BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF SOUTHWESTERN PUBLIC SERVICE COMPANY'S APPLICATION REQUESTING: (1) ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY AUTHORIZING CONSTRUCTION AND OPERATION OF THE EDDY COUNTY TO KIOWA 345-KV TRANSMISSION LINE AND ASSOCIATED FACILITIES; (2) APPROVAL OF THE LOCATION OF THE 345-KV TRANSMISSION LINE AND ASSOCIATED FACILITIES; (3) DETERMINATION OF RIGHT-OF-WAY WIDTH FOR THE TRANSMISSION LINE; AND (4) AUTHORIZATION TO ACCRUE AN ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION FOR THE TRANSMISSION LINE AND ASSOCIATED FACILITIES,	)	**CASE NO. 19-00157-UT**
SOUTHWESTERN PUBLIC SERVICE COMPANY,	)	
APPLICANT.	)	

DIRECT TESTIMONY

of

JERRY G. CRAWFORD

on behalf of

SOUTHWESTERN PUBLIC SERVICE COMPANY

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GLOSSARY OF ACRONYMS AND DEFINED TERMS

<u>Acronym/Defined Term</u>	<u>Meaning</u>
ACSS	Aluminum Conductor Steel Supported
AFUDC	Allowance for Funds Used During Construction
Commission	New Mexico Public Regulation Commission
kcmil	1000 circular mils
kV	Kilovolt(s)
MVA	Megavolt amperes
NESC	National Electric Safety Code
P&D	Patterson & Dewar Engineers
Proposed Project	345-kV transmission line and associated facilities extending from SPS's Kiowa Substation to its Eddy County Substation located in Eddy County, New Mexico
PUA	Public Utility Act (NMSA 1978, § 62-3-1, *et al.*)
ROW	Right-of-Way
SPS	Southwestern Public Service Company, a New Mexico corporation
Xcel Energy	Xcel Energy Inc.
XES	Xcel Energy Services Inc.

LIST OF ATTACHMENTS

Case No. 19-____-UT
Direct Testimony
of
Jerry G. Crawford

I. WITNESS IDENTIFICATION AND QUALIFICATIONS

Q. Please state your name and business address.

A. My name is Jerry G. Crawford, and my business address is 790 South Buchanan Street, Amarillo, Texas 79101.

Q. On whose behalf are you testifying?

A. I am filing testimony on behalf of Southwestern Public Service Company, a New Mexico corporation ("SPS") and wholly-owned subsidiary of Xcel Energy Inc. ("Xcel Energy").

Q. By whom are you employed and in what position?

A. I am employed by Xcel Energy Services Inc. ("XES") as Principal Transmission Engineer.

Q. Please briefly outline your responsibilities as a Principal Transmission Engineer.

A. I am one of the lead engineers that oversee design and related activities involved in the construction and maintenance of transmission lines.

Q. Describe your educational background.

A. I received a Bachelor of Science degree in Civil Engineering with a Structural option from New Mexico State University in January 1982.

Q. Please describe your professional experience.

A. I began my career with SPS in January 1982 as an engineer-in-training in the Transmission & Distribution Design Department. From 1982 to 1988 I held the titles of engineer-in-training, structural engineer and supervising engineer. In 1988, I went to work for Meyer Industries, a division of American Electric, as a design engineer in their Research, Development and Engineering Department, designing tubular steel transmission structures as well as research and development projects designing and testing various connections and components associated with tubular steel transmission structures. In 1991, I returned to SPS to work in their Transmission Engineering and Right-of-Way ("ROW") Department, designing transmission lines, overseeing contract surveyors, and implementing new computer base transmission line design software. From 1991 to 2000 I held positions as a Senior Design Engineer and Principal Design Engineer. In 2002, I accepted a position with Municipal Electric Authority of Georgia in their Engineering Department, with responsibilities managing transmission projects and consultant engineers designing transmission line projects. In 2004, I accepted a position with Patterson & Dewar Engineers ("P&D") as a Project Engineer. My duties included transmission line design, substation steel structure design, foundation design, oil spill prevention, control and countermeasure designs for substations, and site grading design. While at P&D, I advanced from Project Engineer to Principal Engineer, Transmission Line Design Supervisor, Manager of the Transmission Design Group, and finally to Technical Lead.

In 2016, I begin working for XES as a Principal Transmission Engineer. My duties include being lead engineer on transmission projects and mentoring and training young engineers to design transmission lines. Over my career I have designed and provided construction support on over 2,100 miles of transmission line from 46 kilovolt ("kV") to 345-kV voltage. Finally, I have served on the ASCE/SEI 48 Design of Steel Transmission Pole Structures Standard Committee since 1991.

Q. Do you hold any professional licenses?

A. Yes, I'm a registered professional engineer in New Mexico, Texas, Oklahoma, Mississippi, Alabama, Georgia, Tennessee, North Carolina, Kentucky and Florida.

