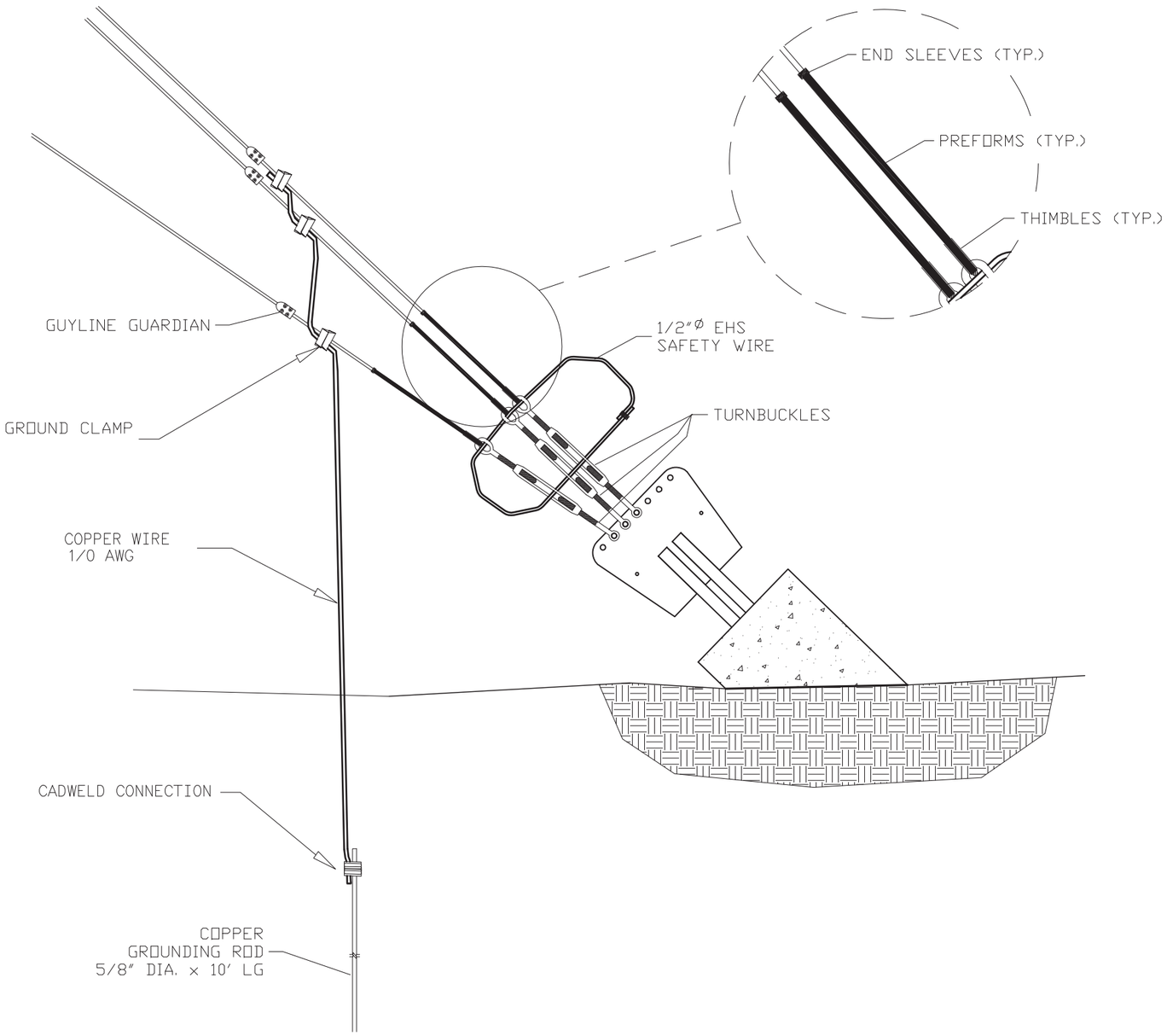
ANCHORING & GROUNDING DETAILS

DESIGNED J. WILD _ _ _ _ _ _ _ _ APPROVED C.L. CLEMANS _ _ _ _ _ _ _ _
SYSTEM CONTROL MANAGER

CAE	JUNE 1, 2003	41	7005

NOTES:

1. ALL GUY ATTACHMENT HARDWARE TO BE PROPERLY SIZED FOR EACH GUY STRAND.
2. GROUNDING ROD IS TO BE AT LEAST 4'-0" AWAY FROM GUY ANCHOR.
3. GROUND CLAMPS SHALL BE BRONZE, STAINLESS STEEL OR BRASS.

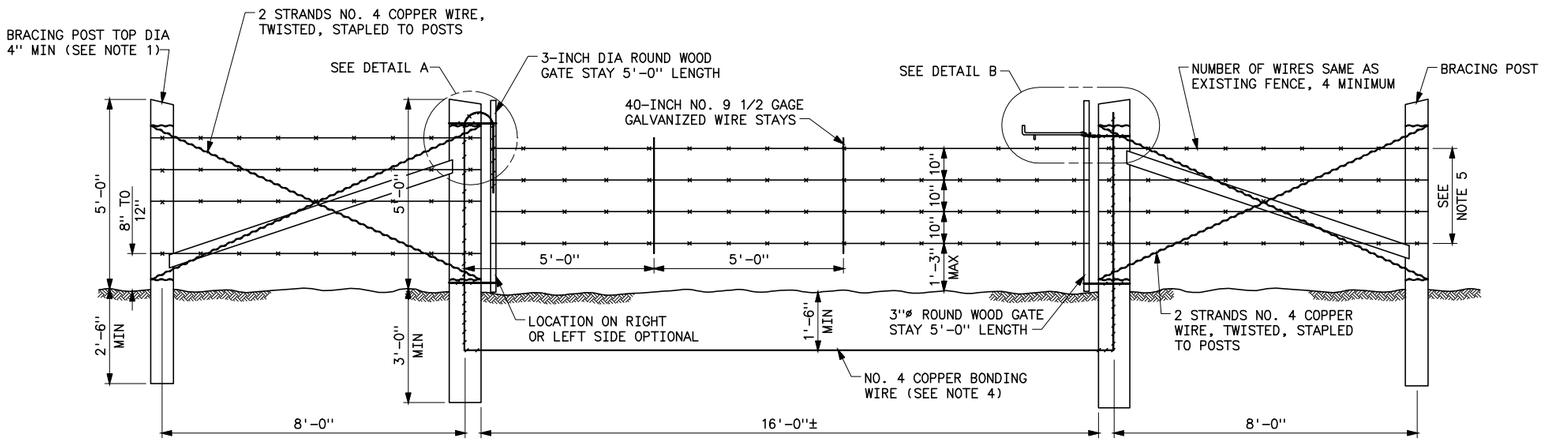


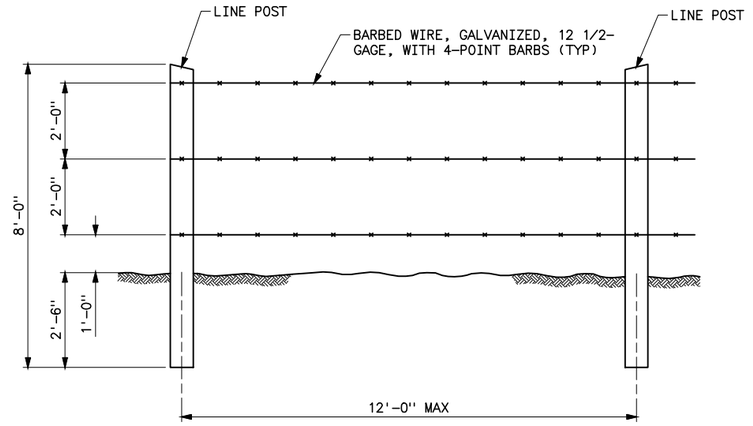
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

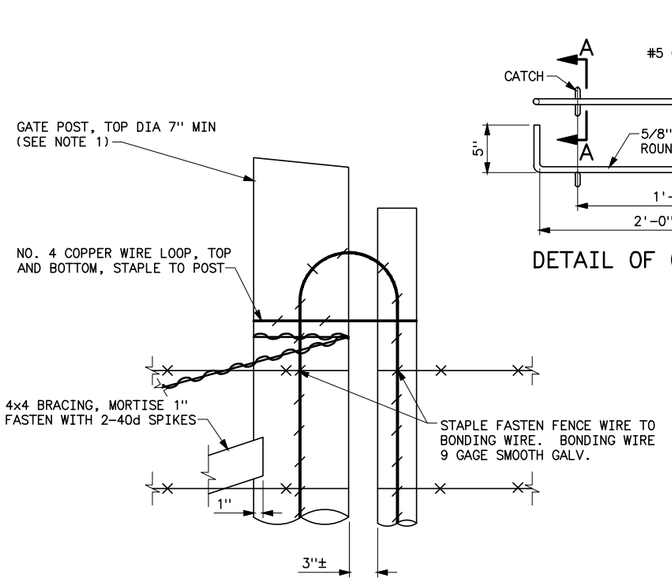
COMMUNICATIONS
GUY TOWER GROUNDING
STANDARD
ANCHOR GROUND DETAILS

DESIGNED S. JOHNSON APPROVED C. L. CLEMANS
SYSTEM CONTROL MANAGER

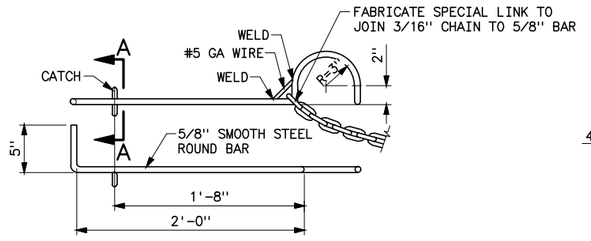
CAE	10-4-04	41	7006



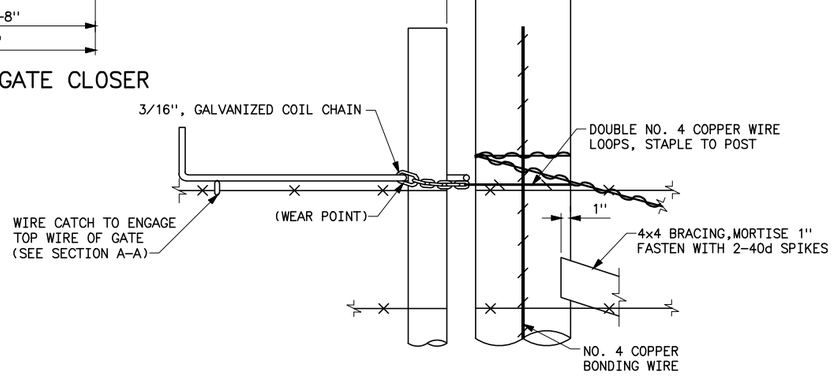




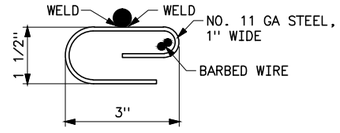
DETAIL A



DETAIL OF GATE CLOSER



DETAIL B



SECTION A-A
(DETAIL OF CATCH)

NOTES

1. GATE CONSTRUCTION INCLUDES POSTS AND BRACING.
2. POSTS AND BRACES SHALL BE PRESSURE-TREATED TIMBER.
3. GATE CLOSER SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM DESIGNATION A-153.
4. INSTALL BOTTOM COPPER BONDING WIRE BETWEEN GATE POSTS ONLY IF GATE IS WITHIN A FENCE WHICH CROSSES UNDER OR IS PARALLEL TO AND WITHIN 150 FEET OF TRANSMISSION LINE CENTERLINE.
5. CONNECT EACH NEW FENCE WIRE TO EXISTING FENCE WIRE FOR ELECTRICAL GROUNDING.

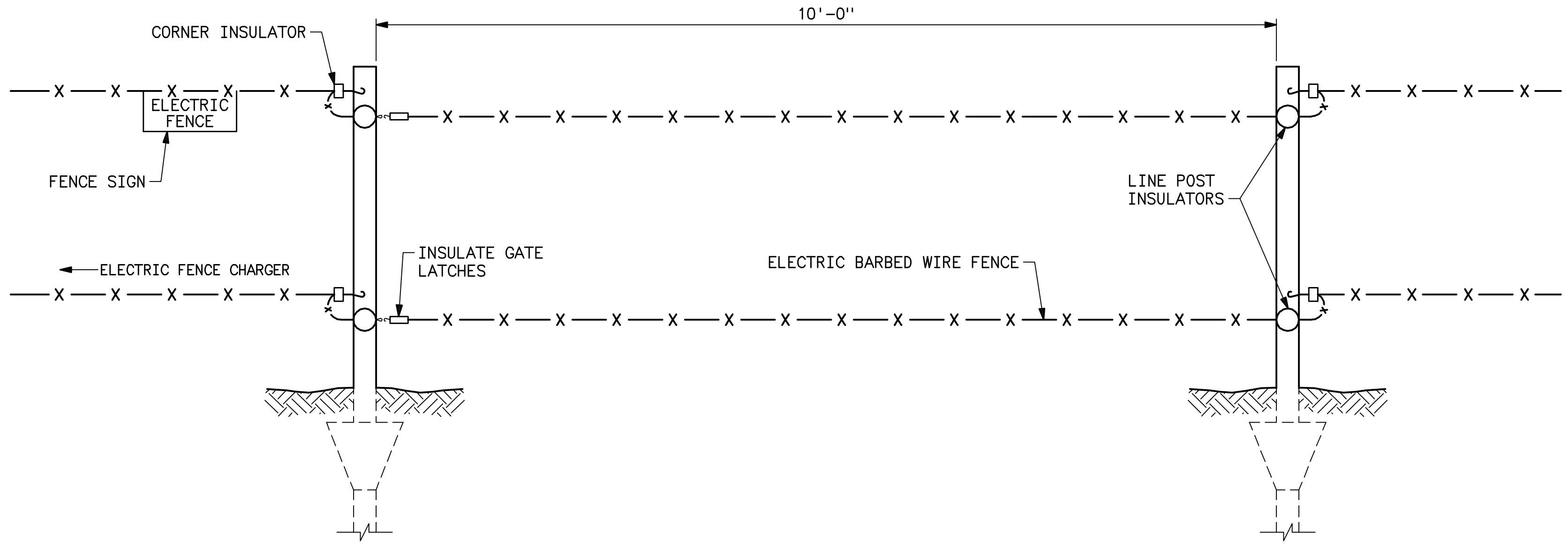
N	10-26-11 A7-KR	MINOR RRVISIONS
M	7-21-10 A7-DH	MINOR REVISIONS.
L	5-15-07 A7-DH	MINOR REVISIONS.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
BARBED WIRE GATE
FOR RIGHT-OF-WAY FENCES

DESIGNED K. ROWE APPROVED W.C. COWAN
CHIEF, TRANSMISSION LINE
STRUCTURAL BRANCH

A-E	APRIL 25,1994	41	9002



LIST OF MATERIALS	
QTY	DESIGNATION
4	BOLT, "J" TYPE, WITH WING NUT
4	INSULATOR, CORNER
4	INSULATOR, LINE POST
2	LATCH, GATE INSULATED
2	POST, ANGLE, 3/4x3/4x7/64 – 4 1/2 FEET HIGH
1	SIGN, ELECTRIC FENCE, 4x8
20'	WIRE, BARBED, 18-GA GALV STEEL FOR ELEC FENCE

NOTE

1. WHERE SINGLE WIRE FENCES EXIST, FURNISH AND INSTALL MATERIALS FOR SINGLE WIRE GATE.

C	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
B	7-13-99 A3-RMC	REDRAWN.

SUPERSEDES DWG NO. 40-D-5910

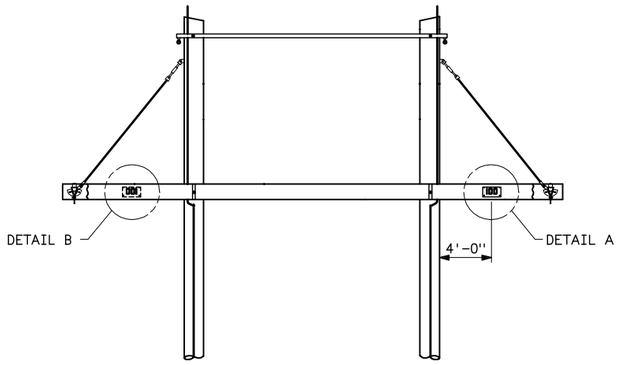
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
ELECTRIC BARBED WIRE GATE
FOR RIGHT-OF-WAY FENCES

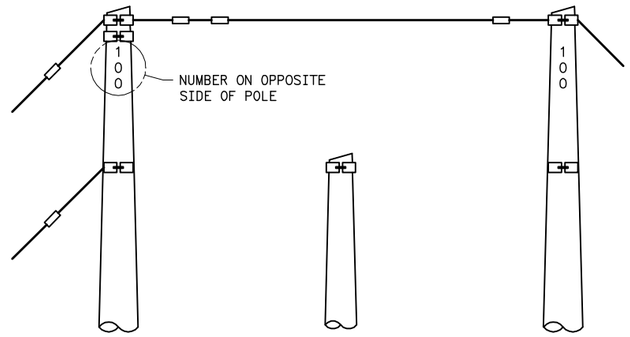
DESIGNED BUREC

APPROVED ROSS M. CLARK
ELECTRICAL ENGINEERING MANAGER

CAE	JUNE 24, 1981	41	9003



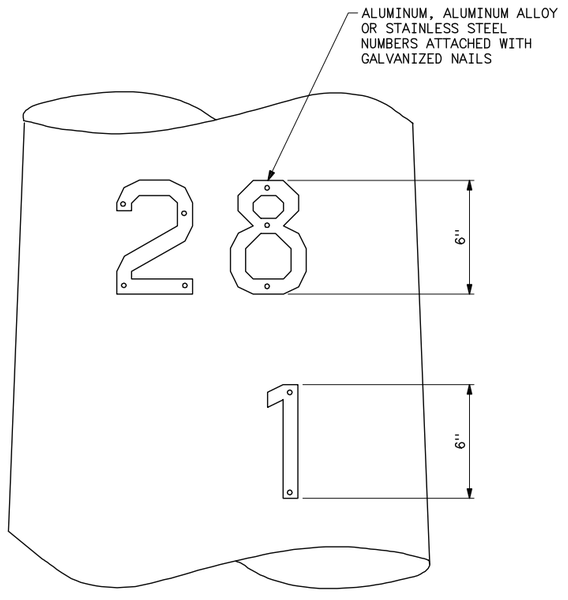
AERIAL PATROL MILE MARKER SIGN LOCATION
H-FRAME STRUCTURE



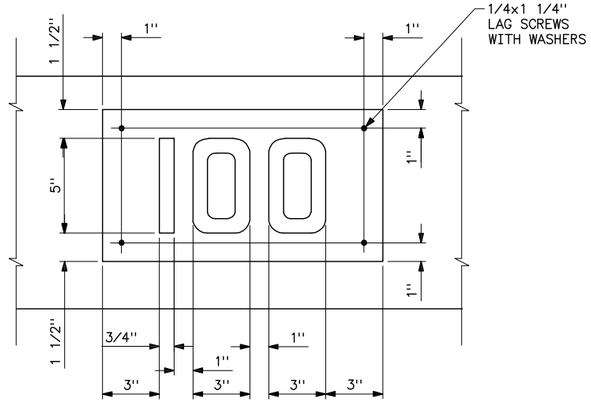
AERIAL PATROL MILE MARKER SIGN LOCATION
3-POLE OR SINGLE POLE STRUCTURES
(SEE NOTE 8)

NOTES

1. SIGNS SHALL BE MADE OF NO. 18 U.S. GAGE SHEET STEEL.
2. FINISH SHALL BE PORCELAIN ENAMEL. BACKGROUND COLOR SHALL BE YELLOW, FIGURES SHALL BE BLACK.
3. FIGURES SHALL BE OF THE "BLOCK" TYPE, 5-INCHES HIGH AND 3-INCHES WIDE. BODY LINES SHALL BE 3/4-INCH WIDE.
4. EACH SIGN SHALL HAVE FOUR FINISHED 1/2-INCH HOLES. HOLES IN SIGNS SHALL BE FITTED WITH BRASS EYELETS.
5. EACH SIGN SHALL BE 8-INCHES HIGH, WIDTH MAY VARY AS FOLLOWS:
   FOR THREE DIGIT SIGNS SUCH AS 200, WIDTH SHALL BE 17-INCHES;
   FOR THREE DIGIT SIGNS SUCH AS 100, WIDTH SHALL BE 15-INCHES;
   FOR TWO DIGIT SIGNS SUCH AS 20, WIDTH SHALL BE 13-INCHES;
   FOR ONE DIGIT SIGNS SUCH AS 2, WIDTH SHALL BE 9-INCHES.
6. THE PORCELAIN ENAMEL SHALL BE IN ACCORDANCE WITH THE RECOMMENDED STANDARDS FOR MANUFACTURE OF PORCELAIN ENAMEL SIGNS (PEI:S-103) OF THE SIGN DIVISION OF THE PORCELAIN ENAMEL INSTITUTE, INC.
7. ALL FERROUS HARDWARE SHALL BE GALVANIZED.
8. 6-INCH HIGH NUMBERS SHALL BE ATTACHED ONE FOOT BELOW LOWEST POLE BAND ON RIGHT HAND POLE SIMILAR TO STRUCTURE NUMBER SIGNS.



STRUCTURE NUMBER SIGNS
(MOUNT 6 FOOT ABOVE GROUNDLINE)



AERIAL PATROL MILE MARKER SIGNS
(ONLY ON FIRST STRUCTURE OF EACH MILE SECTION OF LINE)

DETAIL A (FRONT FACE)
DETAIL B (BACK FACE)

D	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
C	8-21-95 A2-RMC	REVISED AND REDRAWN.

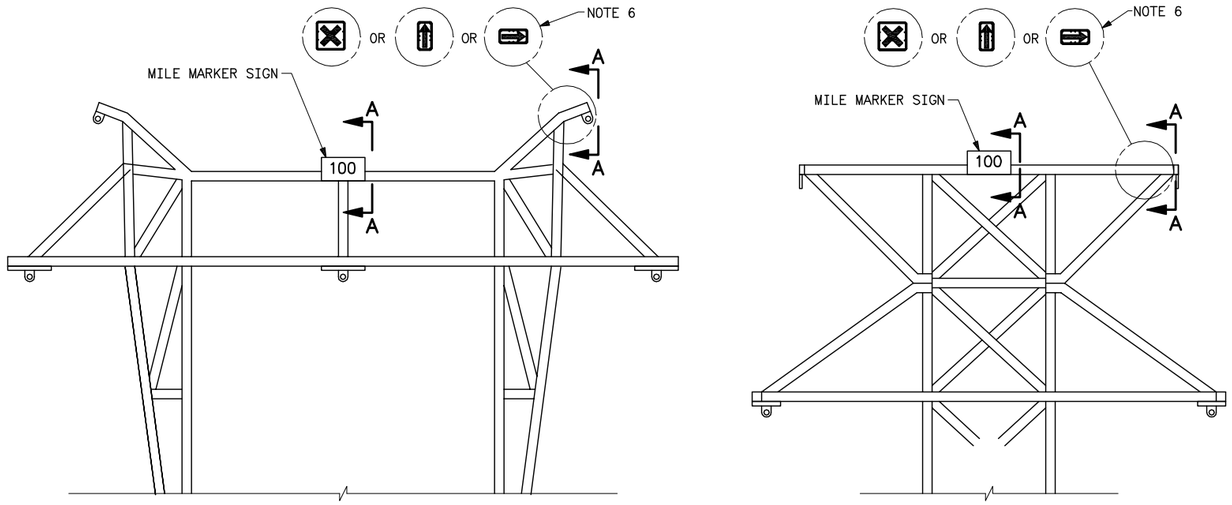
SUPERSEDES DWG NO. 40-D-5174

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

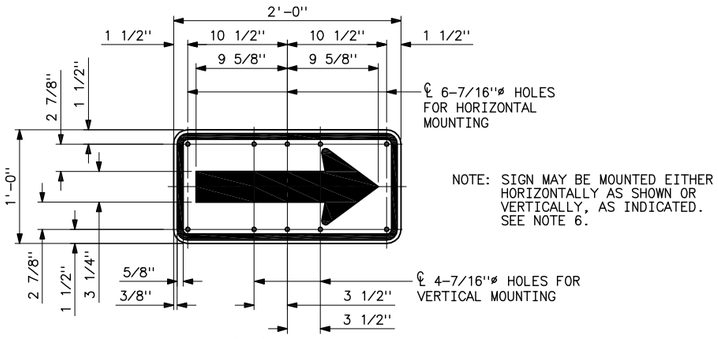
TRANSMISSION LINE STANDARDS
WOOD POLE STRUCTURES
AERIAL PATROL MILE MARKER AND NUMBER SIGNS

DESIGNED K. ROWE APPROVED ROSS CLARK
CHIEF, TRANSMISSION LINE BRANCH

SIZE			
A	AUGUST 21, 1995	41	9004

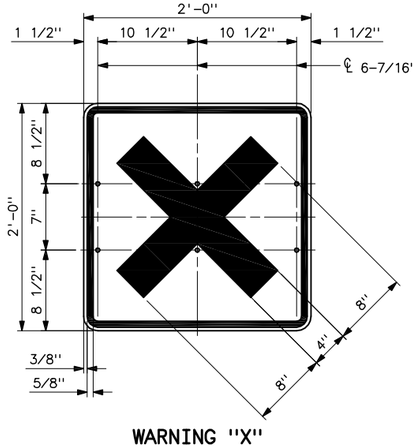


LOCATION AND MOUNTING DETAILS FOR SIGNS ON LATTICE STEEL TOWERS

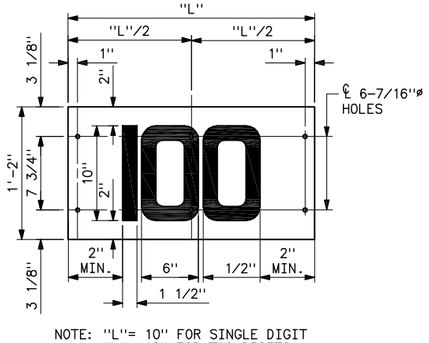


NOTE: SIGN MAY BE MOUNTED EITHER HORIZONTALLY AS SHOWN OR VERTICALLY, AS INDICATED. SEE NOTE 6.

WARNING ARROW

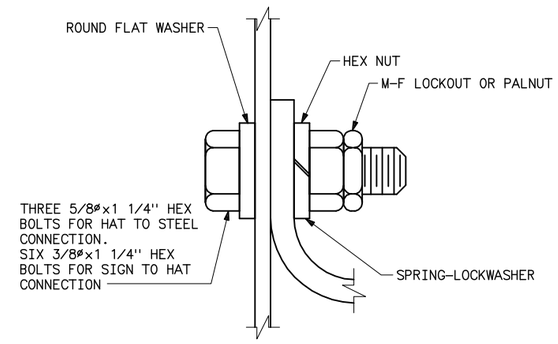


WARNING "X"

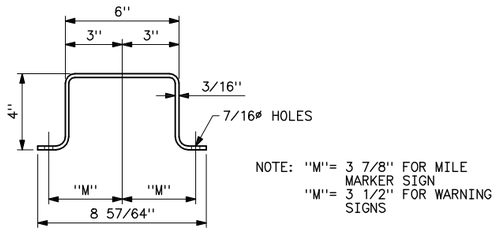


NOTE: "L"= 10" FOR SINGLE DIGIT
"L"= 18" FOR TWO DIGITS
"L"= 26" FOR THREE DIGITS

MILE MARKER SIGNS
2 SIGNS PER TOWER

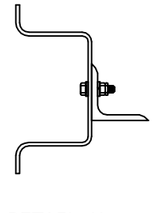


DETAIL B
SIGN MOUNTING HARDWARE
(SEE NOTE 2)

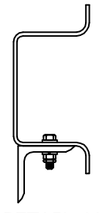


NOTE: "M"= 3 7/8" FOR MILE MARKER SIGN
"M"= 3 1/2" FOR WARNING SIGNS

HAT SECTION
LEGNTH OF HAT SHALL BE SAME AS SIGN

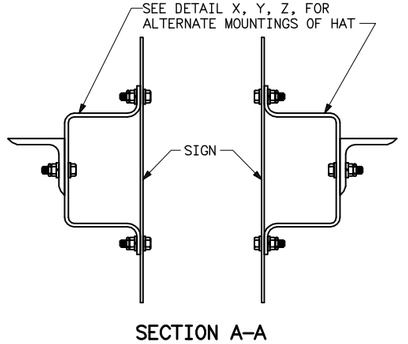


DETAIL X



DETAIL Y
SEE DETAIL B FOR MOUNTING HARDWARE

DETAIL Z



SECTION A-A

MATERIAL SPECIFICATIONS
(FOR MILE MARKER SIGNS)

1. SIGNS SHALL BE MADE OF NO. 16 US GAUGE SHEET STEEL.
2. FINISH SHALL BE PORCELAIN ENAMEL. BACKGROUND COLOR SHALL BE YELLOW. FIGURES SHALL BE BLACK.
3. FIGURES SHALL BE OF THE "BLOCK" TYPE, 10 INCHES HIGH AND 6 INCHES WIDE. BODY LINES SHALL BE 1 1/2 INCHES WIDE.
4. THE PORCELAIN ENAMEL SHALL BE IN ACCORDANCE WITH THE RECOMMENDED STANDARDS FOR MANUFACTURE OF PORCELAIN ENAMEL SIGNS (PEI:S-103) OF THE SIGN DIVISION OF THE PORCELAIN ENAMEL INSTITUTE, INC.
5. ALL FERROUS HARDWARE SHALL BE GALVANIZED.

NOTES

1. FIRST STRUCTURE OF EACH MILE SECTION SHALL BE MARKED WITH TWO METAL AERIAL PATROL NUMBER SIGNS, ONE MOUNTED EACH SIDE OF TOWER AS SHOWN ABOVE. LOCATION AND MOUNTING DETAILS ARE GENERAL AND MAY BE MODIFIED TO SUIT LOCAL CONDITIONS.
2. HOLES FOR MOUNTING HARDWARE SHALL BE 1/16" LARGER THAN SIZE OF BOLT USED. HOLES IN SIGNS SHALL BE FURNISHED AND FITTED WITH BRASS EYELETS. LONGITUDINAL SPACING OF ALL HOLES IN HAT SECTIONS INCLUDING THOSE FOR HAT SECTIONS TO STEEL CONNECTIONS SHALL BE THE SAME AS USED FOR SIGNS.
3. WARNING "X" SIGN SHALL BE STANDARD UNITED STATES DEPARTMENT OF TRANSPORTATION (DOT) FEDERAL HIGHWAY SIGN, DESIGNATION W2-1, TURNED ONE-FOURTH OF A TURN TO BECOME AN "X".
4. WARNING ARROW SIGN SHALL BE STANDARD DOT SIGN DESIGNATION W1-6.
5. BACKGROUND COLOR FOR WARNING SIGNS SHALL BE ENGINEER GRADE YELLOW IN ACCORDANCE WITH ASTM D 4956. "X" OR ARROW SHALL BE BLACK.
6. FOR STRUCTURE LOCATIONS AND REQUIRED TYPE OF WARNING SIGN, SEE SPECIFICATIONS AND PLAN AND PROFILE DRAWINGS.

REFERENCE DRAWING

AERIAL PATROL WARNING SIGNS
AND MARKER BALL MARKING DIAGRAMS_ _ _ _ _ _ _ 41 9029

D	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
C	11-7-00 A3-RMC	REDRAWN, ADDED WARNING SIGNS, NOTES, AND REFERENCE DRAWING NUMBER.
B	7-13-99 A3-RMC	REDRAWN.

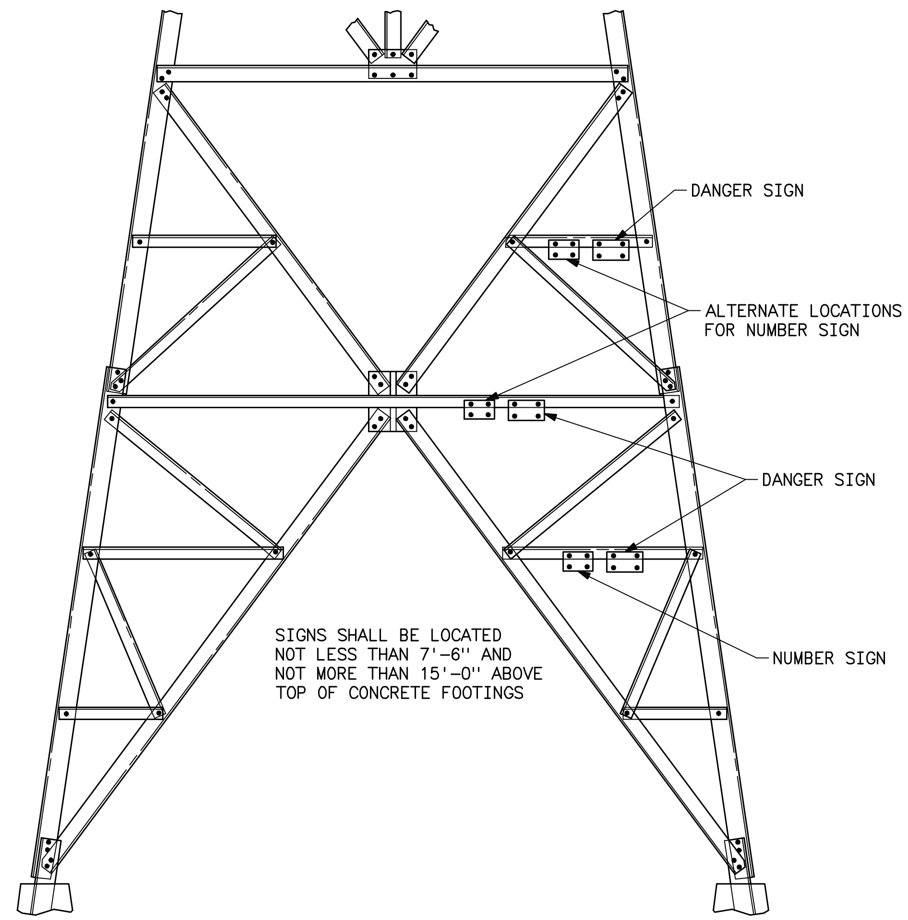
SUPERSEDES DWG NO. 40-D-6045

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

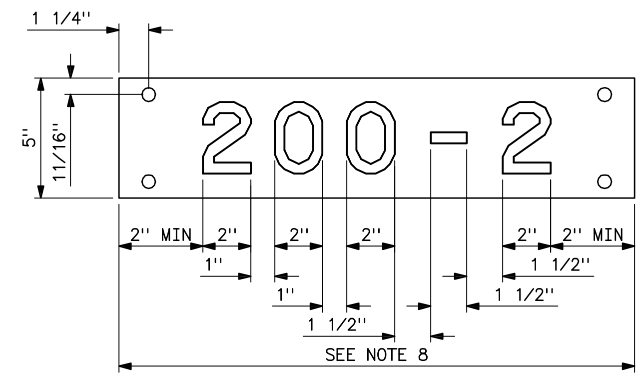
TRANSMISSION LINE STANDARDS
LATTICE STEEL TOWERS
AERIAL PATROL MILE MARKER NUMBER AND WARNING SIGNS

DESIGNED BUREC_ _ _ _ _ _ _ _ APPROVED ROSS M. CLARK_ _ _ _ _ _ _ _
ELECTRICAL ENGINEERING MANAGER

CAD	DATE		
	AUGUST 6, 1979	41	9005



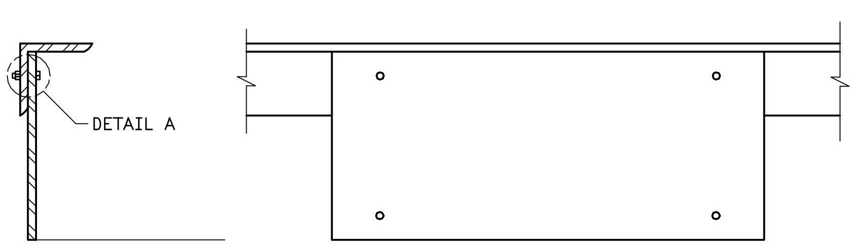
STRUCTURE NUMBER LOCATION



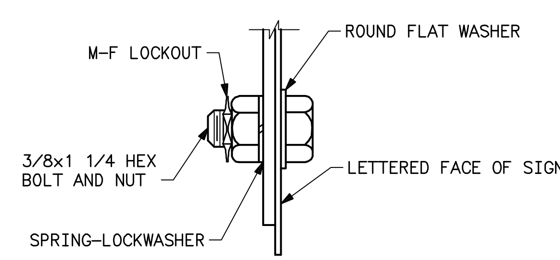
NUMBER SIGN SPECIFICATIONS

NOTES

1. SIGNS SHALL BE FASTENED BY MEANS OF EITHER THE TOP OR THE BOTTOM TWO HOLES.
2. ALL FERROUS HARDWARE SHALL BE GALVANIZED.
3. SEE DRAWING NO. 41 9027 FOR LOCATION OF SIGNS ON TUBULAR STEEL STRUCTURES.
4. SIGNS SHALL BE MADE OF NO. 18 US GAUGE SHEET STEEL.
5. FINISH SHALL BE PORCELAIN ENAMEL. BACKGROUND COLOR SHALL BE YELLOW. FIGURES SHALL BE BLACK.
6. FIGURES SHALL BE OF THE "BLOCK" TYPE, 3-INCHES HIGH AND 2-INCHES WIDE. BODY LINES SHALL BE 1/2-INCH WIDE.
7. EACH SIGN SHALL HAVE FOUR FINISHED HOLES LARGE ENOUGH TO TAKE 3/8-INCH BOLTS. HOLES IN SIGNS SHALL BE FITTED WITH BRASS EYELETS.
8. EACH SIGN SHALL BE 5-INCHES HIGH, WIDTH MAY VARY AS FOLLOWS:
   FOR FOUR DIGIT SIGNS SUCH AS 200-2, WIDTH SHALL BE 18 1/2-INCHES.
   FOR FOUR DIGIT SIGNS SUCH AS 100-2, WIDTH SHALL BE 17-INCHES.
   FOR THREE DIGIT SIGNS SUCH AS 20-2, WIDTH SHALL BE 15 1/2-INCHES.
   FOR TWO DIGIT SIGNS SUCH AS 2-2, WIDTH SHALL BE 12 1/2-INCHES.
9. THE PORCELAIN ENAMEL SHALL BE IN ACCORDANCE WITH THE RECOMMENDED STANDARDS FOR MANUFACTURE OF PORCELAIN ENAMEL SIGNS (PEI:S-103) OF THE SIGN DIVISION OF THE PORCELAIN INSTITUTE, INC.
10. TWO SIGNS PER STRUCTURE ONE AHEAD ON LINE AND ONE BACK.



SIGN FASTENING DETAIL



DETAIL A
SIGN MOUNTING HARDWARE

F	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
E	01-29-03 A7-RMC	REVISED DRAWING NUMBER IN NOTES AND ADDED NOTE 10.
D	7-13-99 A3-RMC	REDRAWN.

SUPERSEDES DWG NO. 40-D-5762

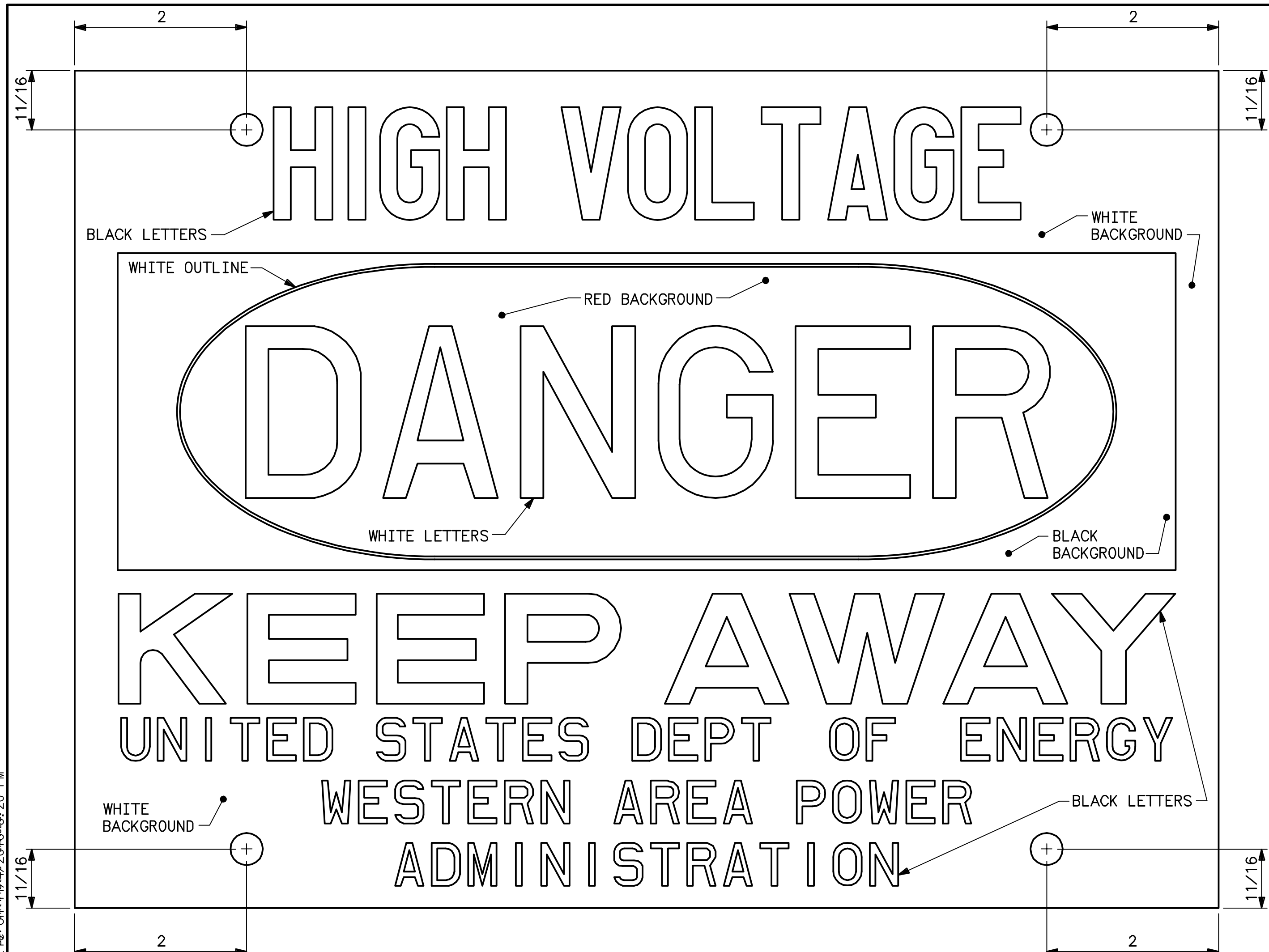
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