II. ASSIGNMENT

Q. What is the purpose of your testimony?

A. My testimony supports SPS's request for a New Mexico Public Regulatory Commission ("Commission") determination that a 150-foot ROW width is necessary to constuct, operate, and maintain the proposed 345-kV transmission line that will extend from SPS's Eddy County Substation[1] to its Kiowa Substation located in Eddy County, New Mexico (i.e., "Proposed Project"), in accordance with Section 62-9-3.2 of the New Mexico Public Utility Act (NMSA 1978, § 62-3-1, et al. ("PUA")). Specifically, my testimony will: (1) discuss the statutory requirements for approval of ROW widths in excess of 100-feet and explain the need for a ROW width of 150-feet for the Proposed Project; (2) describe the circuit design and construction of the Proposed Project; and (3) discuss the estimated costs associated with the Proposed Project, including SPS's request for authorization to accrue an Allowance for Funds Used During Construction ("AFUDC").

[1] The Eddy County and Kiowa facilities have been described as "substations" for purposes of this filing. The facilities however are more accurately defined for circuit design and engineering purposes as "interchanges" in that the station only serves transmission voltages with transformers changing voltages. In contrast, "substations" serve both transmission and distribution voltages with transformers interchanging voltages. For the Proposed Project, neither facility will serve distribution level voltages.

Q. Were Attachments JGC-1 through JGC-3 prepared by you or under your supervision?

A. Yes.

III. NEED FOR ROW WIDTH OF 150-FEET

Q. What are the statutory requirements regarding ROW widths in relation to the proposed 345-kV transmission line?

A. Section 62-9-3.2(A) of the PUA requires utilities to obtain a Commission determination that any proposed ROW width greater than 100-feet is necessary before construction of any transmission line and associated facilities can commence. Utilities are required to file an application that sets forth the facts necessary to allow the Commission to make a determination that the requested ROW width is necessary (*see* NMSA 1978, § 62-9-3.2(C)). Applicants are also required to provide notice of the time and place of the hearing on the application to all landowners and occupants of the property impacted by the requested ROW (*see* NMSA 1978, § 62-9-3.2(D)).[2]

Q. Has SPS determined the ROW width required for the proposed 345-kV transmission line?

A. Yes. The proposed 345-kV Eddy County to Kiowa transmission line will require a 150-foot ROW width that has 75 feet on either side of the centerline.

[2] Please refer to the Direct Testimony of Nisha P. Fleischman at 30.

Q. Please explain why a 150-foot ROW width is required for the Proposed Project.

A. The 150-feet wide ROW is required to comply with the requirements of Rules 234 A-2, B-1, and G of the National Electric Safety Code ("NESC"). Specifically, the NESC specifies minimum horizontal and vertical clearance requirements for overhead lines, which vary depending on the size of the transmission line. For the Proposed Project, the ROW width must be sufficient for the transmission line, which incorporates a basic phase spacing of 30 feet for 345-kV design. The horizontal displacement of the 795 kcmil ("1000 circular mils") ACSS ("Aluminum Conductor Steel Supported") bundled conductors due to a six-pound per square foot wind loading[3] on a 1000-foot span, along with the applicable safety clearances, will be contained within the boundaries of the 150-foot ROW easement.

The proposed 150-foot wide ROW also allows for flexibility during design and construction by allowing spans to be longer than 1000 feet and phase spacing wider than 30 feet as necessary without violating NESC requirements. Further, it is customary in the utility industry to have a ROW width that is slightly larger

[3] *See* NESC Section 234A2 for loading requirement.

than the calculated minimum under the NESC to account for construction tolerances and to provide for the general safety of the public. Finally, a 150-foot wide ROW will be necessary to provide adequate access for maintenance of the transmission line.

In addition to the NESC requirements, SPS also designs transmission lines to maintain a reduced clearance at the edge of the ROW under extreme wind conditions[4] (for this project the extreme wind is 90 miles per hour). The 150-foot wide ROW easement allows this clearance to be maintained.

Q. Did you prepare an analysis supporting SPS's request for a 150-foot ROW width?

A. Yes. Attachment JGC-1 provides the calculations and output reports from SPS's transmission line design software for determining the minimum ROW width needed for the proposed transmission line. SPS has calculated the minimum ROW width needed for transmission lines with spans ranging from 900-feet to 1,100-feet. The calculations are based on NESC wind loading requirements and structure characteristics, and account for extreme wind conditions.

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[4] Extreme wind conditions are defined under NESC Section 250C.

IV. CIRCUIT DESIGN AND CONSTRUCTION FOR THE PROPOSED TRANSMISSION LINE

Q. Please briefly describe the interconnection facilities for the Proposed Project.

A. The existing Eddy County Substation will be expanded to the east to add a new three terminal ring bus with termination points for a 515 MVA ("megavolt amperes"), 345/230-kV autotransformer, one existing 345-kV transmission line, and the proposed new 345-kV transmission line to the Kiowa Substation. The Kiowa Substation will be expanded to the west to reconfigure the existing 345-kV four-terminal ring bus into a five-terminal breaker and one-half configuration with termination points for a 448 MVA, 345/115-kV autotransformer, the three existing 345-kV transmission lines, and the proposed 345-kV transmission line to Eddy County Interchange. See Attachment JJC-5 to SPS witness Jarred J. Cooley's direct testimony for an electrical one-line diagram that shows the interconnection of the 345-kV Eddy County to Kiowa transmission line to SPS's transmission system.