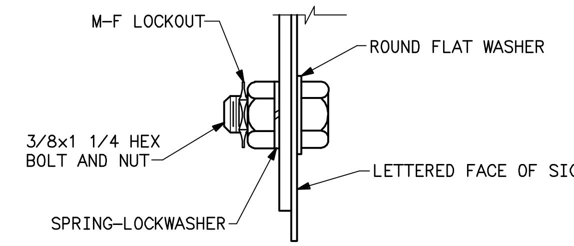
TRANSMISSION LINE STANDARDS
STRUCTURE NUMBER SIGNS
DETAILS AND LOCATION

DESIGNED BUREC APPROVED ROSS M. CLARK
ELECTRICAL ENGINEERING MANAGER

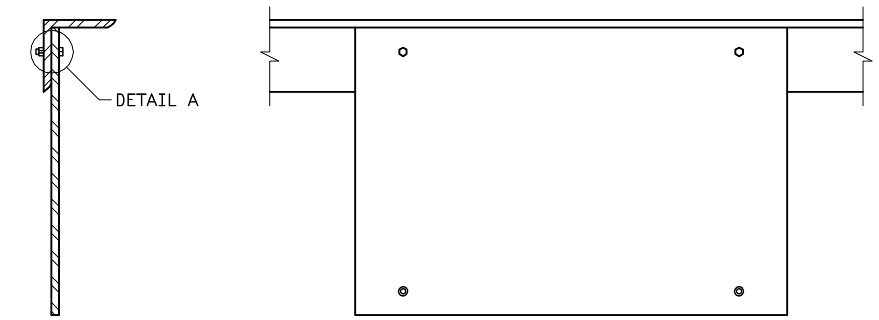
AUGUST 6, 1979 | 41 | 9007

Plotted By: entwistle Nov 04, 2010- 3:30pm

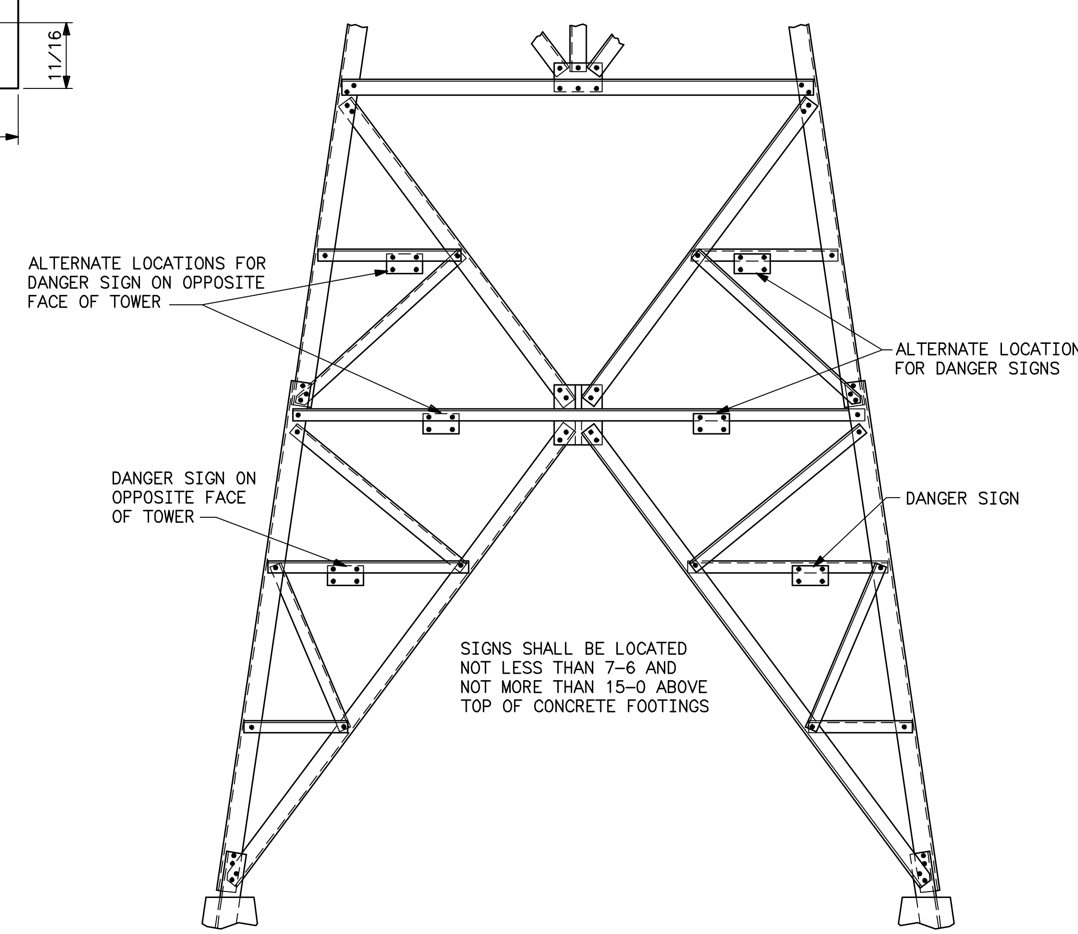




DETAIL A
SIGN MOUNTING HARDWARE



SIGN FASTENING DETAIL



DANGER SIGN LOCATION

NOTES

1. SIGNS SHALL BE MADE OF NO. 16 US GAUGE SHEET STEEL. HEIGHT AND WIDTH DIMENSIONS MAY VARY FROM 10 TO 12 INCHES AND 14 TO 18 INCHES, RESPECTIVELY.
2. FINISH SHALL BE PORCELAIN ENAMEL.
3. EACH SIGN SHALL HAVE FOUR FINISHED HOLES LARGE ENOUGH TO TAKE 3/8 IN. BOLTS. HOLES IN SIGNS SHALL BE FITTED WITH BRASS EYELETS.
4. THE PORCELAIN ENAMEL SHALL BE IN ACCORDANCE WITH THE RECOMMENDED STANDARDS FOR MANUFACTURE OF PORCELAIN ENAMEL SIGNS (PEI:S-103) OF THE SIGN DIVISION OF THE PORCELAIN ENAMEL INSTITUTE, INC.
5. SIZE OF LETTERING AND BACKGROUND SHALL BE PROPORTIONAL TO THOSE SHOWN.
6. ALL FERROUS HARDWARE SHALL BE GALVANIZED.
7. SIGNS SHALL BE FASTENED BY MEANS OF EITHER THE TOP OR THE BOTTOM TWO HOLES.

E	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
D	10-2-95 A2-CG	REDRAWN. REVISED TO ADD LOCATION OF SIGNS.

SUPERSEDES DWG NO. 41-9009 & 40-D-4387

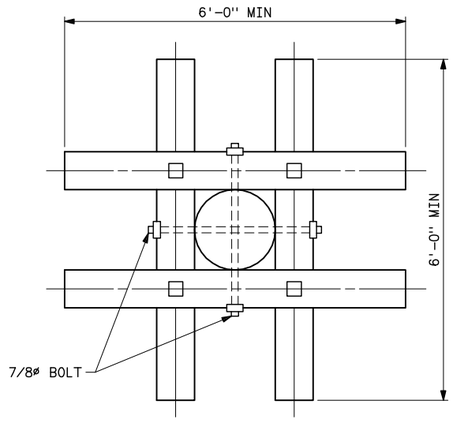
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
LATTICE TOWERS
DANGER SIGNS
DETAILS AND LOCATIONS

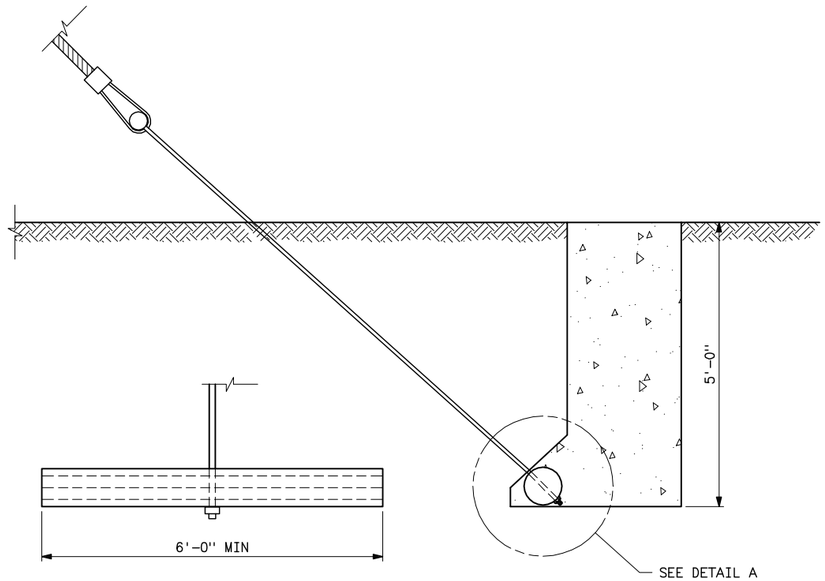
DESIGNED CHARLIE GARCIA APPROVED DOUG HANSON
CIVIL ENGINEERING MANAGER

OCTOBER 2, 1995	41	9008

Plotted By:entwistle Nov 04, 2010- 3:31pm



TOP VIEW OF BOG SHOE



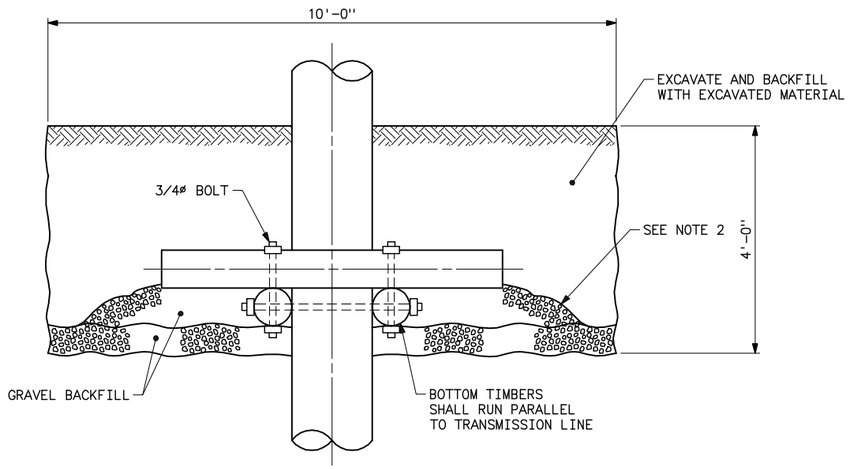
BOG ANCHOR

LIST OF MATERIALS	
BOG SHOE	
NO. REQD	DESCRIPTION
4	BOG SHOE, WOOD, 8x6-0
2	7/8x42 DOUBLE ARMING BOLT
12	4x4x1/4 SQUARE CURVED WASHER
4	3/4x24 DOUBLE ARMING BOLT

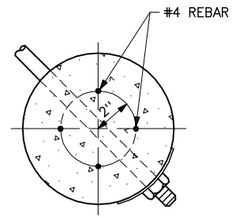
BOG ANCHOR	
NO. REQD	DESCRIPTION
1	CONCRETE ANCHOR
1	ANCHOR ROD, 3/4x8-0
1	3x3x1/4 CURVED WASHER, GALVANIZED
4	#4 REINFORCING BARS PER DETAIL A

NOTES

1. BOG SHOES SHALL BE PACIFIC COAST DOUGLAS FIR AND SHALL HAVE A MINIMUM OF 6 FEET IN LENGTH BY 8 INCHES IN DIAMETER AND SHALL HAVE THE SAME FULL-LENGTH PRESSURE PRESERVATIVE TREATMENT AS THAT REQUIRED FOR THE POLES.
2. BOTTOM AND TOP TIMBERS SHALL BE PLACED ON LEVEL BEARING SURFACES.
3. TREAT ALL FIELD DRILLED HOLES IN ACCORDANCE WITH THE SPECIFICATIONS.
4. BOG ANCHORS SHALL BE REINFORCED CONCRETE WITH A MINIMUM SIZE OF 6 FEET IN LENGTH BY 8 INCHES IN DIAMETER.
5. POLES WITH BOG SHOES OR BOG ANCHORS INSTALLED SHALL BE TAGGED WITH 24 GAGE, 2 INCHES DIAMETER, ALUMINUM DISCS. THE DISCS SHALL BE ATTACHED WITH TWO 2 INCH ALUMINUM TWIST NAILS. ALTERNATE TAGS MAY BE SUBMITTED FOR APPROVAL BY CONTRACTOR. TAGS SHALL BE MOUNTED APPROXIMATELY 5 FEET ABOVE THE GROUNDLINE.
6. THE DISCS FOR POLES WITH BOG SHOES SHALL BE EMBOSSED WITH A BS AND THE DISCS FOR POLES WITH BOG ANCHORS SHALL BE EMBOSSED WITH A BA ALONG WITH THE YEAR INSTALLED.
7. GRAVEL SHALL BE PIT-RUN, FREE-DRAINING MATERIAL WITH A MAXIMUM SIZE OF 2 1/2 INCHES.



BOG SHOE



DETAIL A

ALUMINUM DISC
(SEE NOTE 5 AND 6)

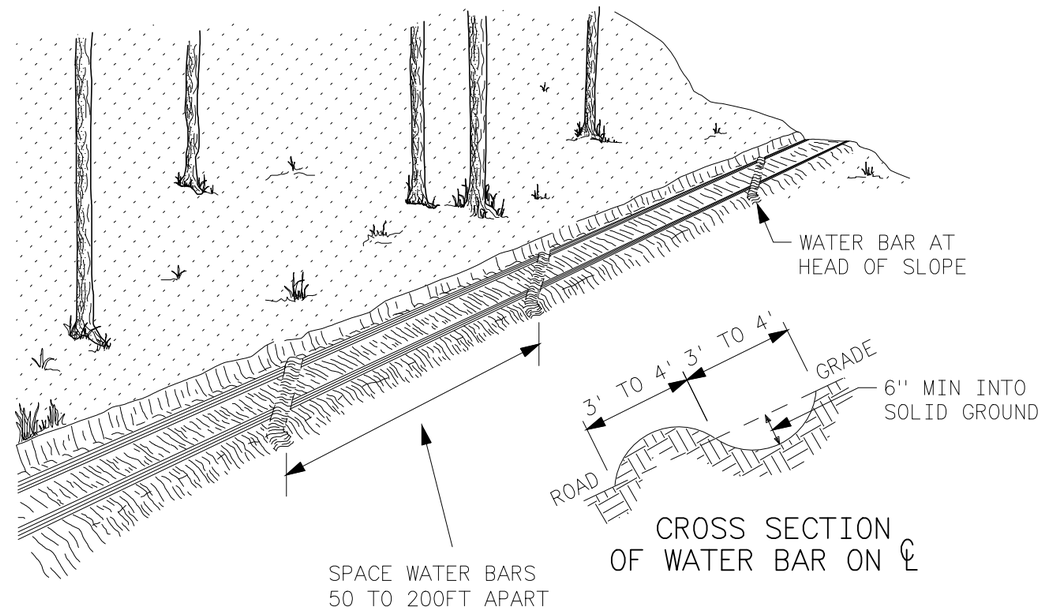
C	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
B	2-7-95 A2-RMC	REVISED AND REDRAWN ON CAE.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
WOOD POLE STRUCTURES
BOG SHOE AND BOG ANCHOR

DESIGNED K.K. ROWE APPROVED ROSS CLARK
CHIEF, TRANSMISSION LINE BRANCH

SIZE	DATE		
A	JULY 17, 1980	41	9019



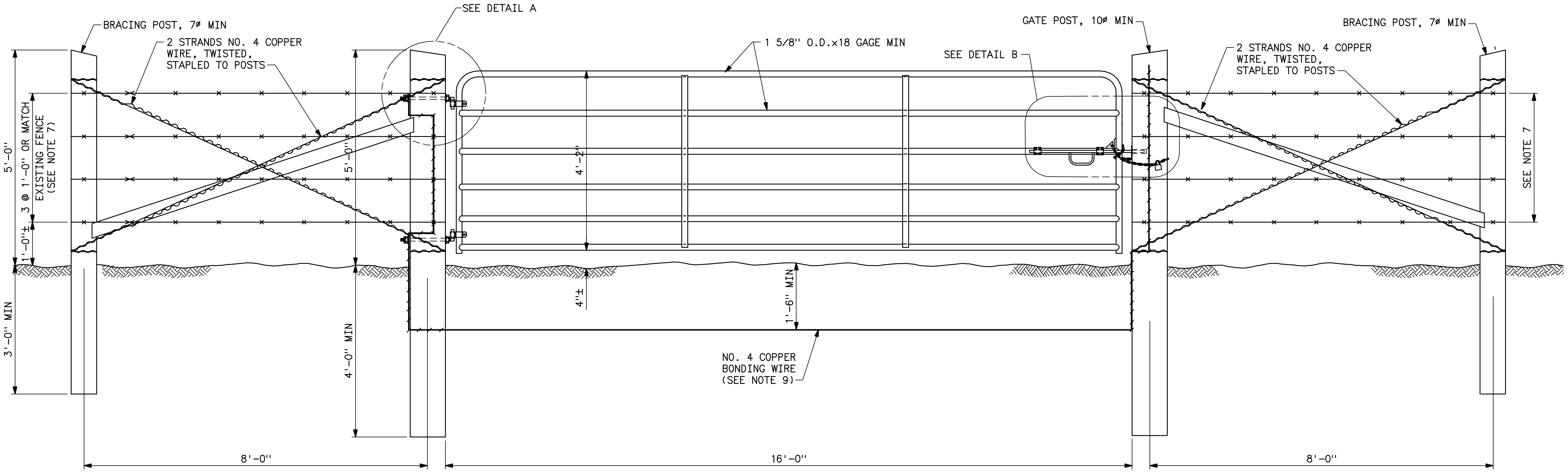
A	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.

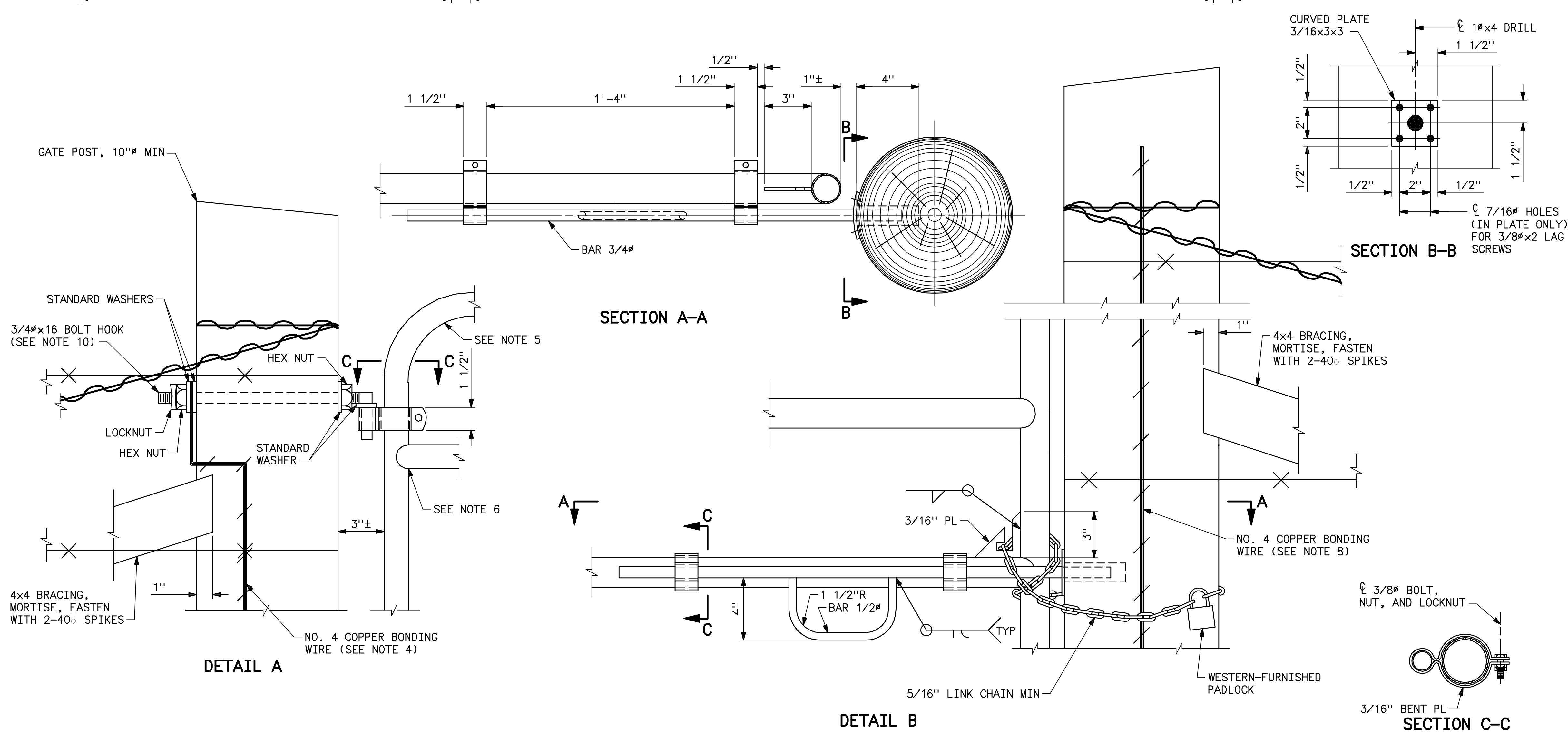
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
ACCESS ROAD REHABILITATION
WATER BAR CONSTRUCTION

DESIGNED KAREN ROWE APPROVED DOUG HANSON
CIVIL ENGINEERING MANAGER

C.A.E.	DECEMBER 31, 1996	41	9021





NOTES

1. GATE CONSTRUCTION INCLUDES POSTS AND BRACING.
2. GATE, HARDWARE, AND WIRE SHALL BE ZINC COATED.
3. POSTS AND BRACING SHALL BE PRESSURE-TREATED TIMBER.
4. CONNECT BONDING WIRE TO TOP AND BOTTOM BOLT HOOKS AND STAPLE INTERSECTIONS OF FENCE WIRE AND BONDING WIRE TO GATE POSTS FOR ELECTRICAL GROUNDING.
5. DIAMETER OF TUBING SHALL BE APPROXIMATELY MAINTAINED WHEN BENDING TOP TWO CORNERS OF OUTSIDE GATE FRAME.
6. INTERIOR CROSS TUBES SHALL BE MITERED TO OUTSIDE GATE FRAME.
7. CONNECT EACH NEW FENCE WIRE TO EXISTING FENCE WIRE FOR ELECTRICAL GROUNDING.
8. STAPLE INTERSECTIONS OF FENCE WIRE AND COPPER BONDING WIRE TO GATE POSTS FOR ELECTRICAL GROUNDING.
9. INSTALL BOTTOM COPPER BONDING WIRE BETWEEN GATE POSTS ONLY IF GATE IS WITHIN A FENCE WHICH CROSSES UNDER OR IS PARALLEL TO AND WITHIN 150 FEET OF TRANSMISSION LINE CENTERLINE.
10. INSTALL TOP BOLT HOOK POINTING UPWARD OR DOWNWARD, AS DIRECTED BY THE COR.

D	8-1-05 A7-DH	CHANGED GALVANIZED WIRE TO COPPER AND REVISED NOTES 8, 9, AND 10.
C	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
B	8-26-94 A2-WCC	MINOR REVISIONS.
A	3-22-94 A2-WCC	ADDED BURIED BONDING WIRE. MINOR REVISIONS.

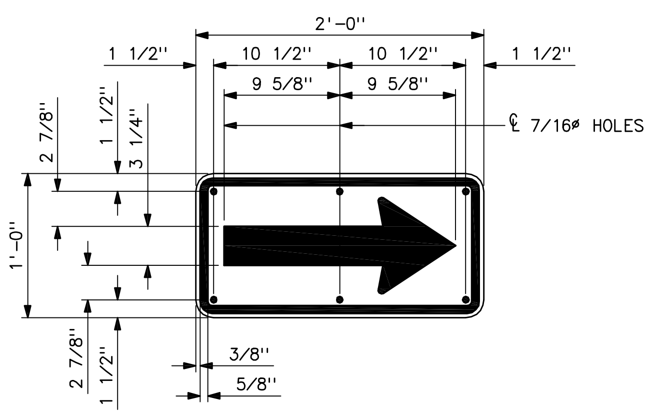
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS

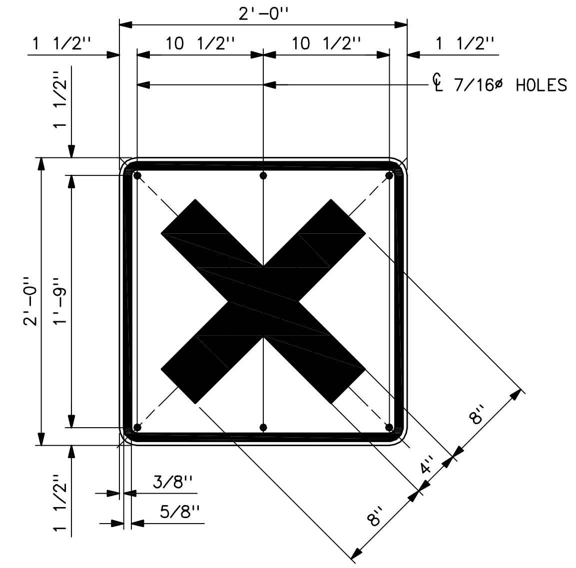
PREFABRICATED TUBULAR STEEL GATE

DESIGNED B.G. HAGLER APPROVED G.O. THOMAS
DIRECTOR, DIVISION OF TRANSMISSION LINE AND BUILDING DESIGN

CAF	JANUARY 23, 1991	41	9024

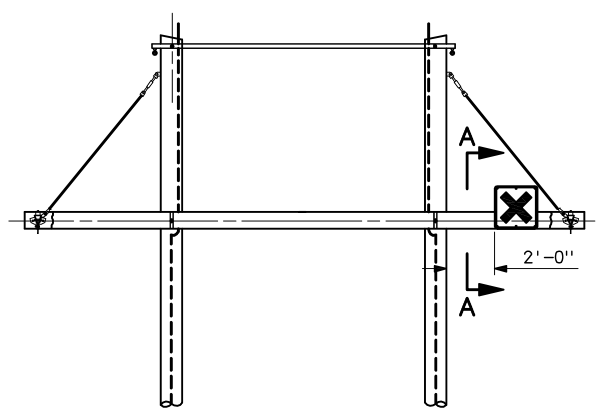


WARNING ARROW

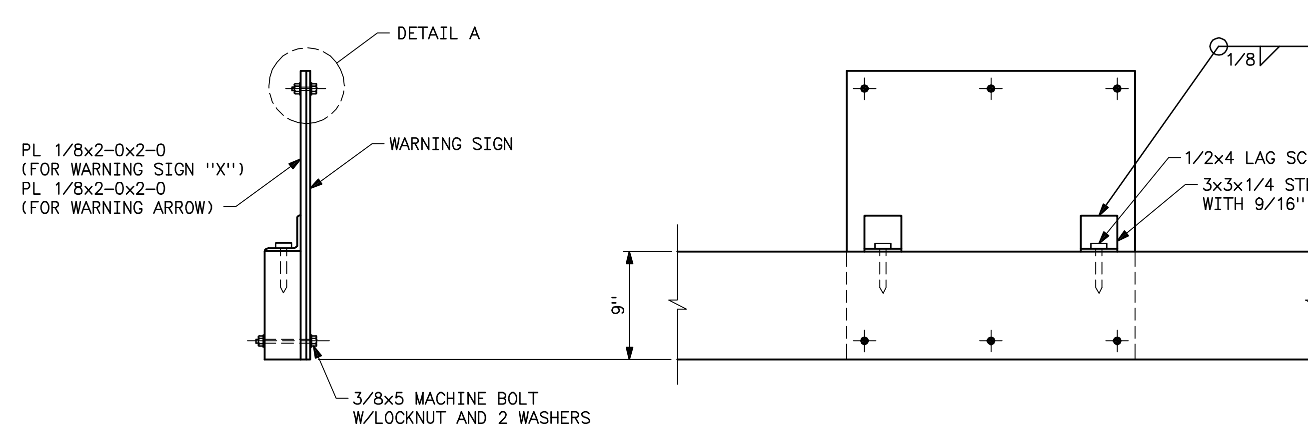


WARNING "X"

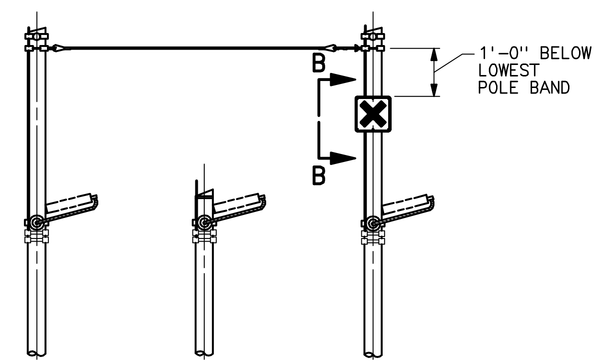
AERIAL PATROL WARNING SIGNS



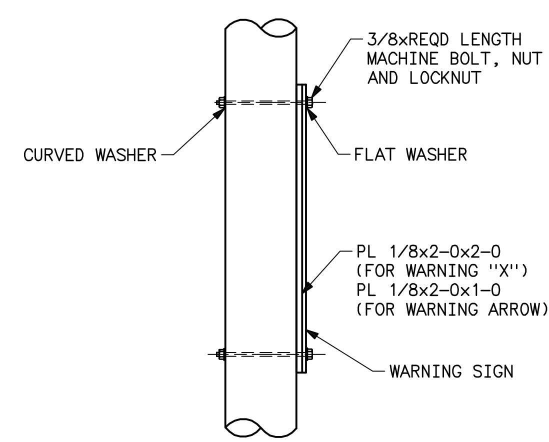
H-FRAME STRUCTURE



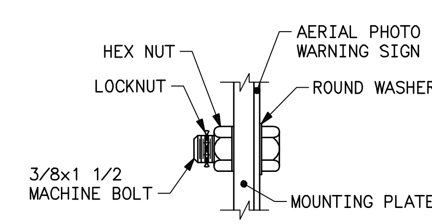
SECTION A-A



3-POLE STRUCTURE
(SIMILAR FOR 1-POLE STRUCTURES)



SECTION B-B



DETAIL A

NOTES

1. WARNING "X" SIGN SHALL BE STANDARD UNITED STATES DEPARTMENT OF TRANSPORTATION (DOT) FEDERAL HIGHWAY SIGN, DESIGNATION W2-1, TURNED ONE-FOURTH OF A TURN TO BECOME AN "X".
2. WARNING ARROW SIGN SHALL BE STANDARD DOT SIGN DESIGNATION W1-6.
3. SIGNS SHALL BE MADE OF NO. 18 U.S. GAGE SHEET METAL.
4. FINISH SHALL BE PORCELAIN ENAMEL. BACKGROUND SHEETING COLOR SHALL BE ENGINEER GRADE YELLOW IN ACCORDANCE WITH ASTM D 4956-94. "X" OR ARROW SHALL BE BLACK.
5. EACH SIGN SHALL HAVE HOLES FITTED WITH BRASS EYELETS. FINISHED HOLES SHALL BE LARGE ENOUGH TO TAKE 3/8-INCH BOLTS.
6. MOUNTING PLATES SHALL CONFORM TO ASTM A 36.
7. ALL ATTACHMENT HARDWARE SHALL BE GALVANIZED.
8. HOLES THROUGH CROSSARM SHALL BE FIELD DRILLED 1/8 INCH LARGER THAN BOLT DIAMETER.
9. CLEARANCE SHALL BE MAINTAINED BETWEEN AERIAL WARNING SIGNS AND ALL GUYS AND GROUNDING HARDWARE.
10. FOR STRUCTURE LOCATIONS AND REQUIRED TYPE OF WARNING SIGN, SEE SPECIFICATIONS AND PLAN AND PROFILE DRAWINGS.

REFERENCE DRAWING

AERIAL PATROL WARNING SIGNS AND MARKER BALL MARKING DIAGRAMS__________41 9029

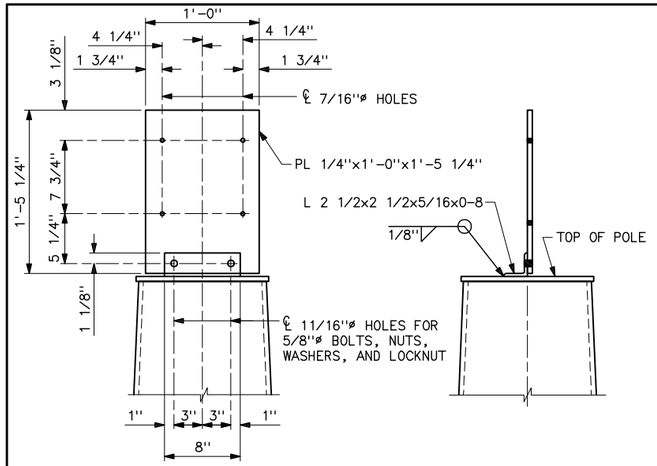
C	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
B	11-7-00 A3-RMC	ADDED REFERENCE DRAWING
A	11-17-95 A2-RMC	UPDATED SIGN DETAILS TO NEW STANDARD

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

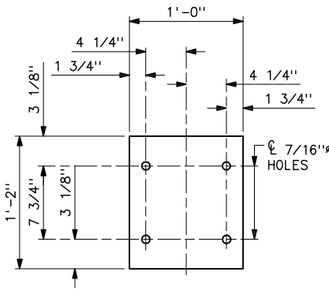
TRANSMISSION LINE STANDARDS
WOOD POLE STRUCTURES
AERIAL PATROL WARNING SIGNS
DETAILS AND LOCATIONS

DESIGNED K. ROWE — APPROVED ROSS CLARK, CHIEF, TRANSMISSION LINE BRANCH

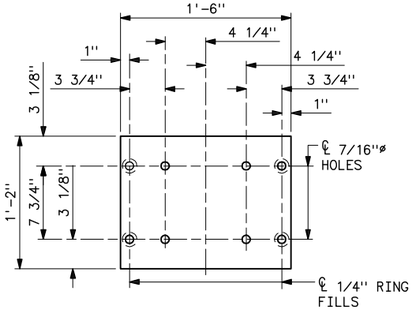
AUGUST 21, 1995 | 41 | 9026



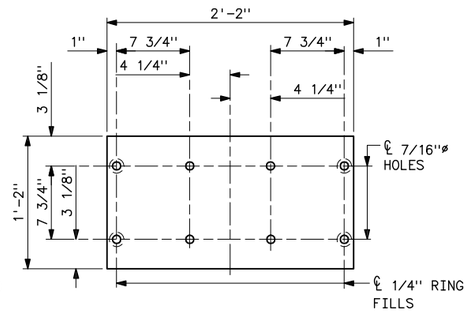
AERIAL PATROL MILE MARKER SIGN MOUNTING PLATE



1-DIGIT MILE NUMBER

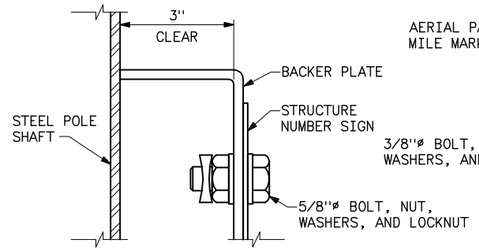


2-DIGIT MILE NUMBER

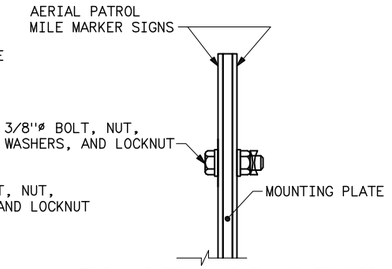


3-DIGIT MILE NUMBER

AERIAL PATROL MILE MARKER SIGNS

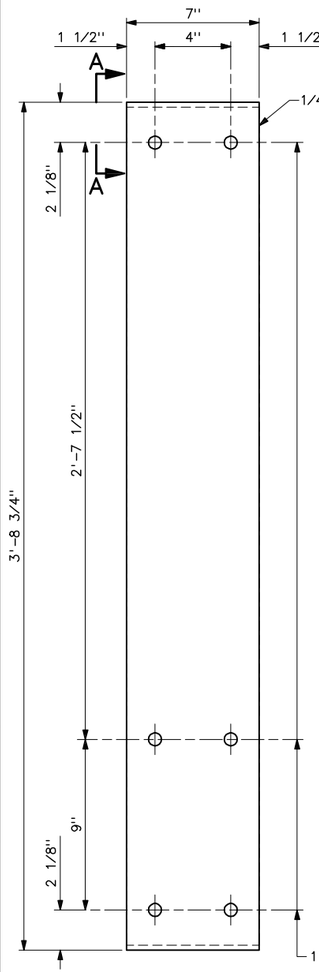


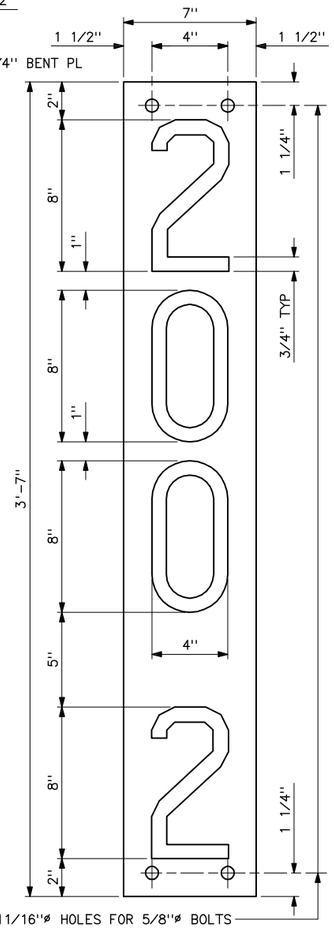
SECTION A-A
STRUCTURE NUMBER SIGN



AERIAL PATROL MILE MARKER SIGN

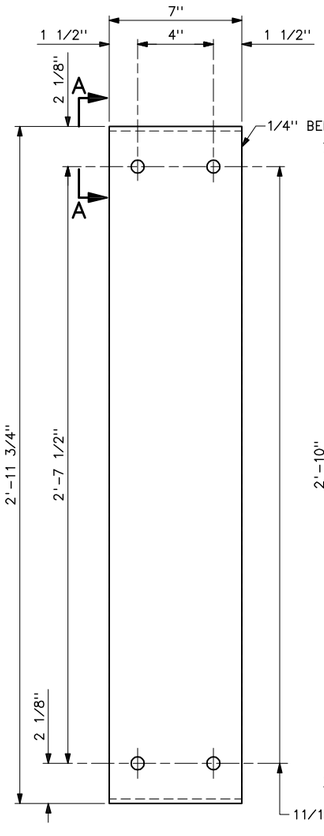
ATTACHMENT DETAILS

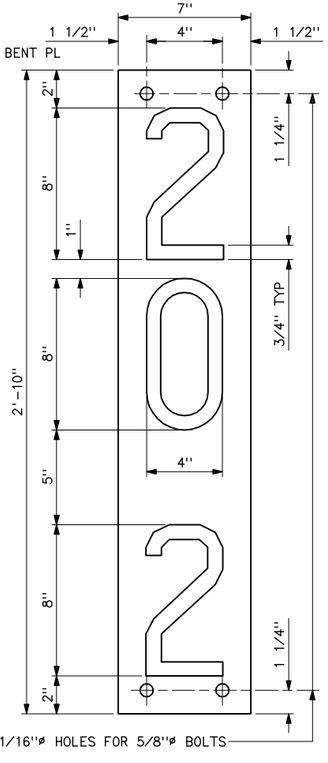




11/16"ø HOLES FOR 5/8"ø BOLTS

3-DIGIT MILE NUMBER

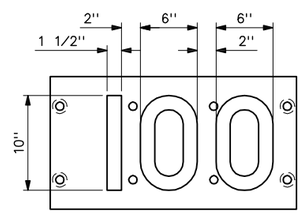




11/16"ø HOLES FOR 5/8"ø BOLTS

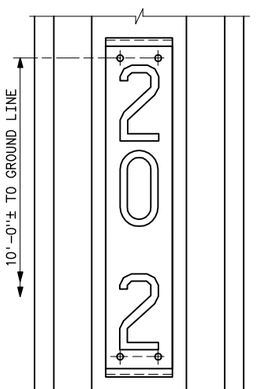
1-AND 2-DIGIT MILE NUMBERS

STRUCTURE NUMBER SIGNS, LETTER DIMENSIONS, AND BACKER PLATES
(NOTE 11)



LETTERING TO BE CENTERED HORIZONTALLY AND VERTICALLY

AERIAL PATROL MILE MARKER SIGN LETTER DIMENSIONS



STRUCTURE NUMBER SIGN LOCATION
(NOT TO SCALE)

NOTES

1. SIGN SHALL BE NO 18 U.S. GAGE SHEET STEEL.
2. FINISH FOR SIGN SHALL BE PORCELAIN ENAMEL. BACKGROUND COLOR SHALL BE YELLOW AND FIGURES SHALL BE BLACK.
3. PORCELAIN ENAMEL SHALL BE IN ACCORDANCE WITH THE RECOMMENDED STANDARDS FOR MANUFACTURE OF PORCELAIN ENAMEL SIGNS (PEI: S-103) OF THE SIGN DIVISION OF THE PORCELAIN ENAMEL INSTITUTE, INC.
4. FIGURES SHALL BE "BLOCK" TYPE.
5. HOLES IN SIGNS SHALL BE FURNISHED AND FITTED WITH BRASS EYELETS.
6. AERIAL PATROL MILE MARKER SIGN MOUNTING PLATES AND ANGLES WELDED TO GALVANIZED STEEL POLES SHALL CONFORM TO ASTM A 36 AND SHALL BE GALVANIZED.
7. ANGLE WELDED TO WEATHERING STEEL POLES SHALL CONFORM TO ASTM A 242 OR ASTM A 588.
8. STRUCTURE NUMBER SIGN BACKER PLATES SHALL BE THE SAME TYPE OF MATERIAL AND FINISH AS THE STEEL POLE.
9. INSTALL TWO AERIAL PATROL MILE MARKER SIGNS ON THE FIRST STRUCTURE OF EACH MILE SECTION. MOUNTING PLATE SHALL BE PERPENDICULAR TO THE DIRECTION OF THE TRANSMISSION LINE. MOUNT SIGNS BACK-TO-BACK ON MOUNTING PLATE. LOCATION AND MOUNTING DETAILS MAY BE VARIED SLIGHTLY TO SUIT CONDITIONS.
10. INSTALL STRUCTURE NUMBER SIGNS ON BOTH THE AHEAD AND BACK SPAN SIDE OF EACH STRUCTURE.
11. FOR STRUCTURE NUMBER SIGNS REQUIRING 5 DIGITS; E.G., 135/2A, DIMENSIONS FOR FIGURES SHALL BE 4" WIDE BY 6 1/4" HIGH IN LIEU OF 4" WIDE BY 8" HIGH. 5-DIGIT SIGN DIMENSIONS SHALL BE IN ACCORDANCE WITH THE 3-DIGIT MILE NUMBER DETAIL.