Q. Please briefly describe the design of the circuit for the Proposed Project.

A. The 345-kV Eddy County to Kiowa transmission line will utilize self-supporting steel structures installed on concrete foundations at corners and terminations of the transmission line. The remaining tangent (in-line) structures will typically be direct buried H-frame steel structures. If there are locations that require a narrower footprint to avoid existing oil wells and terrain restrictions, single-pole steel structures on concrete foundations will be installed.

Typical structure configuration drawings are shown in Attachment JGC-2. The conductors will typically be 30 feet apart on both single-pole structures and H-frame structures. The conductors will be bundled 795 kcmil ACSS for the 345-kV transmission line. The new shield wires will be a combination of 3/8 inch extra high strength steel and optical ground wire. One of the two (2) shield wires will be a 3/8 inch extra high strength steel. The other will be an optical ground wire with fiber optic strands internally in tubes, placed in the stranded cable replacing some of the solid strands. The fiber optic strands are used for communication between relays and other substation equipment, and transmit operational information to SPS control centers.

Q. Please describe the tangent (in-line) structures and how many will be installed.

A. The single-circuit H-Frame tangent structures will utilize steel arms to support the transmission line conductors. The H-Frame structure consists of two poles, X-braces, cross arm and two static peaks (support arms for shield wires). The typical tangent structure configuration is shown on drawing SD-T0-672 in Attachment JGC-2. These structures will typically be spaced approximately 850 to 1,100 feet apart and will be fabricated of self-weathering steel. The total line length of the 345-kV transmission line will be approximately 33.9 miles and approximately 148 steel tangent structures will be installed.

Q. Please describe the corner and termination structures and how many will be installed.

A. The most common structures used at corners and terminations of the 345-kV transmission line will be self-supporting self-weathering steel 3-pole structures installed on concrete foundations as shown in Attachment JGC-2. Approximately 36 of these structures will be used along the route. Vertical, self-supporting self-weathering single-pole steel structures may be utilized in congested areas where reduced horizontal space is available and along the line for phasing purposes. Typical corner, angle and transposition structure configurations are shown on drawings in Attachment JGC-2.

Q. What is the construction timetable for the Proposed Project?

A. Preliminary transmission line design began in January 2019 and is ongoing. Material requests will be submitted beginning in mid-2019, about halfway through the design process. All material should be available approximately 9 to 12 months after the material requests are initiated. Construction should take approximately 11 months to complete. The expected in-service date of the Proposed Project is November 2020.

V. ESTIMATED COSTS ASSOCIATED WITH PROPOSED PROJECT

Q. What is the total cost of the Proposed Project?

A. The total cost of the Proposed Project is approximately $60.8 million.[5] Please refer to Attachment JGC-3 for a breakdown of the estimated costs by component.

Q. How did you quantify the total cost of the Proposed Project?

A. The four major components that comprise the Proposed Project's estimated cost are: (1) labor; (2) equipment; (3) material; and (4) other.

Q. Explain the labor component of the estimated costs.

A. The labor costs are determined by the length of the Proposed Project, as well as the number and types of structures required to construct the Proposed Project. The length of the Proposed Project dictates the amount of labor required to install conductor and overhead shield wire.[6] The length also affects the required number of structures that need to be installed to support the circuit from the beginning to the end of the Proposed Project's route.

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[5] Please refer to the Direct Testimony of Jarred J. Cooley at 19-20 for a discussion of the projected allocation of the total cost of the Proposed Project based on SPP's Highway/Byway cost allocation methodology along with an illustrative example of the projected allocation of the total costs to be borne by SPS and SPS's New Mexico retail customers.

[6] Shield wire is connected directly to the top of a transmission structure to protect conductors from a direct lightning strike, minimizing the possibility of power outages.

The type of structure also dictates the amount of labor required to install each structure and its associated foundation, if applicable, and hardware. SPS uses design software to determine the number and type of structures required to complete the Proposed Project. Once the number and types of structures are identified, the labor costs (such as labor rates and overhead rates) are estimated based on actual labor costs experienced by SPS on prior transmission projects.

Q. Explain the equipment component of the estimated costs further.

A. The majority of the equipment used for transmission projects is owned or rented by contractors. Thus, the costs for the equipment are determined by the contractors and will be included in the contractors' bids. Because SPS does not receive contractor bids until after the design has been completed and a construction package has been issued, the estimated costs for equipment are based on bid units received for SPS's past transmission projects and included in the contract labor costs estimated above.

Q. Explain the material component of the estimated costs further.

A. The major materials required to construct the Proposed Project include steel structures, foundation material, insulators, pole hardware, conductor, and overhead shield wires. As I discussed earlier, SPS uses design software to determine the number and types of the structures required to complete the Proposed Project. SPS also uses this design software to estimate the weight and cost of each structure type. The remainder of the major materials for the structures is estimated using past transmission projects' material costs.

Q. What types of costs fall under the "other" category of costs?

A. The types of costs that fall into this category are for overhead, contingency and escalation. The rates used for all three of these types of costs are provided by SPS. Overhead includes all costs except for direct labor, direct materials, and direct expenses. Contingency accounts are for unexpected cost items that may arise during the project. Escalation accounts are for possible increases in estimated costs due to inflation or other factors.

Q. What amount of the total cost of the Proposed Project represents AFUDC?

A. Approximately $2.14 million of the total cost is estimated for AFUDC (*see* Attachment JGC-3). The AFUDC is based on SPS's annual weighted average cost of capital rate that is applicable during the construction phase of the project and is explained by Mr. Cooley.

Q. Does this conclude your pre-filed testimony?

A. Yes.

VERIFICATION

STATE OF TEXAS)
) ss.
COUNTY OF POTTER)

Jerry G. Crawford, first being sworn on his oath, states:

I am the witness identified in the preceding testimony. I have read the testimony and the accompanying attachments and am familiar with their contents. Based upon my personal knowledge, the facts stated in the direct testimony are true. In addition, in my judgment and based upon my professional experience, the opinions and conclusions stated in the testimony are true, valid, and accurate.

Jerry G. Crawford

SUBSCRIBED AND SWORN TO before me this 28 day of May, 2019.

CINDY BAEZA
Notary Public, State of Texas
Notary ID #13078365-0
My Commission Expires 10-06-2020

Cindy Baeza
Notary Public, State of Texas
My Commission Expires: 10-06-2020

REQUIRED RIGHT OF WAY WIDTH

Project Name: J24 Eddy County to Kiowa Date: March 12, 2019
Project Engineer: Jerry G. Crawford P.E.

Structure Disc: H-Frame Tangent Structures

Conductor: 795 MCM ACSS Drake Insulator Length (ft): 13.3125
Diameter (in): 1.108 Wind/Weight Span Ratio: 1.0
Weight (lb/ft): 1.093

Wind Loading Conditions
6 psf (48.4 mph) @ 60 Deg. F [(1)]
Extreme Wind 90 mph (20.74 psf) @ 60 Deg. F [(2)]

Conductor Swing = 26.87 Degrees 48.4 MPH Wind 6.00 psf
Conductor Swing = 60.29 Degrees 90 MPH Wind 20.74 psf

Insulator Swing = 26.87 Degrees 48.4 MPH Wind 6.00 psf
Insulator Swing = 60.29 Degrees 90 MPH Wind 20.74 psf

Ruling Span Length (ft)	Maximum Span Length (ft)	Maximum Span Sag (ft)	Horiz. Displac. (ft)	Structure Ht. (3) (ft)	Structure Type (4)	1/2 Str. Width (ft)	Structure Deflection (5) %	Structure Deflection (5) (ft)	Electrical Clearance (ft) (6)	Min. ROW Width (ft)	(7)
6 psf (48.4 mph) @ 60 deg. F											
1000	900	21.14	15.57	106.00	H-Frame	30	2	2.12	14.0	121.26	
1000	1000	26.12	17.82	106.00	H-Frame	30	2	2.12	14.0	125.76	
1000	1100	31.60	20.30	106.00	H-Frame	30	2	2.12	14.0	130.71	
Extreme Wind 90 mph (20.74 psf) @ 60 Deg. F											
1000	900	22.94	31.49	106.00	H-Frame	30	3	3.18	1.8	129.76	+
1000	1000	28.34	36.18	106.00	H-Frame	30	3	3.18	1.8	139.14	+
1000	1100	34.29	41.35	106.00	H-Frame	30	3	3.18	1.8	149.47	+
Summary for Required Right-of-Way Width											
1000	900	22.94	31.49	106.00	H-Frame	30	3	3.18	1.8	129.76	
1000	1000	28.34	36.18	106.00	H-Frame	30	3	3.18	1.8	139.14	
1000	1100	34.29	41.35	106.00	H-Frame	30	3	3.18	1.8	149.47	

Notes:
(1) Per NESC Section 234A2
(2) Per NESC Section 250C
(3) Required height to supporting arm of top or critical phase for horizontal clearance at at maximum span length under loading condition
(4) Structure type being considered
(5) Structure deflections are based on the % entered and the height (Ht.)
(6) Electrical clearance under 6 psf wind case (48.4 mph) based on NESC Rule 234A2 plus Xcel Energy design buffer
Electrical clearance under the Extreme Wind case should provide enough air gap space to withstand 60-HZ flashover
(7) + Indicates limiting condition

JERRY G. CRAWFORD
NEW MEXICO
10143
PROFESSIONAL ENGINEER

6/6/2019

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Criteria Notes:
XCEL ENERGY PLS-CADD Criteria File (.cri) Version 2