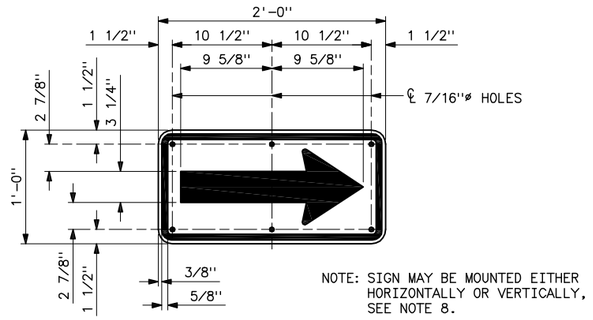
E	08-08-07 A7-BGH	ADDED 2-DIGIT MILE NUMBER HOLES TO 3-DIGIT MILE NUMBER BACKER PLATE.
D	12-13-05 A7-BGH	REVISED STRUCTURE NUMBER SIGN BACKER PLATES AND NOTES.
C	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
B	11-30-01 A7-BH	CLARIFIED NOTE 8, ADDED NOTE 10.
A	12-15-95 A2-RMC	REVISED MOUNTING PLATE DETAILS AND NOTES. ADD STRUCTURE NUMBER SIGN ATTACHMENT DETAIL.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STANDARDS
STEEL POLE STRUCTURES
AERIAL PATROL MILE MARKER AND NUMBER SIGNS

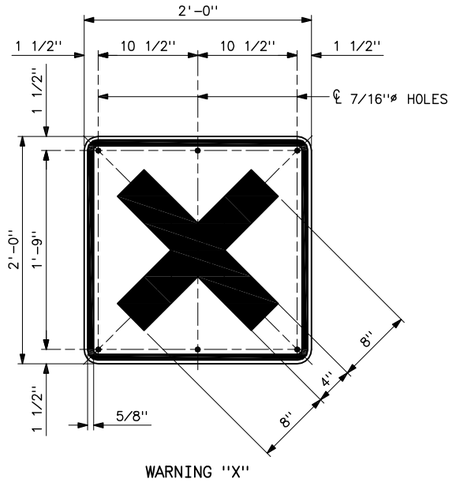
DESIGNED BOBBY HAGLER — APPROVED ROSS CLARK, CHIEF, TRANSMISSION LINE BRANCH

CAD	DATE	41	9027
E	AUGUST 30, 1995		



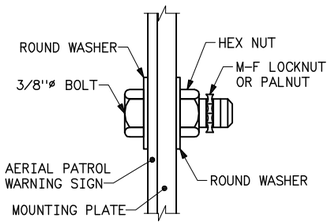
NOTE: SIGN MAY BE MOUNTED EITHER HORIZONTALLY OR VERTICALLY, SEE NOTE 8.

WARNING ARROW



WARNING "X"

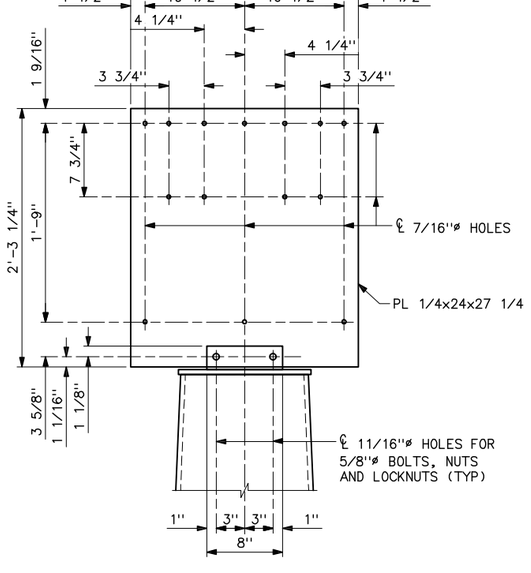
AERIAL PATROL WARNING SIGNS



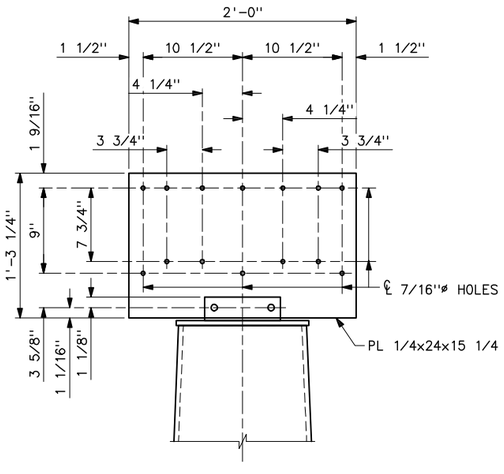
ATTACHMENT DETAIL

NOTES

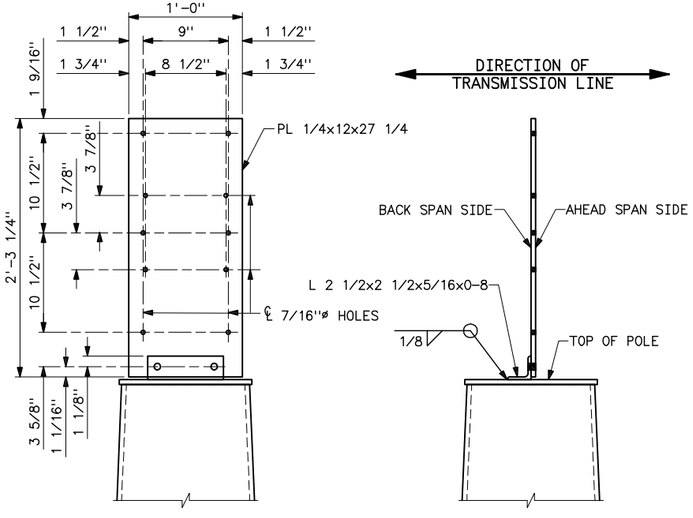
1. WARNING "X" SIGN SHALL BE STANDARD UNITED STATES DEPARTMENT OF TRANSPORTATION (DOT) FEDERAL HIGHWAY SIGN, DESIGNATION W2-1, TURNED ONE-FOURTH OF A TURN TO BECOME AN "X".
2. WARNING ARROW SIGN SHALL BE STANDARD DOT SIGN DESIGNATION W1-6.
3. SIGNS SHALL BE NO. 18 U.S. GAGE SHEET STEEL.
4. FINISH FOR SIGNS SHALL BE PORCELAIN ENAMEL. BACKGROUND COLOR SHALL BE ENGINEER GRADE YELLOW IN ACCORDANCE WITH ASTM D 4956. "X" OR ARROW SHALL BE BLACK.
5. HOLES IN SIGNS SHALL BE FURNISHED AND FITTED WITH BRASS EYELETS. FINISHED HOLES SHALL BE LARGE ENOUGH TO TAKE 3/8" BOLT.
6. MOUNTING PLATES SHALL CONFORM TO ASTM A36, AND SHALL BE PERPENDICULAR TO THE DIRECTION OF TRANSMISSION LINE.
7. ALL ATTACHMENT HARDWARE SHALL BE GALVANIZED; EXCEPT ANGLES WELDED TO WEATHERING STEEL STRUCTURES SHALL CONFORM TO ASTM A242 OR ASTM A588.
8. FOR STRUCTURE LOCATIONS AND REQUIRED TYPE OF WARNING SIGN, SEE SPECIFICATIONS AND PLAN AND PROFILE DRAWINGS.



WARNING "X"



HORIZONTAL WARNING ARROW



VERTICAL WARNING ARROW

SIDE VIEW (TYPICAL)

AERIAL PATROL WARNING SIGN MOUNTING PLATES

REFERENCE DRAWING

AERIAL PATROL WARNING SIGNS AND MARKER BALL MARKING DIAGRAMS _____ 41 9029

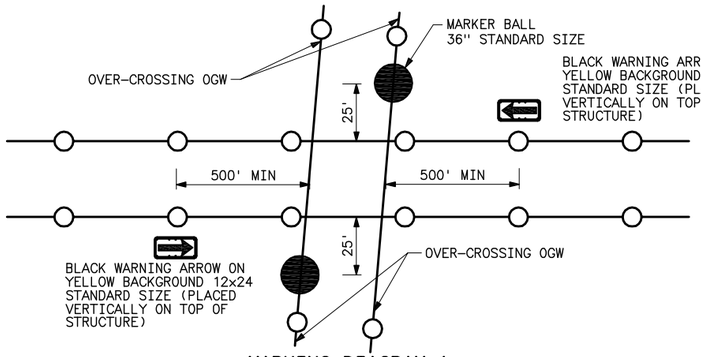
D	4-22-09 A7-BGH	ADDED HOLES FOR AERIAL PATROL MILE MARKER SIGNS TO MOUNTING PLATES
C	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.
B	11-30-01 A7-BH	REVISED NOTE 6.
A	11-7-00 A3-RMC	ADDED REFERENCE DRAWING

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

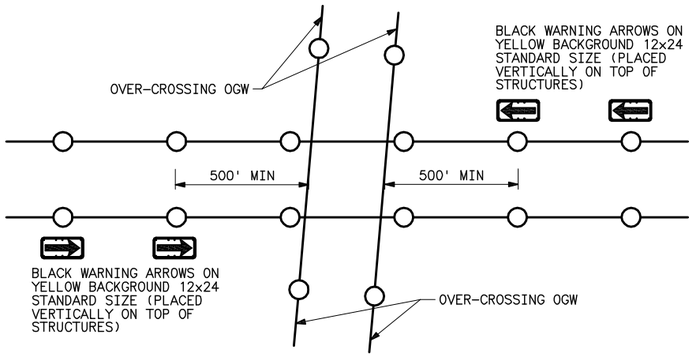
TRANSMISSION LINE STANDARDS
STEEL POLE STRUCTURES
AERIAL PATROL WARNING SIGNS DETAILS AND LOCATIONS

DESIGNED BOBBY HAGLER _____ APPROVED DOUG HANSON _____
CHIEF, TRANSMISSION LINE BRANCH

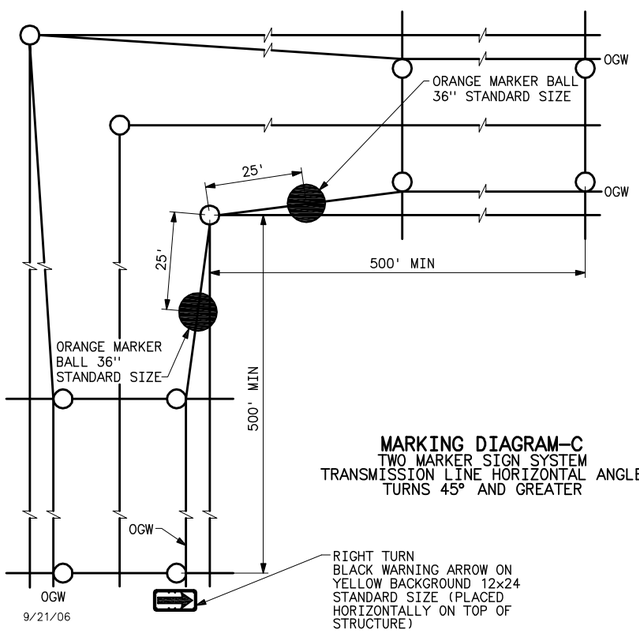
CAF	DECEMBER 15, 1995	41	9028



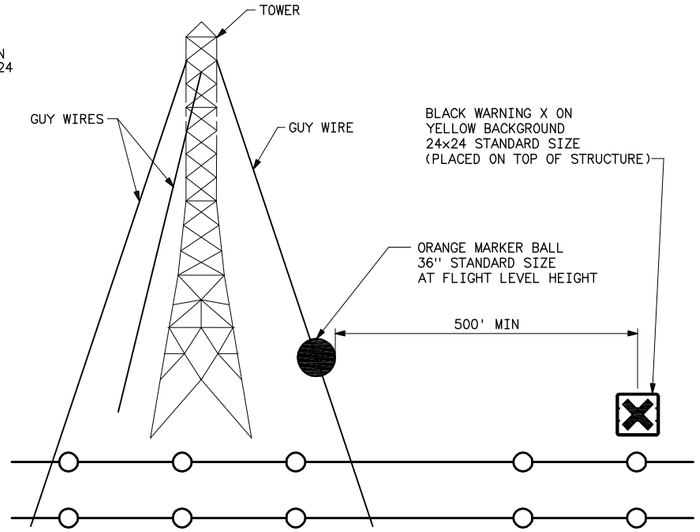
MARKING DIAGRAM-A
TWO MARKER SIGN SYSTEM
TRANSMISSION LINE OVER-CROSSING



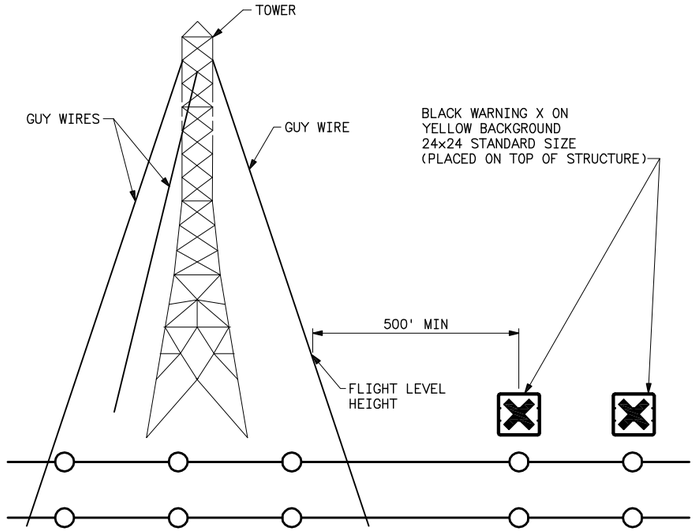
MARKING DIAGRAM-B
(WHEN PERMISSION TO INSTALL BALLS ON OVER-CROSSING IS NOT GRANTED BY OWNER.)
FOUR MARKER SIGN SYSTEM
TRANSMISSION LINE OVER-CROSSING



MARKING DIAGRAM-C
TWO MARKER SIGN SYSTEM
TRANSMISSION LINE HORIZONTAL ANGLE
TURNS 45° AND GREATER



MARKING DIAGRAM-D
TWO MARKER SIGN SYSTEM
(ONE IN EACH APPROACH DIRECTION, AS SHOWN FOR ONE DIRECTION.)
TRANSMISSION LINE, OTHER HAZARDS



MARKING DIAGRAM-E
FOUR MARKER SIGN SYSTEM
(TWO IN EACH APPROACH DIRECTION, AS SHOWN FOR ONE DIRECTION.)
(WHEN PERMISSION TO INSTALL BALL ON GUY WIRE IS NOT GRANTED BY OWNER.)
TRANSMISSION LINE, OTHER HAZARDS

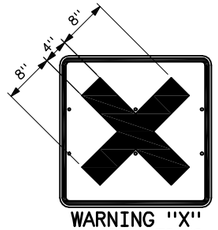
B	09/20/06 A7-BGH	REVISED WARNING ''X'' AND WARNING ARROW NOTES 1 AND 2.

TRANSMISSION LINE HAZARD MARKING SYSTEM

1. **GENERAL:**
DOE ORDER 5480.13A, 10.i., DATED 2-23-93, REQUIRES THAT DOE AND COVERED CONTRACTOR ORGANIZATIONS THAT CONDUCT POWERLINE PATROLS AT ALTITUDES OF LESS THAN 500 FEET ABOVE GROUND LEVEL(AGL) SHALL USE A SYSTEM OF WARNING SIGNS AND MARKING BALLS, TO ALERT PILOTS TO HAZARDS WITHIN POWERLINE RIGHT-OF-WAY.

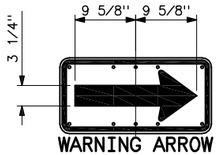
DOE ORDER 5480.13A, 10.J., ALSO STATES THAT FAA ADVISORY CIRCULARS SHOULD BE USED TO THE EXTENT POSSIBLE IN AIRCRAFT AND FACILITY OPERATIONS. FAA ADVISORY CIRCULAR AC 70/7460-1H DESCRIBES FAA STANDARDS FOR MARKING AND LIGHTING STRUCTURES TO PROMOTE AVIATION SAFETY.

THE FOLLOWING TRANSMISSION LINE MARKING SYSTEM UTILIZES, TO THE MAXIMUM EXTENT POSSIBLE, THE SAFETY STANDARDS DESCRIBED IN ADVISORY CIRCULAR AC 70/7460-1H AND IS INTENDED TO PROVIDE WESTERN FIELD OFFICES WITH A STANDARDIZED METHOD FOR MARKING TRANSMISSION LINE SYSTEM HAZARDS.



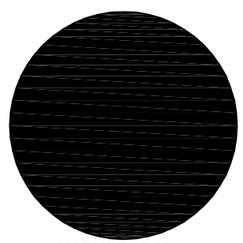
WARNING ''X''
SPECIFICATIONS

1. SIGNS SHALL BE MADE OF NO. 18 U.S. GAGE STEEL SHEET. THE STANDARD SIZE SHALL BE 24''x24''.
2. FINISH FOR SIGNS SHALL BE PORCELAIN ENAMEL. BACKGROUND COLOR SHALL BE ENGINEER GRADE YELLOW IN ACCORDANCE WITH ASTM D 4956. ''X'' SHALL BE BLACK.
3. EACH SIGN SHALL HAVE HOLES FITTED WITH BRASS EYELETS. FINISHED HOLES SHALL BE LARGE ENOUGH TO TAKE 3/8'' BOLTS.
4. HOLE SPACING SHALL BE PER APPLICABLE REFERENCE DRAWING.
5. DOT HIGHWAY CROSSING SIGN DESIGNATED W2-1 TURNED 1/4 TURN TO BECOME AN ''X''.



WARNING ARROW
SPECIFICATIONS

1. SIGNS SHALL BE MADE OF NO. 18 U.S. GAGE STEEL SHEET. THE STANDARD SIZE SHALL BE 24''x12''.
2. FINISH FOR SIGNS SHALL BE PORCELAIN ENAMEL. BACKGROUND COLOR SHALL ENGINEER GRADE YELLOW IN ACCORDANCE WITH ASTM D 4956. ''ARROW'' SHALL BE BLACK.
3. EACH SIGN SHALL HAVE HOLES FITTED WITH BRASS EYELETS. FINISHED HOLES SHALL BE LARGE ENOUGH TO TAKE 3/8'' BOLTS.
4. HOLE SPACING SHALL BE PER APPLICABLE REFERENCE DRAWING.
5. DOT SIGN DESIGNATED W1-6.



MARKER BALL
SPECIFICATIONS

1. THE STANDARD SIZE SHALL BE A 36'' MARKER BALL.
2. AN OPTIONAL 24'' BALL MAY BE USED ON POWER LINES BELOW 50 FEET ABOVE GROUND.
3. THE COLOR SHALL BE INTERNATIONAL ORANGE.
4. FAA ADVISORY CIRCULAR AC 70/7460 (CH2) 34a.(1)

TRANSMISSION LINE HAZARD MARKING SYSTEM(CONT)

2. **TRANSMISSION LINE WARNING SIGNS AND MARKER BALLS:**
HAZARDS ALONG WESTERN'S TRANSMISSION LINE PATROL ROUTES SHALL BE MARKED WITH WARNING SIGNS AND MARKER BALLS AS SHOWN ON THIS DRAWING.

3. **TRANSMISSION LINE MARKING PROCEDURES:**
HAZARDS ALONG WESTERN'S TRANSMISSION LINE PATROL ROUTES SHALL BE MARKED AS SHOWN ON THIS DRAWING AND IN THE FOLLOWING MANNER:

OVER CROSSINGS:
OVER CROSSINGS SHALL BE IDENTIFIED WITH A COMBINATION OF ONE WARNING ARROW SIGN AND ONE MARKER BALL IN EACH APPROACH DIRECTION.(MARKING DIAGRAM A)

WARNING ARROW SIGNS, TO IDENTIFY UPCOMING HAZARDS, SHALL BE LOCATED NOT LESS THAN 500 FEET FROM THE OVER-CROSSING. THE ARROW SIGNS SHALL BE ATTACHED DIRECTLY TO THE TOP OF THE STRUCTURES.

MARKER BALLS, USED TO MARK THE OVER-CROSSING OVERHEAD GROUND WIRE(OGW), SHALL BE LOCATED ON THE OVER-CROSSING OGW AT A DISTANCE OF 25 FEET FROM THE OUTSIDE CONDUCTOR PHASE (LOWER CIRCUIT CONDUCTOR). IF THE OVER-CROSSING LINE HAS TWO OGW'S, ONE MARKER BALL SHALL BE ON THE FIRST OGW FOR EACH OVER-CROSSING APPROACH.

ALL WESTERN-OWNED TRANSMISSION CIRCUIT OVERHEAD GROUND WIRES WILL BE MARKED WITH MARKER BALLS AS DESCRIBED ABOVE. OVER-CROSSINGS NOT OWNED BY WESTERN WILL ALSO BE MARKED AS DESCRIBED ABOVE WITH PERMISSION FROM THE OWNER.

IF PERMISSION IS NOT GRANTED BY THE OWNER, TO INSTALL MARKER BALLS ON THE OGW, THEN THE OVER-CROSSING WILL BE MARKED WITH FOUR WARNING ARROWS, TWO IN EACH APPROACH DIRECTION TO IDENTIFY UPCOMING HAZARDS. THE FIRST VERTICAL ARROW, SHALL BE LOCATED NOT LESS THAN 500 FEET FROM THE OVER-CROSSING. THE SECOND VERTICAL ARROW SHALL BE LOCATED AT THE NEXT STRUCTURE AWAY FROM THE FIRST ARROW. THE WARNING ARROWS SHALL BE ATTACHED DIRECTLY TO THE TOP OF THE STRUCTURES. (MARKING DIAGRAM B)

HORIZONTAL ANGLES:
FOR HORIZONTAL LINE ANGLES (RIGHT TURNS) OF 45 DEGREES AND GREATER, ONE WARNING ARROW AND TWO MARKER BALLS SHALL BE REQUIRED TO MARK THE TRANSMISSION LINE ANGLE. (MARKING DIAGRAM C)

A HORIZONTAL ARROW POINTING IN THE DIRECTION OF A RIGHT TURN, SHALL BE LOCATED NOT LESS THAN 500 FEET PRIOR THE ANGLE STRUCTURE. THE ARROW SHOULD BE ATTACHED DIRECTLY TO THE TOP OF THE STRUCTURE.

A MARKER BALL SHALL BE INSTALLED ON THE INSIDE OGW 25 FEET PRIOR TO AND AFTER THE INSIDE ANGLE STRUCTURE.

UNDER CROSSINGS:
UNDER-CROSSINGS, NOT OWNED BY WESTERN NEED NOT BE MARKED.

OTHER HAZARDS:
ALL OTHER AERIAL TRANSMISSION LINE PATROL HAZARDS SHALL BE MARKED USING A WARNING ''X'' AND A MARKER BALL IN THE TWO APPROACH DIRECTIONS. WARNING ''X'S'' SHALL BE LOCATED NOT LESS THAN 500 FEET FROM THE HAZARD. AN EXAMPLE MAY BE A TOWER. (MARKING DIAGRAM D)

OTHER HAZARDS NOT OWNED BY WESTERN SHALL ALSO BE MARKED AS DESCRIBED ABOVE WITH PERMISSION OF THE OWNER.