****Version History****

06/28/2018 Version 0 - Initial version for general review
07/27/2018 Version 1 - First release version (updated insulator swing criteria)
01/05/2019 Version 2 - Added insulator swing weather cases for PSC Front Range Wind Speeds

****This criteria file is based on XCEL ENERGY Design Criteria as outlined in the following documents****

**** XEL-STD-TRANSMISSION LINE STRUCTURAL LOADING CRITERIA, Version 1.2
**** XEL-STD-TRANSMISSION LINE CLEARANCE CRITERIA, Version 2.2
**** XEL-STD-DESIGN GUIDE FOR TRANSMISSION LINE CONDUCTOR, Version 1.0
**** XEL-STD-CRITERIA FOR END & DESIGN FOR FOUNDATION DEFLECTION AND ROTATION DESIGN, Version 2.0
**** XEL-STD-DESIGN GUIDE FOR TRANSMISSION LINE INSULATORS, Version 2.0
**** XEL-POL-FACILITY RATING METHODOLOGY, Version 10.1

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Section Sagging Data

Circuit	Sec. No.	Cable File Name	From Str.	To Str.	Voltage (kV)	Ruling Span (ft)	Sagging Data: Condition	Sagging Data: Temp. (deg F)	Sagging Data: Catenary Constant (ft)	Sagging Data: Horiz. Tension (lbs)	Sagging Data: Weather Case	Display: Condition	Display: Catenary Constant (ft)
	1	drake_acss.wir	1	11	345	1002.4	Initial RS	60.0	5410.7	5916.1	392° F	Creep RS	3332.7

Sag Tension Report For 900 Foot Span

Note: Maximum tensions and sags are for the indicated span (not for level ruling span)

Sec. No.	Sag Tension Type	Wind From	Span From Str.	Span From Set	Span From Ph.	Span To Str.	Span To Set	Span To Ph.	#	Weather Case Description	Cable Load Hor. (lbs/ft)	Cable Load Vert (lbs/ft)	Cable Load Res. (lbs/ft)	Initial Cond. Max. Tens. (lbs)	Initial Cond. Hori. Tens. (lbs)	Initial Cond. Max Ten %UL	Initial Cond. C (ft)	Initial Cond. Span Sag (ft)	Final Cond. After Creep Max. Tens. (lbs)	Final Cond. After Creep Hori. Tens. (lbs)	Final Cond. After Creep Max Ten %UL	Final Cond. After Creep C (ft)	Final Cond. After Creep Span Sag (ft)	Final Cond. After Load Max. Tens. (lbs)	Final Cond. After Load Hori. Tens. (lbs)	Final Cond. After Load Max Ten %UL	Final Cond. After Load C (ft)	Final Cond. After Load Span Sag (ft)
1	RS	Right	6	5	1	7	5	1	2	NESC 250C (90 MPH)	1.55	1.09	1.90	8418	8375	33	4417	22.94	8418	8375	33	4417	22.94	8418	8375	33	4417	22.94
1	RS	Right	6	5	2	7	5	2	2	NESC 250C (90 MPH)	1.55	1.09	1.90	8418	8375	33	4417	22.94	8418	8375	33	4417	22.94	8418	8375	33	4417	22.94
1	RS	Right	6	5	3	7	5	3	2	NESC 250C (90 MPH)	1.55	1.09	1.90	8418	8375	33	4417	22.94	8418	8375	33	4417	22.94	8418	8375	33	4417	22.94
1	RS	Right	6	5	1	7	5	1	25	NESC BLOWOUT (60° F - 6 PSF)	0.55	1.09	1.23	6393	6370	25	5197	19.50	6393	6370	25	5197	19.50	5900	5874	23	4792	21.14
1	RS	Right	6	5	2	7	5	2	25	NESC BLOWOUT (60° F - 6 PSF)	0.55	1.09	1.23	6393	6370	25	5197	19.50	6393	6370	25	5197	19.50	5900	5874	23	4792	21.14
1	RS	Right	6	5	3	7	5	3	25	NESC BLOWOUT (60° F - 6 PSF)	0.55	1.09	1.23	6393	6370	25	5197	19.50	6393	6370	25	5197	19.50	5900	5874	23	4792	21.14

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	1	drake_acss.wir	1	11	345	1000.2	Initial RS	60.0	5410.7	5916.1	392° F	Creep RS	3329.0

Sag Tension Report For 1000 Foot Span

Note: Maximum tensions and sags are for the indicated span (not for level ruling span)

Sec. No.	Sag Tension Type	Wind From	Span From Str.	Span From Set	Span From Ph.	Span To Str.	Span To Set	Span To Ph.	Weather Case #	Weather Case Description	Cable Load Hor. (lbs/ft)	Cable Load Vert (lbs/ft)	Cable Load Res. (lbs/ft)	Initial Cond. Max. Tens. (lbs)	Initial Cond. Hori. Tens. (lbs)	Initial Cond. Max Ten %UL	Initial Cond. C (ft)	Initial Cond. Span Sag (ft)	Final Cond. After Creep Max. Tens. (lbs)	Final Cond. After Creep Hori. Tens. (lbs)	Final Cond. After Creep Max Ten %UL	Final Cond. After Creep C (ft)	Final Cond. After Creep Span Sag (ft)	Final Cond. After Load Max. Tens. (lbs)	Final Cond. After Load Hori. Tens. (lbs)	Final Cond. After Load Max Ten %UL	Final Cond. After Load C (ft)	Final Cond. After Load Span Sag (ft)
1	RS	Right	6	5	1	7	5	1	2	NESC 250C (90 MPH)	1.55	1.09	1.90	8426	8372	33	4415	28.34	8426	8372	33	4415	28.34	8426	8372	33	4415	28.34
1	RS	Right	6	5	2	7	5	2	2	NESC 250C (90 MPH)	1.55	1.09	1.90	8426	8372	33	4415	28.34	8426	8372	33	4415	28.34	8426	8372	33	4415	28.34
1	RS	Right	6	5	3	7	5	3	2	NESC 250C (90 MPH)	1.55	1.09	1.90	8426	8372	33	4415	28.34	8426	8372	33	4415	28.34	8426	8372	33	4415	28.34
1	RS	Right	6	5	1	7	5	1	25	NESC BLOWOUT (60° F - 6 PSF)	0.55	1.09	1.23	6399	6370	25	5197	24.07	6399	6370	25	5197	24.07	5904	5872	23	4790	26.12
1	RS	Right	6	5	2	7	5	2	25	NESC BLOWOUT (60° F - 6 PSF)	0.55	1.09	1.23	6399	6370	25	5197	24.07	6399	6370	25	5197	24.07	5904	5872	23	4790	26.12
1	RS	Right	6	5	3	7	5	3	25	NESC BLOWOUT (60° F - 6 PSF)	0.55	1.09	1.23	6399	6370	25	5197	24.07	6399	6370	25	5197	24.07	5904	5872	23	4790	26.12

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Project Name: 'C:\Users\Public\Documents\PLS\pls_cadd\examples\projects\J24_ROW_Study.don'

Criteria Notes:
XCEL ENERGY PLS-CADD Criteria File (.cri) Version 2

****Version History****

06/28/2018 Version 0 - Initial version for general review
07/27/2018 Version 1 - First release version (updated insulator swing criteria)
01/05/2019 Version 2 - Added insulator swing weather cases for PSC Front Range Wind Speeds

****This criteria file is based on XCEL ENERGY Design Criteria as outlined in the following documents****

**** XEL-STD-TRANSMISSION LINE STRUCTURAL LOADING CRITERIA, Version 1.2
**** XEL-STD-TRANSMISSION LINE CLEARANCE CRITERIA, Version 2.2
**** XEL-STD-DESIGN GUIDE FOR TRANSMISSION LINE CONDUCTOR, Version 1.0
**** XEL-STD-CRITERIA FOR END & DESIGN FOR FOUNDATION DEFLECTION AND ROTATION DESIGN, Version 2.0
**** XEL-STD-DESIGN GUIDE FOR TRANSMISSION LINE INSULATORS, Version 2.0
**** XEL-POL-FACILITY RATING METHODOLOGY, Version 10.1

JERRY G. CRAWFORD
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10143
PROFESSIONAL ENGINEER