IF PERMISSION IS NOT GRANTED BY THE OWNER TO INSTALL MARKER BALLS ON THE HAZARD, THEN THE HAZARD (ALL HAZARDS OTHER THAN OVER-CROSSING) WILL BE MARKED USING TWO MARKER SIGNS (X'S) IN EACH APPROACH DIRECTION. THE FIRST WARNING ''X'S'' SHALL BE LOCATED NOT LESS THAN 500 FEET FROM THE HAZARD. THE SECOND WARNING ''X'S'' SHALL BE LOCATED AT THE NEXT STRUCTURE AWAY FROM THE FIRST WARNING ''X'S''. AN EXAMPLE MAY BE A TOWER. (MARKING DIAGRAM E)

REFERENCE DRAWINGS

AERIAL WARNING SIGNS
FOR LATTICE STEEL TOWERS _____ 41 9005
FOR WOOD POLE STRUCTURES _____ 41 9026
FOR STEEL POLE STRUCTURES _____ 41 9028

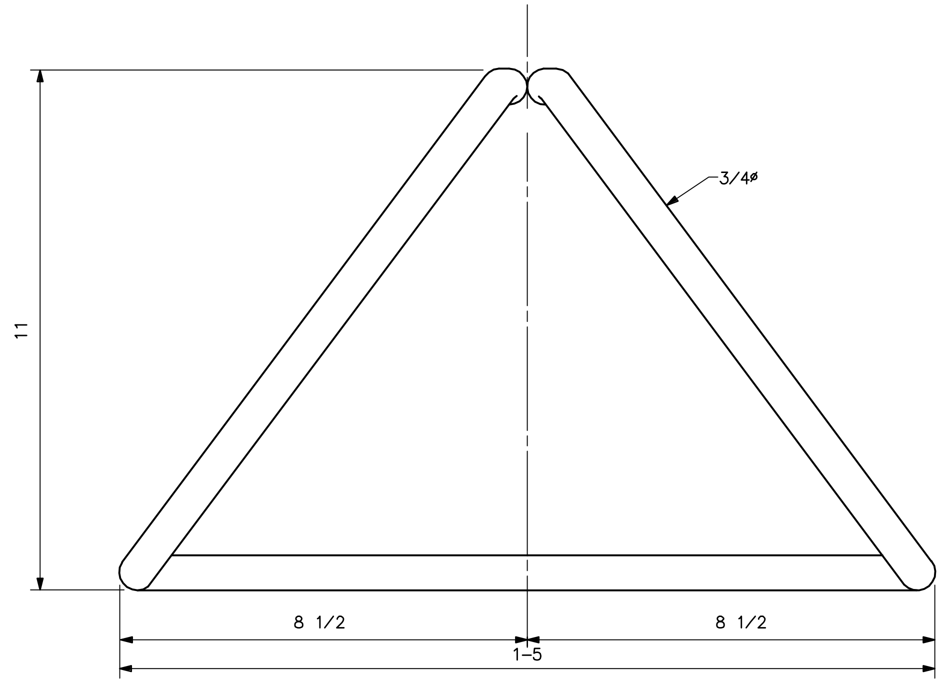
A	7-15-03 A7-RC	REVISED TITLE BLOCK ONLY.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

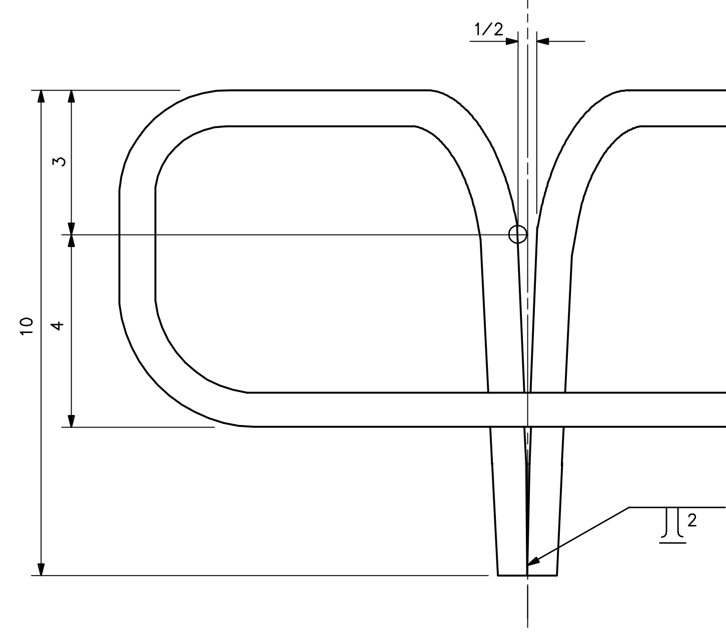
TRANSMISSION LINE STANDARDS AERIAL PATROL WARNING SIGNS AND MARKER BALL MARKING DIAGRAMS

DESIGNED C.A. CABRAL APPROVED ROSS M. CLARK
ELECTRICAL ENGINEERING MANAGER

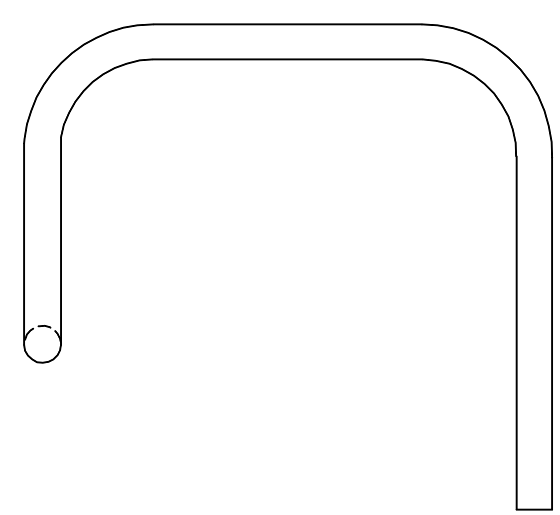
CAE	DECEMBER 4, 2000	41	9029



PLAN



ELEVATION



SIDE VIEW

NOTES

1. GALVANIZE MATERIAL AFTER FABRICATION.
2. MINIMUM INSIDE COLD BENDING RADIUS : 2 1/4 INCHES.

REFERENCE DRAWINGS

MAINTENANCE PROVISIONS
OUTLINES ________________ 43 2204 THRU 2209
DETAILS ___________________ 43 2202 & 2210

B	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
A	7-10-92 A2-WCC	REVISED REFERENCE DRAWINGS

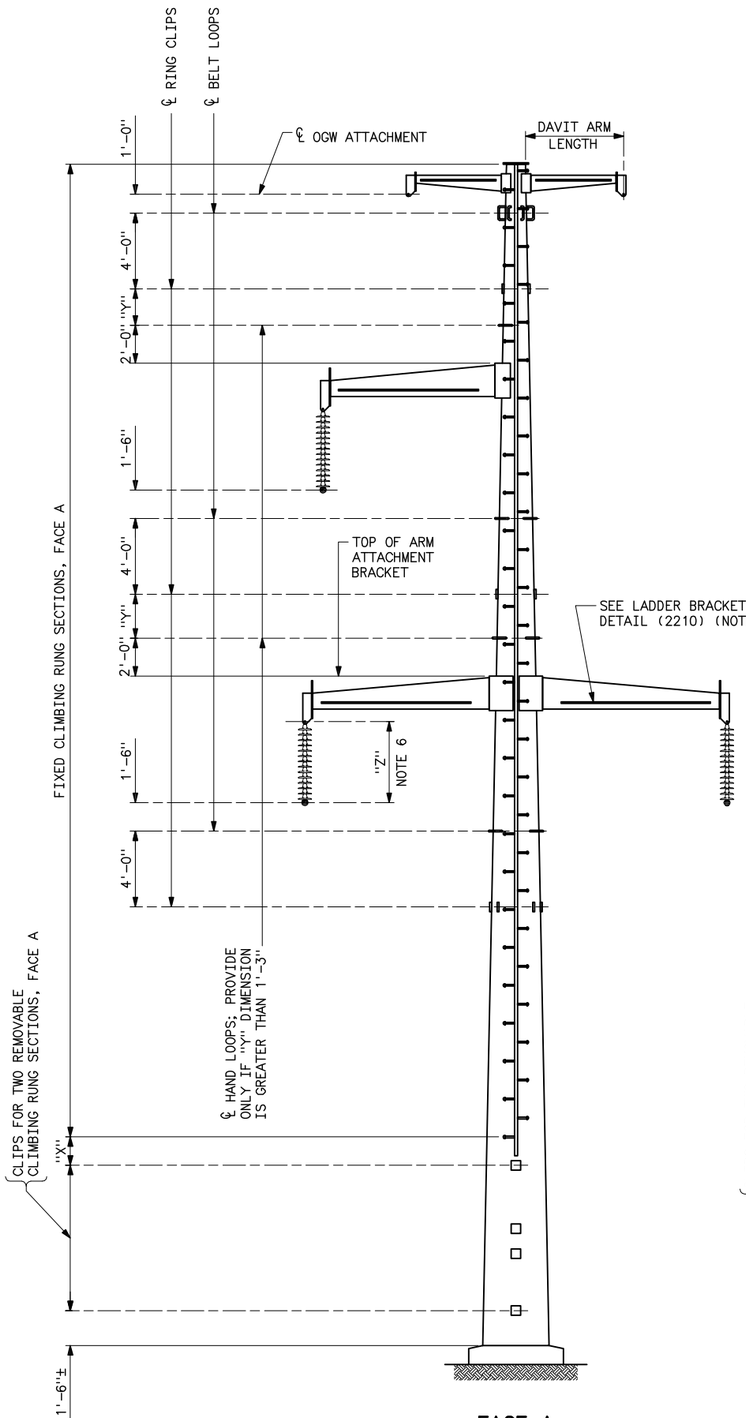
UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE
STRUCTURE STANDARDS
STEEL POLE STRUCTURES
MAINTENANCE PROVISIONS-WORK RING

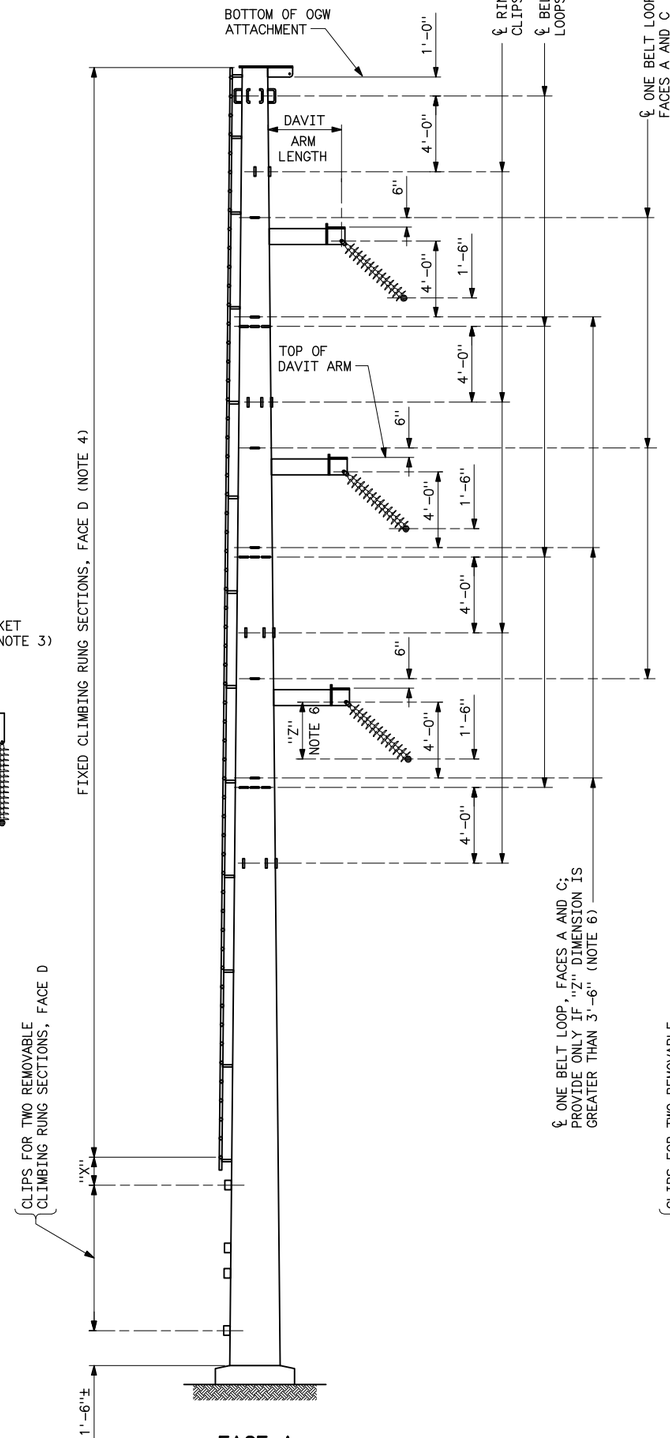
DESIGNED B.G. HAGLER APPROVED W.C. COWAN
DIRECTOR, DIVISION OF TRANSMISSION LINE AND BUILDING DESIGN

MARCH 31, 1989	43	2203

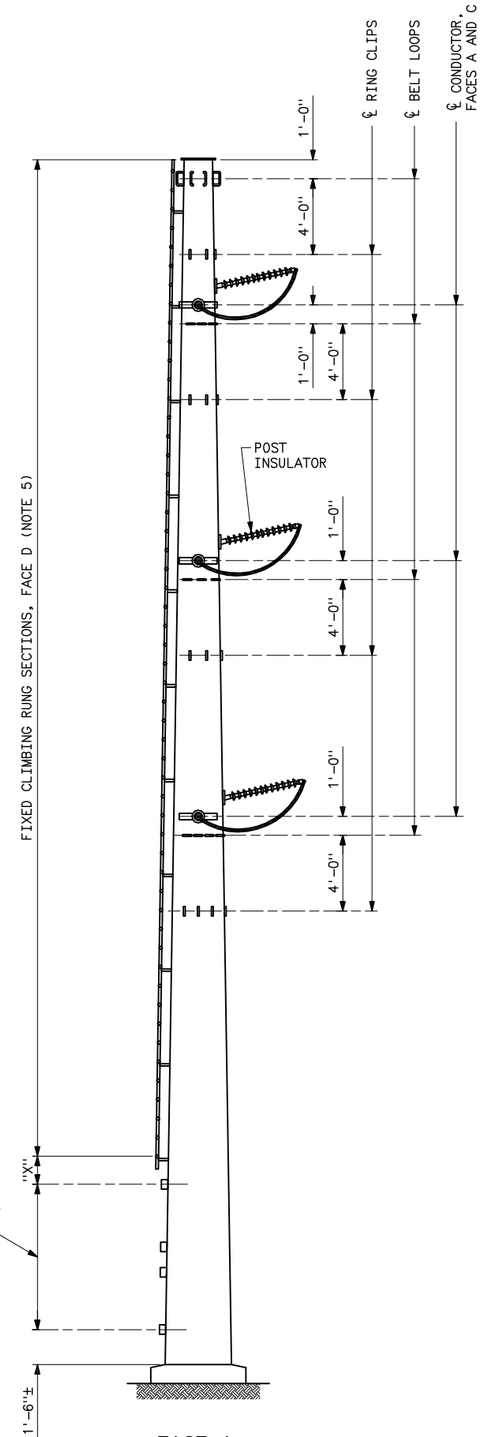
Plotted By:entwistle Nov 04, 2010- 3:31pm



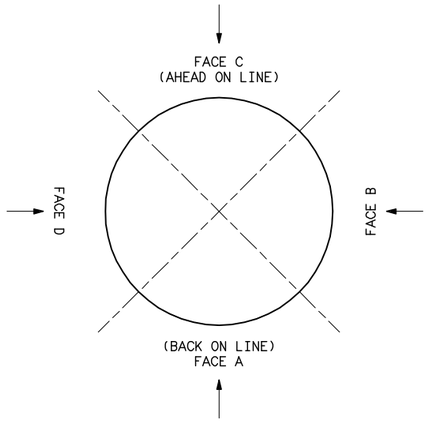
FACE A
TANGENT AND SMALL ANGLE
SUSPENSION STRUCTURES



FACE A
MEDIUM AND LARGE ANGLE
SUSPENSION STRUCTURES



FACE A
TENSION STRUCTURES



PLAN

(ALL VIEWS TAKEN LOOKING IN DIRECTION OF ARROW)

NOTES

1. "X" DIMENSION SHALL BE MINIMUM REQUIRED TO INSTALL TOP REMOVABLE CLIMBING RUNG SECTION.
2. DISTANCE FROM STEPS TO FACE OF POLE SHAFTS SHALL BE THE SAME FOR FIXED AND REMOVABLE CLIMBING RUNG SECTIONS.
3. PROVIDE LADDER BRACKETS ON DAVIT ARMS LONGER THAN 3'-0", AS SHOWN ON DRAWING 43 2210.
4. FOR MEDIUM AND LARGE ANGLE SUSPENSION STRUCTURES, LOCATE FIXED CLIMBING RUNG SECTIONS AND CLIPS FOR REMOVABLE CLIMBING RUNG SECTIONS ON POLE FACE OPPOSITE SUSPENSION INSULATORS.
5. FOR TENSION STRUCTURES, LOCATE FIXED CLIMBING RUNG SECTIONS AND CLIPS FOR REMOVABLE CLIMBING RUNG SECTIONS ON POLE FACE OPPOSITE POST INSULATORS.
6. FOR VERTICAL COMPONENT OF INSULATOR LENGTH, "Z", SEE SPECIFICATIONS.
7. WELDS TO ATTACH MAINTENANCE PROVISIONS TO STRUCTURES SHALL DEVELOP THE ULTIMATE TENSILE STRENGTH OF THE ATTACHED PART.
8. FOR STRUCTURES WITH CONDUCTOR AND GROUND WIRE ATTACHMENT COMBINATIONS NOT SHOWN, PROVIDE ONLY THOSE MAINTENANCE PROVISIONS WHICH APPLY TO THAT TYPE OF ATTACHMENT.

REFERENCE DRAWING

MAINTENANCE PROVISIONS – DETAILS_ _ _ _ _ _ _43 2210

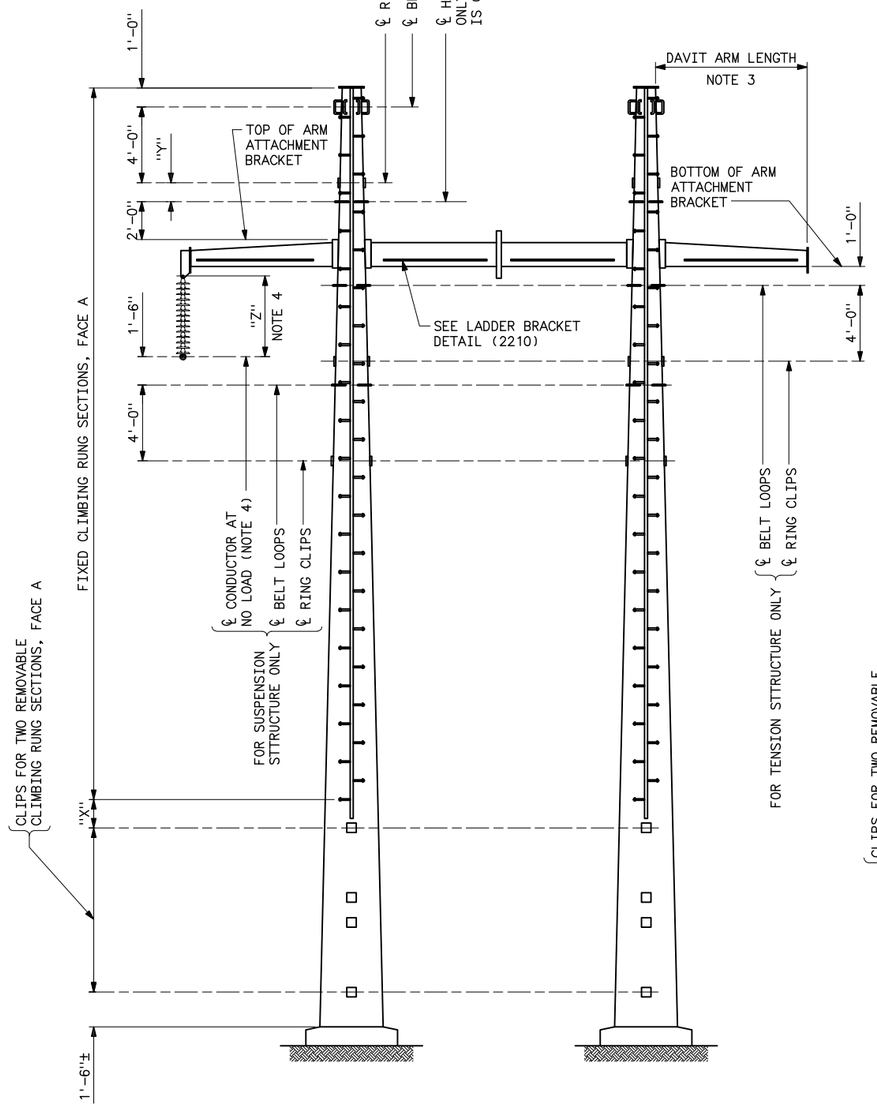
H	09-12-06 A7-BGH	REVISED LADDER BRACKETS.
G	3-1-06 A7-RMC	CORRECTED MISSPELLED WORD IN NOTE 5.
F	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
E	10-11-02 A7-BGH	REDRAWN AND MINOR REVISIONS.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