6/6/2019

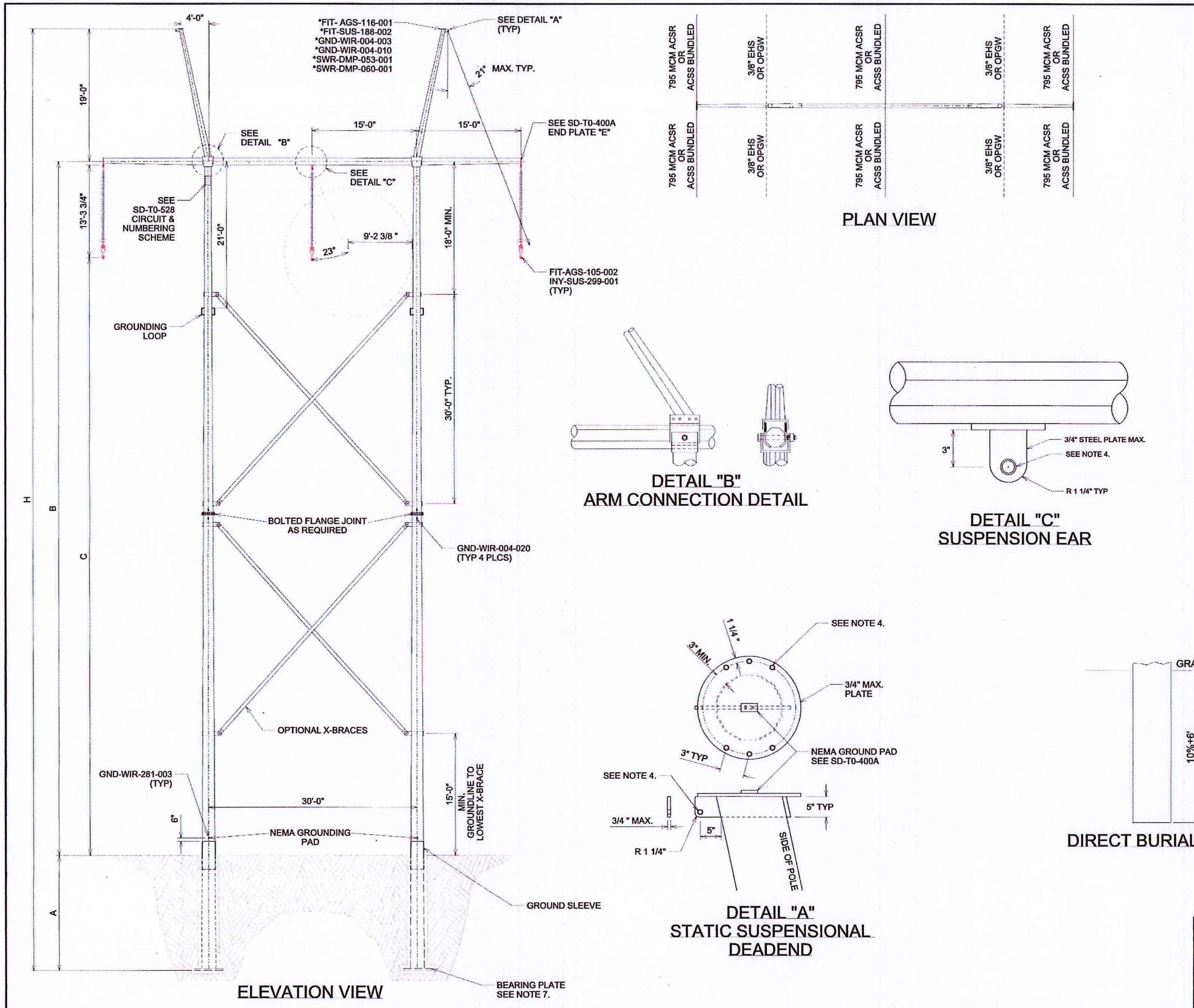
Section Sagging Data

Circuit Sec. No.	Cable File Name	From Str.	To Str.	Voltage (kV)	Ruling Span (ft)	Sagging Data: Condition	Temp. (deg F)	Catenary Constant (ft)	Horiz. Tension (lbs)	Weather Case	Display: Condition	Catenary Constant (ft)
1	drake_acss.wir	1	11	345	1002.5	Initial RS	60.0	5410.7	5916.1	392° F	Creep RS	3332.7

Sag Tension Report For 1100 Foot Span

Note: Maximum tensions and sags are for the indicated span (not for level ruling span)

Sec. No.	Sag Tension Type	Wind From	Span From Str.	Set	Ph.	Span To Str.	Set	Ph.	Weather Case #	Description	Cable Load Hor. (lbs/ft)	Vert (lbs/ft)	Res. (lbs/ft)	Initial Cond. Max. Tens. (lbs)	Hori. Tens. (lbs)	Max Ten %UL	C (ft)	Span Sag (ft)	Final Cond. After Creep Max. Tens. (lbs)	Hori. Tens. (lbs)	Max Ten %UL	C (ft)	Span Sag (ft)	Final Cond. After Load Max. Tens. (lbs)	Hori. Tens. (lbs)	Max Ten %UL	C (ft)	Span Sag (ft)
1	RS	Right	6	5	1	7	5	1	2	NESC 250C (90 MPH)	1.55	1.09	1.90	8440	8375	33	4417	34.29	8440	8375	33	4417	34.29	8440	8375	33	4417	34.29
1	RS	Right	6	5	2	7	5	2	2	NESC 250C (90 MPH)	1.55	1.09	1.90	8440	8375	33	4417	34.29	8440	8375	33	4417	34.29	8440	8375	33	4417	34.29
1	RS	Right	6	5	3	7	5	3	2	NESC 250C (90 MPH)	1.55	1.09	1.90	8440	8375	33	4417	34.29	8440	8375	33	4417	34.29	8440	8375	33	4417	34.29
1	RS	Right	6	5	1	7	5	1	25	NESC BLOWOUT (60° F - 6 PSF)	0.55	1.09	1.23	6405	6370	25	5197	29.13	6405	6370	25	5197	29.13	5913	5874	23	4792	31.60
1	RS	Right	6	5	2	7	5	2	25	NESC BLOWOUT (60° F - 6 PSF)	0.55	1.09	1.23	6405	6370	25	5197	29.13	6405	6370	25	5197	29.13	5913	5874	23	4792	31.60
1	RS	Right	6	5	3	7	5	3	25	NESC BLOWOUT (60° F - 6 PSF)	0.55	1.09	1.23	6405	6370	25	5197	29.13	6405	6370	25	5197	29.13	5913	5874	23	4792	31.60