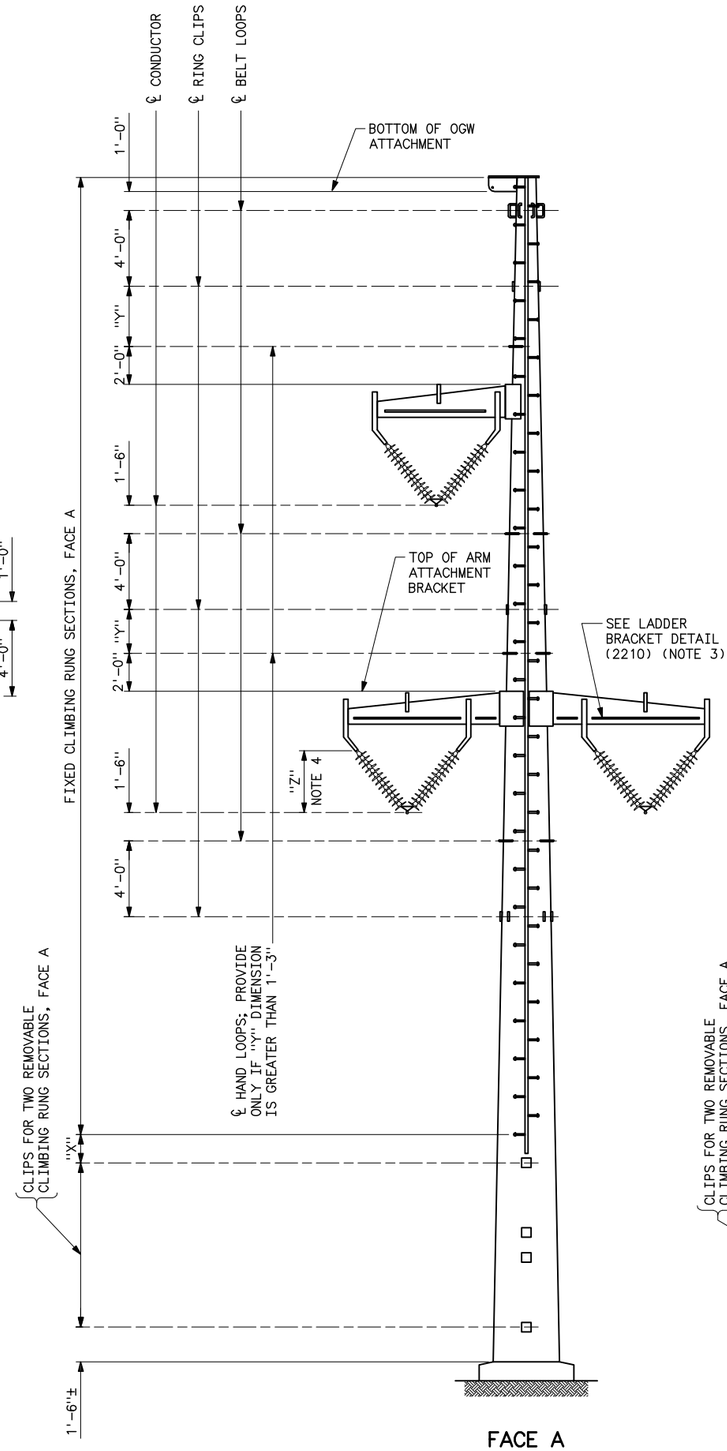
TRANSMISSION LINE STRUCTURE STANDARDS
STEEL POLE STRUCTURES
MAINTENANCE PROVISIONS – OUTLINES

DESIGNED BOBBY HAGLER _ _ _ _ _ APPROVED DOUG HANSON _ _ _ _ _ _ _ _ _ _
CIVIL ENGINEERING MANAGER

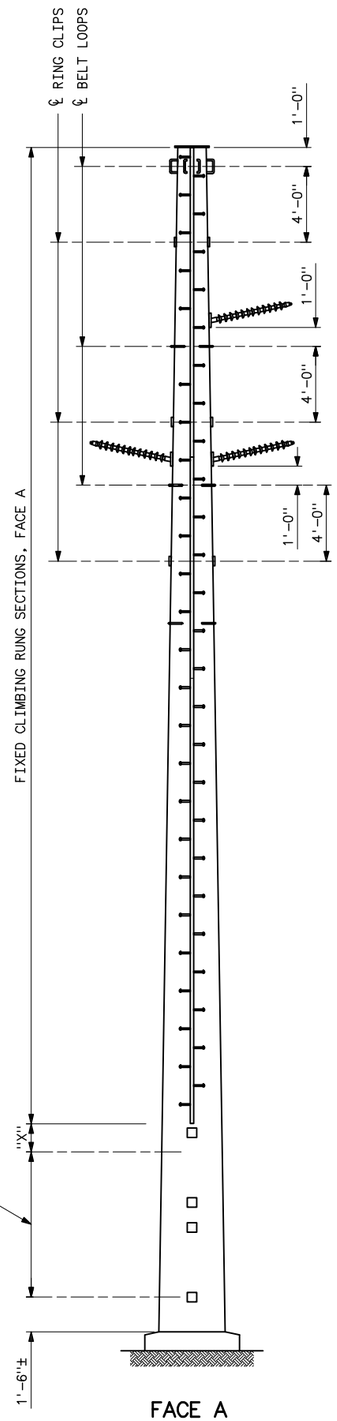
CAD FILE	OCTOBER 11, 2002	43	2206



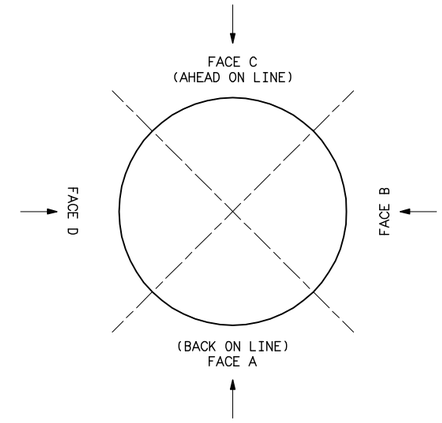
FACE A
H-FRAME STRUCTURES



FACE A
STRUCTURES WITH
VEE-STRINGS



FACE A
STRUCTURES WITH
POST INSULATORS



PLAN

(ALL VIEWS TAKEN LOOKING IN DIRECTION OF ARROW)

NOTES

1. "X" DIMENSION SHALL BE MINIMUM REQUIRED TO INSTALL TOP REMOVABLE CLIMBING RUNG SECTION.
2. DISTANCE FROM STEPS TO FACE OF POLE SHAFTS SHALL BE THE SAME FOR FIXED AND REMOVABLE CLIMBING RUNG SECTIONS.
3. PROVIDE LADDER BRACKETS ON DAVIT ARMS LONGER THAN 3'-0", AS SHOWN ON DRAWING 43 2210.
4. FOR VERTICAL COMPONENT OF INSULATOR LENGTH, "Z", SEE SPECIFICATIONS.
5. WELDS TO ATTACH MAINTENANCE PROVISIONS TO STRUCTURES SHALL DEVELOP THE ULTIMATE TENSILE STRENGTH OF THE ATTACHED PART.
6. FOR STRUCTURES WITH CONDUCTOR AND GROUND WIRE ATTACHMENT COMBINATIONS NOT SHOWN, PROVIDE ONLY THOSE MAINTENANCE PROVISIONS WHICH APPLY TO THAT TYPE OF ATTACHMENT.

REFERENCE DRAWING

MAINTENANCE PROVISIONS - DETAILS_ _ _ _ _ _ _43 2210

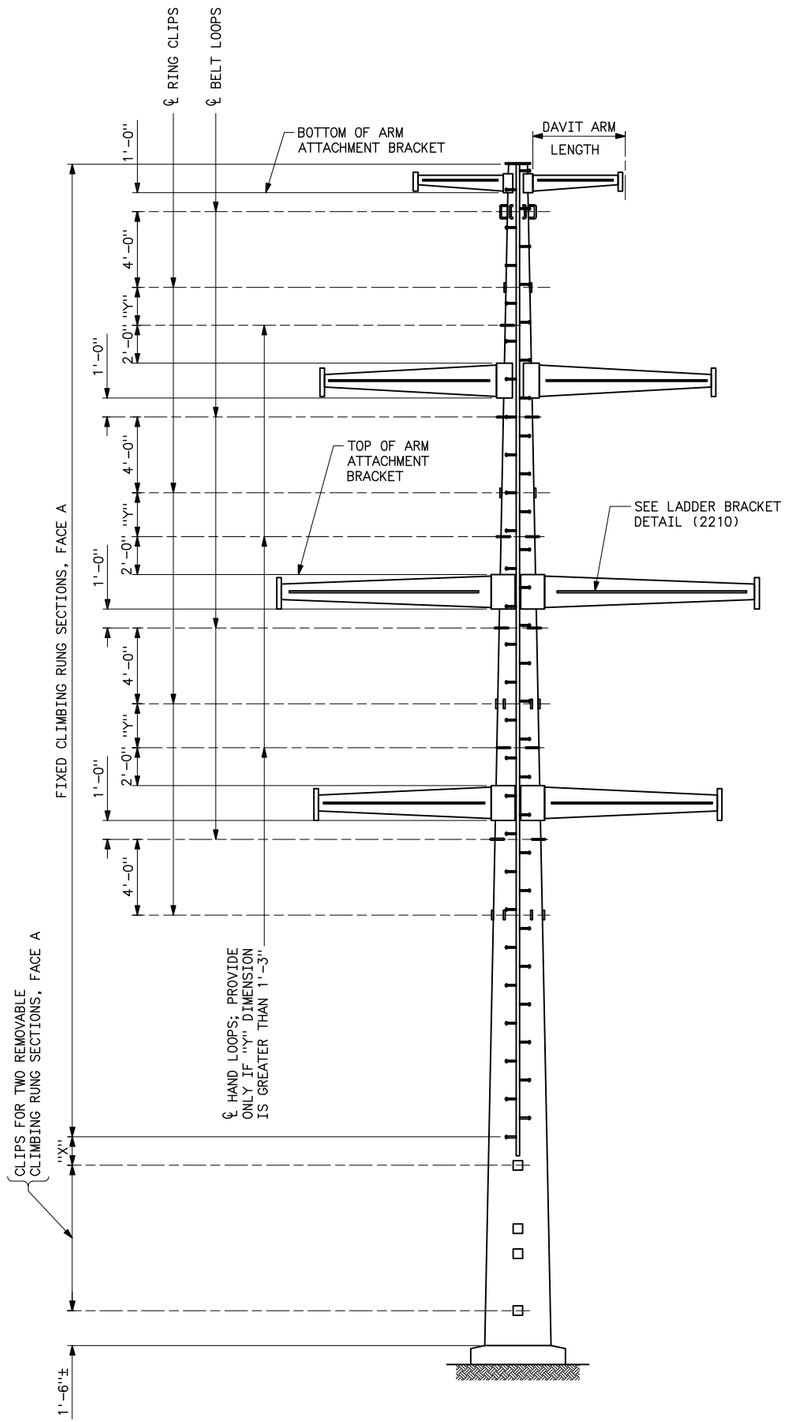
G	09-12-06 A7-BGH	REVISED LADDER BRACKETS.
F	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
E	10-16-02 A7-BGH	REDRAWN AND MINOR REVISIONS.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

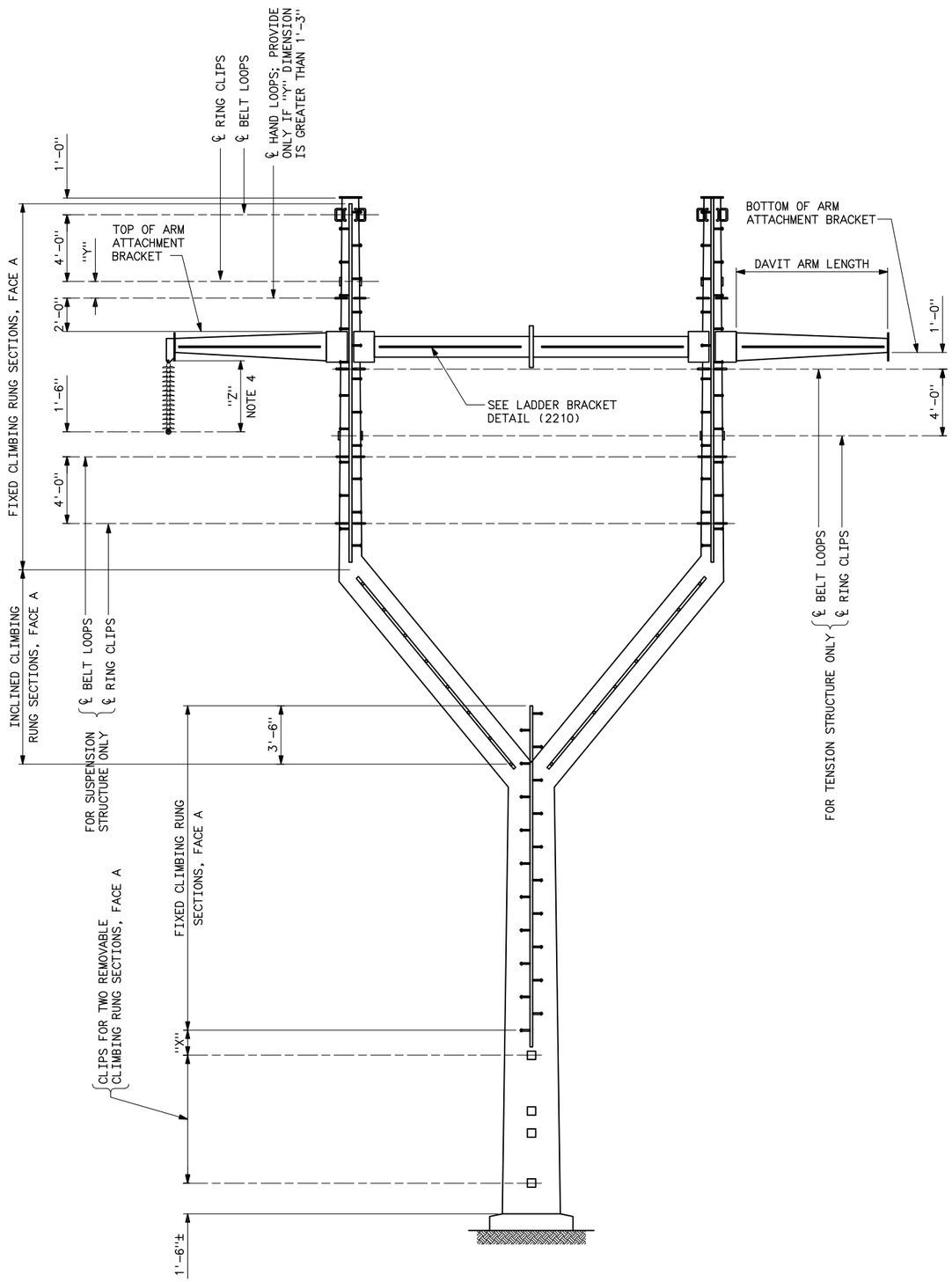
TRANSMISSION LINE STRUCTURE STANDARDS
STEEL POLE STRUCTURES
MAINTENANCE PROVISIONS - OUTLINES

DESIGNED BOBBY HAGLER _ _ _ _ _ APPROVED DOUG HANSON _ _ _ _ _ _ _ _ _ _
CIVIL ENGINEERING MANAGER

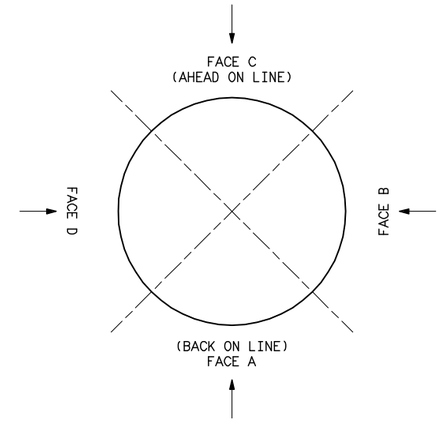
DATE		
OCTOBER 16, 2002	43	2207



FACE A
TENSION STRUCTURE WITH DAVIT ARMS



FACE A
Y-TYPE STRUCTURE



PLAN
(ALL VIEWS TAKEN LOOKING IN DIRECTION OF ARROW)

NOTES

1. "X" DIMENSION SHALL BE MINIMUM REQUIRED TO INSTALL TOP REMOVABLE CLIMBING RUNG SECTION.
2. DISTANCE FROM STEPS TO FACE OF POLE SHAFTS SHALL BE THE SAME FOR FIXED AND REMOVABLE CLIMBING RUNG SECTIONS.
3. PROVIDE LADDER BRACKETS ON DAVIT ARMS LONGER THAN 3'-0", AS SHOWN ON DRAWING 43 2210.
4. FOR VERTICAL COMPONENT OF INSULATOR LENGTH, "Z", SEE SPECIFICATIONS.
5. WELDS TO ATTACH MAINTENANCE PROVISIONS TO STRUCTURES SHALL DEVELOP THE ULTIMATE TENSILE STRENGTH OF THE ATTACHED PART.
6. FOR STRUCTURES WITH CONDUCTOR AND GROUND WIRE ATTACHMENT COMBINATIONS NOT SHOWN, PROVIDE ONLY THOSE MAINTENANCE PROVISIONS WHICH APPLY TO THAT TYPE OF ATTACHMENT.

REFERENCE DRAWING

MAINTENANCE PROVISIONS – DETAILS_____43 2210

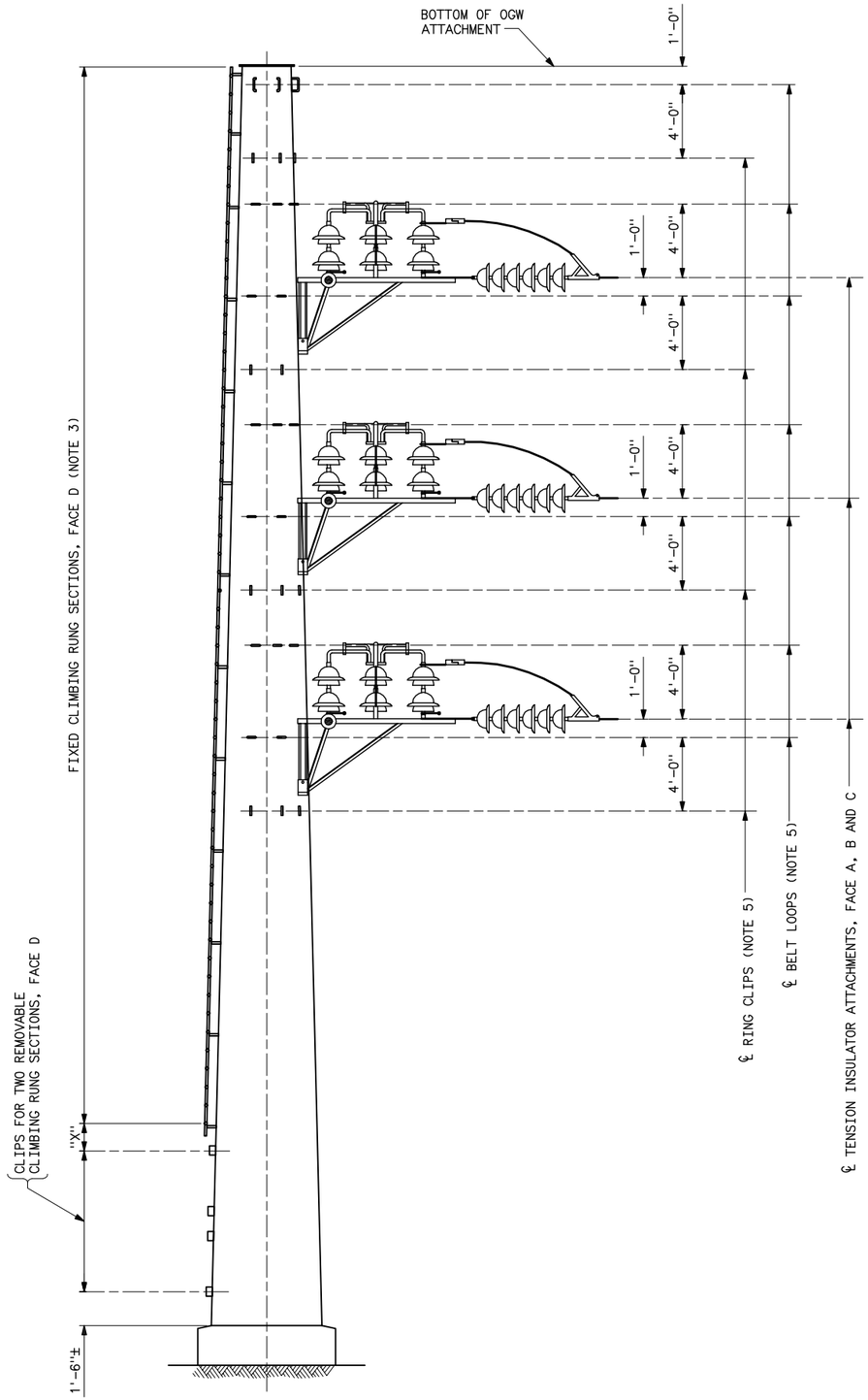
H	09-12-06 A7-BGH	REVISED LADDER BRACKETS.
G	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
F	10-17-02 A7-BGH	REDRAWN AND MINOR REVISIONS.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

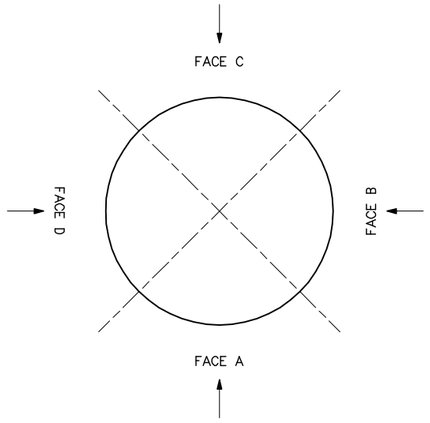
TRANSMISSION LINE STRUCTURE STANDARDS
STEEL POLE STRUCTURES
MAINTENANCE PROVISIONS – OUTLINES

DESIGNED BOBBY HAGLER _____ APPROVED DOUG HANSON _____ CIVIL ENGINEERING MANAGER

C.A.E.	OCTOBER 17, 2002	43	2208



FACE A
SWITCH STRUCTURE



PLAN
(ALL VIEWS TAKEN LOOKING IN DIRECTION OF ARROW)

NOTES

1. "X" DIMENSION SHALL BE MINIMUM REQUIRED TO INSTALL TOP REMOVABLE CLIMBING RUNG SECTION.
2. DISTANCE FROM STEPS TO FACE OF POLE SHAFTS SHALL BE THE SAME FOR FIXED AND REMOVABLE CLIMBING RUNG SECTIONS.
3. FOR SWITCH STRUCTURES, LOCATE FIXED CLIMBING RUNG SECTIONS AND CLIPS FOR REMOVABLE CLIMBING RUNG SECTIONS ON POLE FACE OPPOSITE SWITCHES.
4. WELDS TO ATTACH MAINTENANCE PROVISIONS TO STRUCTURES SHALL DEVELOP THE ULTIMATE TENSILE STRENGTH OF THE ATTACHED PART.
5. DO NOT PROVIDE RING CLIPS OR BELT LOOPS ON FACE B DIRECTLY UNDER SWITCH FRAMES.

REFERENCE DRAWING

MAINTENANCE PROVISIONS - DETAILS_ _ _ _ _ _ _43 2210

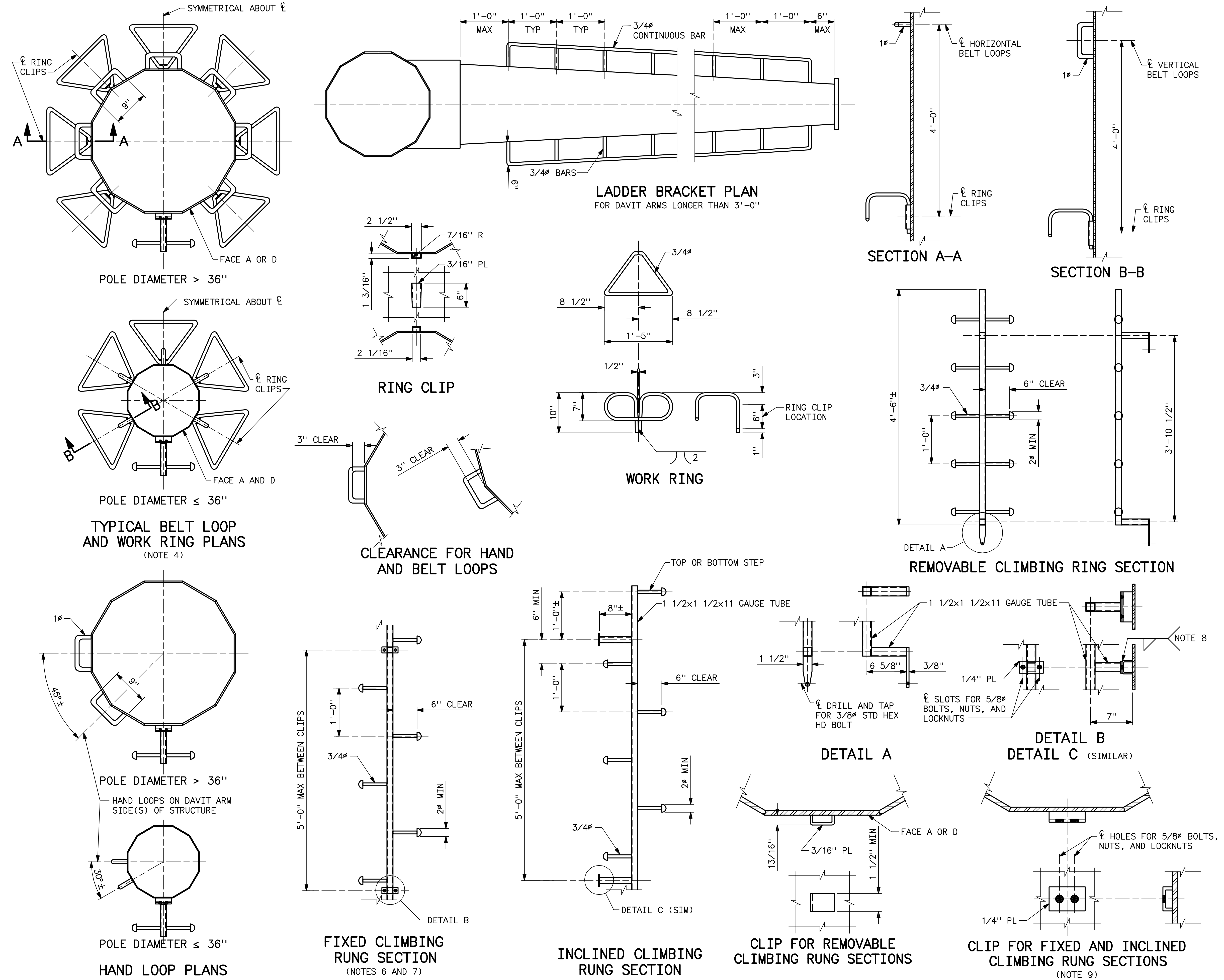
G	4-14-09 A7-DH	ADDED NOTE 5.
F	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
E	01-23-03 A7-BGH	REDRAWN.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE STRUCTURE STANDARDS
STEEL POLE STRUCTURES
MAINTENANCE PROVISIONS - OUTLINES

DESIGNED BOBBY HAGLER _ _ _ _ _ APPROVED DOUG HANSON _ _ _ _ _ _ _ _ _ _
CIVIL ENGINEERING MANAGER

CAD FILE	JANUARY 23, 2003	43	2209



NOTES

1. MINIMUM INSIDE COLD BENDING RADII (INCHES):
   3/4"ø BAR=2 1/4"
   1"ø BAR=3"
2. WELDS TO ATTACH MAINTENANCE PROVISIONS TO STRUCTURES SHALL DEVELOP THE ULTIMATE TENSILE STRENGTH OF THE ATTACHED PART.
3. DISTANCE FROM STEPS TO FACE OF POLE SHAFTS SHALL BE THE SAME FOR FIXED CLIMBING RUNG SECTIONS AND REMOVABLE CLIMBING RUNG SECTIONS.
4. PROVIDE ONE BELT LOOP ABOVE EACH RING CLIP.
5. FIXED CLIMBING RUNG SECTIONS LOCATED ACROSS SLIP JOINTS SHALL BE DESIGNED TO ACCOMMODATE VERTICAL MOVEMENT OF THE SLIP JOINTS.
6. FIXED CLIMBING RUNG SECTIONS SHALL BE SPLICED TOGETHER TO FORM A CONTINUOUS CENTER SUPPORT FOR THE FULL HEIGHT OF THE STRUCTURE. SPLICES SHALL BE DESIGNED TO ENSURE FULL STRUCTURAL CONTINUITY OF THE CENTER SUPPORT.
7. TOP OR BOTTOM CANTILEVERED EXTENSIONS OF FIXED CLIMBING RUNG SECTIONS SHALL NOT EXTEND MORE THAN 2 FEET BEYOND THE NEAREST CLIP.
8. FOR WEATHERING-STEEL STRUCTURES, AFTER INSTALLING FIXED AND INCLINED CLIMBING RUNG SECTIONS WITH BOLTS, NUTS, AND LOCKNUTS, SPOT WELD THE RUNG SECTION MOUNTING PLATES TO THE CLIPS ON THE POLE SHAFTS. WELDING SHALL BE SUFFICIENT TO PROVIDE ELECTRICAL CONTINUITY BETWEEN CLIMBING RUNG SECTIONS AND THE POLE SHAFT.
9. ALTERNATIVE METHODS FOR ATTACHING FIXED AND INCLINED CLIMBING RUNG SECTIONS MAY BE SUBMITTED FOR APPROVAL.

REFERENCE DRAWINGS

MAINTENANCE PROVISIONS–
WORK RING ____ 43 2203
OUTLINES ____ 2206 THRU 2209

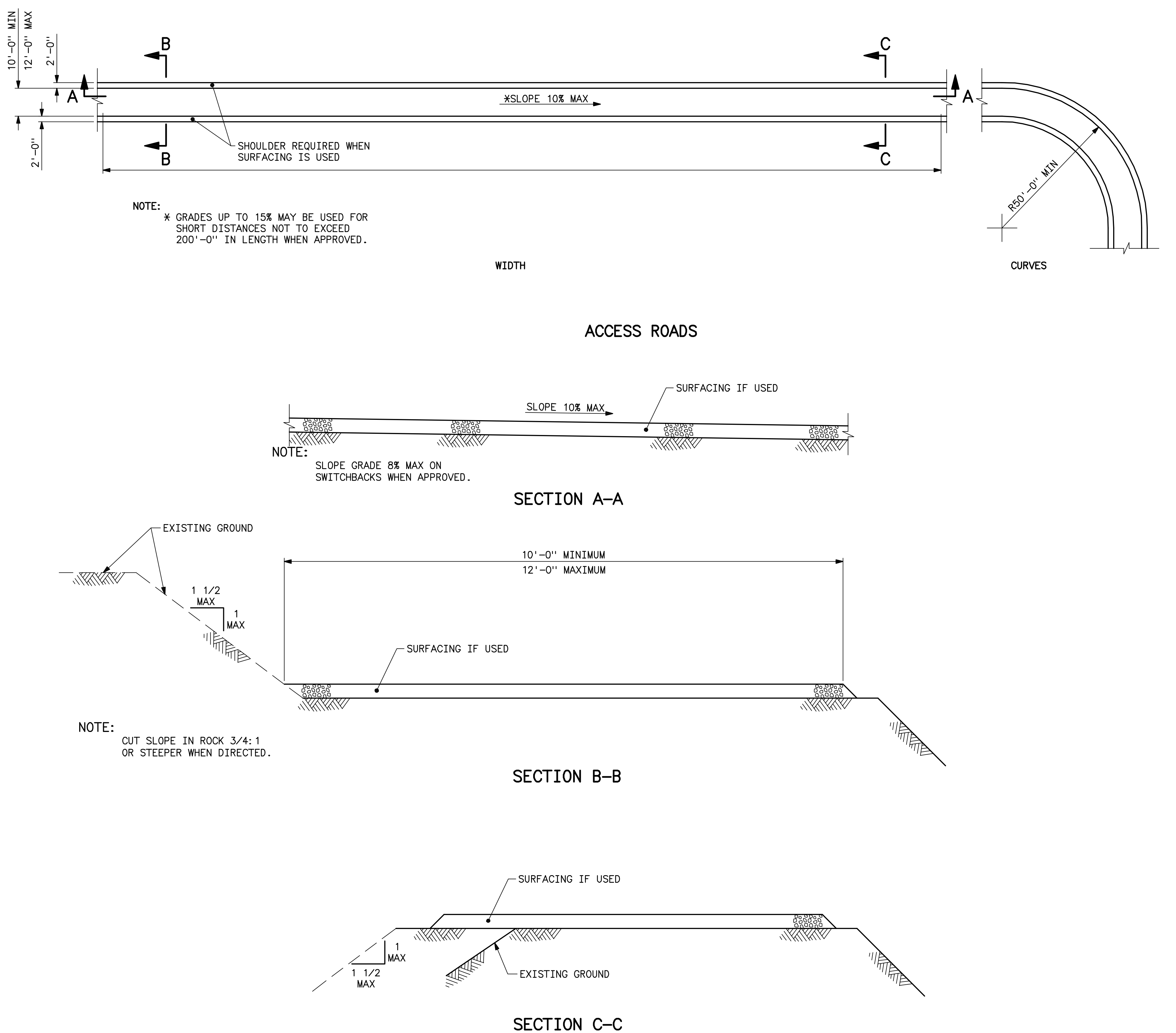
H	12-22-05 A7-BH	REVISED LADDER BRACKET PLAN.
G	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.
F	10-28-02 A7-BGH	REDRAWN. ADDED NOTES 6, 7, AND 9. MINOR REVISIONS.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

TRANSMISSION LINE
STRUCTURE STANDARDS
STEEL POLE STRUCTURES
MAINTENANCE PROVISIONS – DETAILS

DESIGNED BOBBY HAGLER APPROVED DOUG HANSON CIVIL ENGINEERING MANAGER

CAE | OCTOBER 28, 2002 | 43 | 2210



UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE – LAKEWOOD, COLORADO

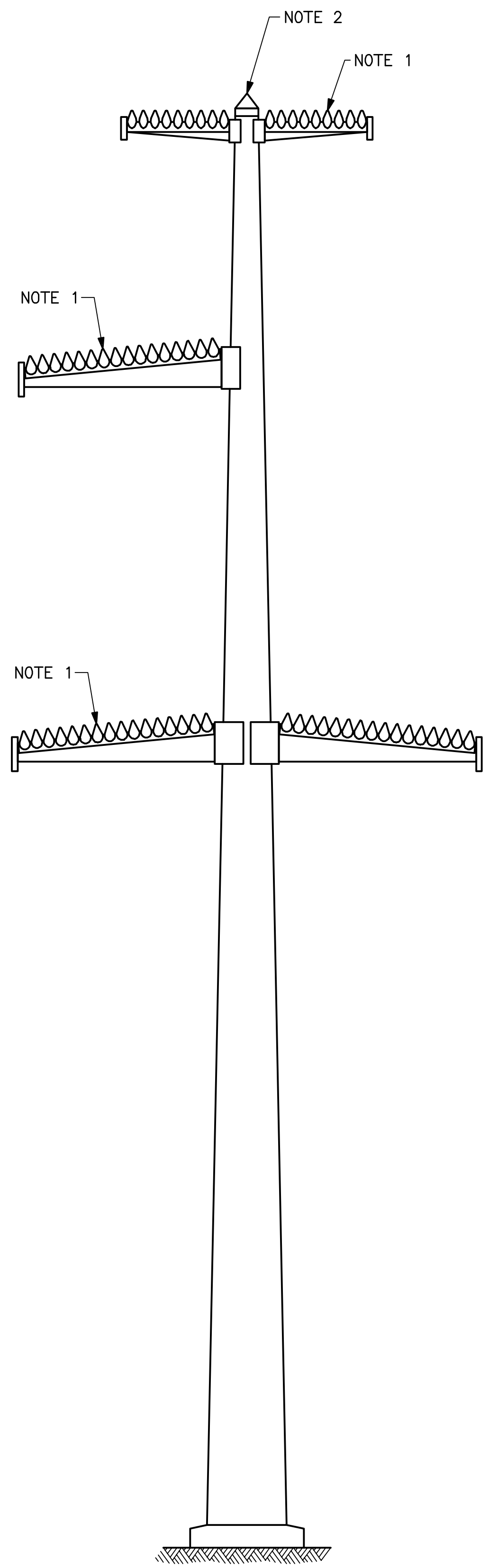
ACCESS ROAD STANDARDS
ACCESS ROADS
GENERAL REQUIREMENTS

DESIGNED DOUG HANSON — APPROVED DOUG HANSON, CIVIL ENGINEERING MANAGER

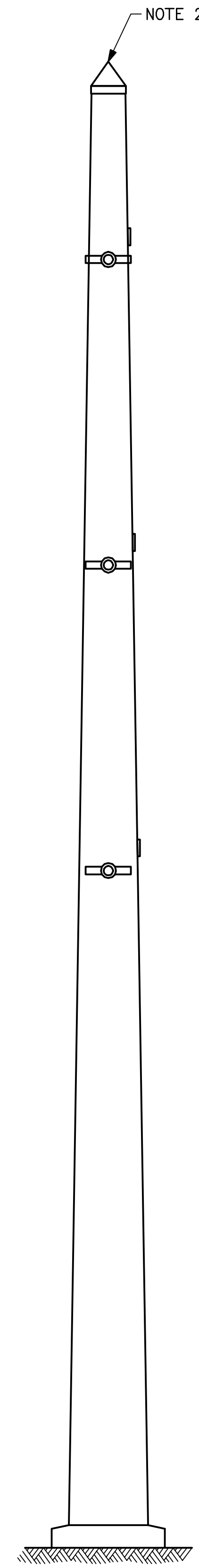
CAE | OCTOBER 25, 2002 | 43 | 2212

SUITABLE FOR CONSTRUCTION AS OF: Jan 29, 2003- 3:47pm

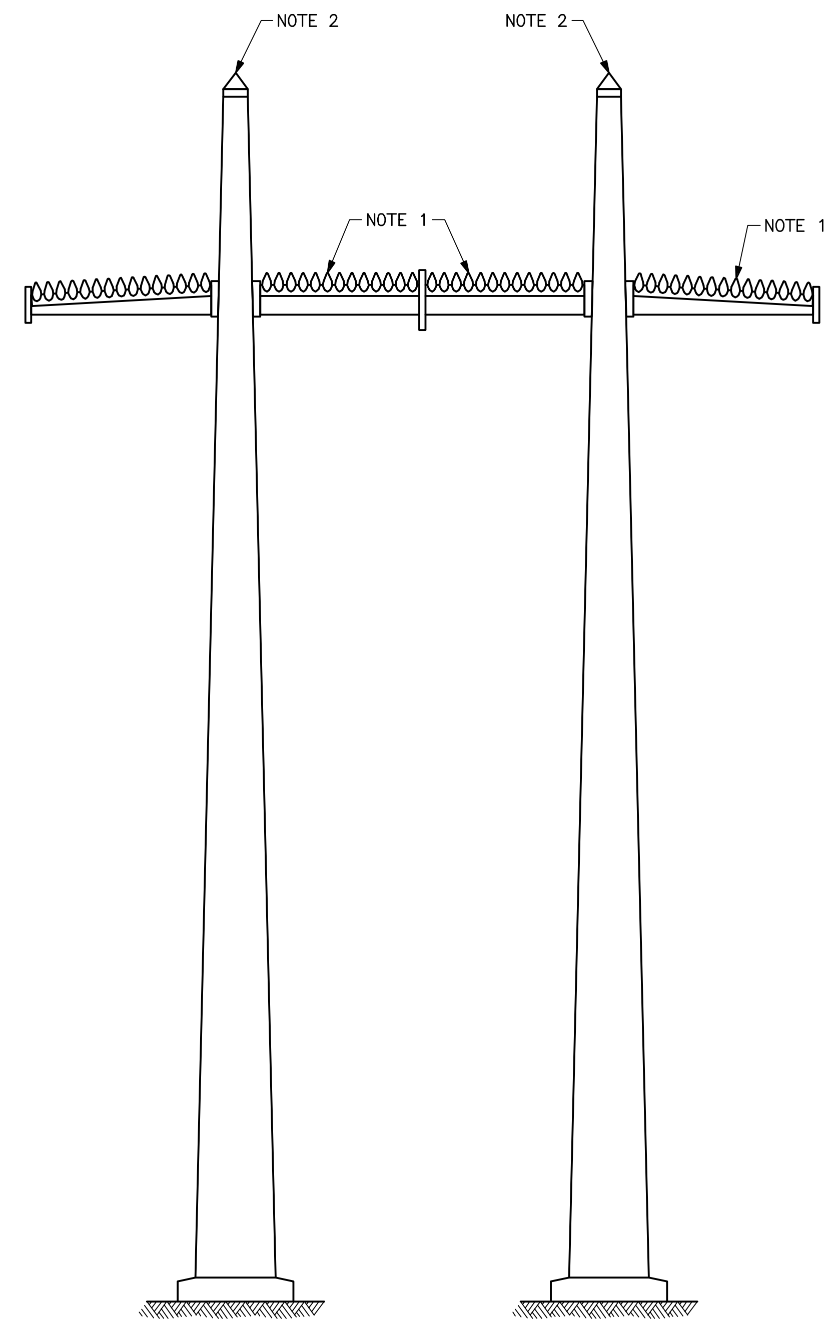
Plotted By: entwistle Nov 04, 2010- 3:31pm



SINGLE POLE STRUCTURE
WITH DAVIT ARMS



SINGLE POLE STRUCTURE
WITHOUT DAVIT ARMS



H-FRAME STRUCTURE
(Y-TYPE STRUCTURE SIMILAR)

NOTES

1. ANTI PERCH DEVICES FOR STEEL POLE DAVIT ARMS SHALL BE BLACK POLYETHYLENE WITH UV STABILIZER AND CONICAL IN SHAPE APPROXIMATELY 6" TALL. PERMANENTLY ATTACH THE DEVICES TO THE TOPS OF ALL OVERHEAD GROUNDWIRE AND CONDUCTOR DAVIT ARMS AND CROSSARMS WITH STAINLESS STEEL STRAPS. ANTI PERCH DEVICES SHALL COVER THE ENTIRE LENGTH OF THE ARMS AND SHALL BE EQUAL TO: ZENA PERCH PREVENTER MANUFACTURED BY ZENA OF PROMMEL ENTERPRISES INC., 12551 174TH COURT N., JUPITER. FL 33478.
2. ANTI PERCH DEVICES FOR THE POLE TOPS SHALL BE BLACK POLYETHYLENE WITH UV STABILIZER AND SHALL BE CONE-SHAPED APPROXIMATELY 17" TALL. PERMANENTLY ATTACH THE DEVICES TO ALL POLE TOPS WITH STAINLESS STEEL STRAPS OR BOLTS. DEVICES SHALL BE EQUAL TO: ZENA CONE MANUFACTURED BY ZENA OF PROMMEL ENTERPRISES INC., 12551 174TH COURT N., JUPITER. FL 33478.

EXCEPTION: ANTI PERCH DEVICES FOR THE POLE TOPS ARE NOT REQUIRED ON STRUCTURES WITH AERIAL PATROL MILE MARKER OR WARNING SIGNS MOUNTED TO POLE TOPS.

A	7-15-03 A7-DH	REVISED TITLE BLOCK ONLY.

UNITED STATES DEPARTMENT OF ENERGY
WESTERN AREA POWER ADMINISTRATION
CORPORATE SERVICES OFFICE - LAKEWOOD, COLORADO

TRANSMISSION LINE
STRUCTURE STANDARDS
STEEL POLE STRUCTURES
ANTI PERCH PROVISIONS

DESIGNED BOBBY HAGLER APPROVED DOUG HANSON
CIVIL ENGINEERING MANAGER

CAE	JANUARY 13 ,2003	43	2213