NOTES

1. STRUCTURE SHOULD BE WEATHERING STEEL AND DESIGNED IN ACCORDANCE WITH SPS DESIGN DRAWINGS REFERENCED BELOW.
2 STRUCTURE DESIGN SHOWN IS FOR CONFIGURATION ONLY. ENGINEERING STRENGTH CALCULATIONS AND STRUCTURE DESIGN DETAILS MUST BE PERFORMED FOR EACH PROJECT.
3. POLE HOLE DEPTH SHALL BE ACCURATE. WHEN HOLES DO NOT ALLOW STRUCTURE TO BE EVEN AND LEVEL. THE DEEP HOLE SHALL BE BACKFILLED AND THOROUGHLY TAMPED TO PROPER DEPTH.
4. 1" DIAMETER HOLE WITH 1/8" CHAMFER BOTH SIDES.
5. POLE NUMBER SHALL BE INSTALLED ON EACH POLE AS REQUIRED.
6. SUSPENSION INSULATORS TO BE 345kV POLYMER INSULATORS.
7. BEARING PLATES TO BE MINIMUM 12" LARGER THAN POLE DIAMETER. PLATE THICKNESS IS TO BE 3/4".

REFERENCE DRAWINGS

1. SEE SHEET SD-T0-400 FOR GENERAL DETAILS.
2 SEE SHEET SD-T0-400A FOR ARM END PLATE DETAILS.
3. SEE SHEET SD-T0-400E FOR NUMBER PLATE DETAILS.
4. SEE SHEET SD-T0-400I FOR STRUCTURE GROUNDING.
5. SEE SHEET SD-T0-528 FOR CIRCUIT & POLE NUMBERING SCHEME.
6. SEE SHEET LD-T0-672 FOR STRUCTURE LOADING.
7. FIT- AGS-116-001 - FITTING, SUSPENSION, ARMOR GRIP, W/ Y-CLEVIS BALL, SOCKET EYE, RANGE 0.537"-0.559" OPGW (BY PHASE)
8. FIT-SUS-188-002 - FITTING, SUSPENSION, CLAMP, W/ ARMOR ROD AND SHACKLE, 3/8" EHS STEEL
9. FIT-AGS-105-002 - FITTING, SUSPENSION, ARMOR GRIP, W/ SOCKET EYE, YOKE PLATE, 25 K ULT, 795 KCMIL 26/7 ACSS (DRAKE), PARROT BILL (BY PHASE)
10. GND-WIR-004-003 - GROUNDING, SUSPENSION, STEEL POLE, SHIELD WIRE, FOR VANG OR ARM ON STEEL POLE
11. GND-WIR-004-010 - GROUNDING, SUSPENSION, STEEL POLE, OPGW SHIELD WIRE, FOR VANG OR ARM ON STEEL POLE
12. GND-WIR-004-020 - GROUNDING, STEEL SHAFTS, JOINT BONDING CONNECTIONS, TO GROUND PAD, W/ 5/32" DIAMETER WIRE, 7/19 STRAND
13. GND-WIR-281-003 - GROUNDING, STEEL POLE TO GROUND ROD
14. INY-SUS-299-001 - INSULATOR, POLYMER, SUSPENSION, Y-CLEVIS BALL, W/ SHACKLE, 345 KV, 30 K SPECIFIED MECHANICAL LOAD, MACLEAN
15. SWR-DMP-053-001 - SHIELD WIRE, DAMPER, VIBRATION, SPIRAL, OPGW & SHIELD, DIAMETER RANGE 0.463" TO 0.563"
16. SWR-DMP-060-001 - SHIELD WIRE, DAMPER, SPIRAL, 51" LONG, RANGE 0.327" TO 0.461"

DIMENSIONS

H	A	B	C
105'	16' - 6"	69' - 6"	55' - 4"
110'	17' - 0"	74' - 0"	59' - 10"
115'	17' - 6"	78' - 6"	64' - 4"
120'	18' - 0"	83' - 0"	68' 10"
125'	18' - 6"	87' - 6"	73 - 4"
130'	19' - 0"	92' - 0"	77' - 10"
135'	19' - 6"	96'- 6"	82' - 4"
140'	20' - 0"	101' - 0"	86' - 10"
145'	20' - 6"	106' - 6"	92' - 4"
150'	21' - 0"	111' - 0"	95' - 10"

ISSUED BY ENGINEERING DEPT FOR: CONSTRUCTION

J24, J-24 EDDY COUNTY SUB-KIOWA SUB 345kV
STRUCTURE DRAWING - T0 - STEEL
345KV 0-2 STEEL TANGENT STRUCTURE

Xcel Energy | SD-T0-672 | SCALE NONE | REV 0

3/28/2019 1:06:09 PM

SD-T0-672.DGN

REV	DATE	WBS #	REVISION DESCRIPTION
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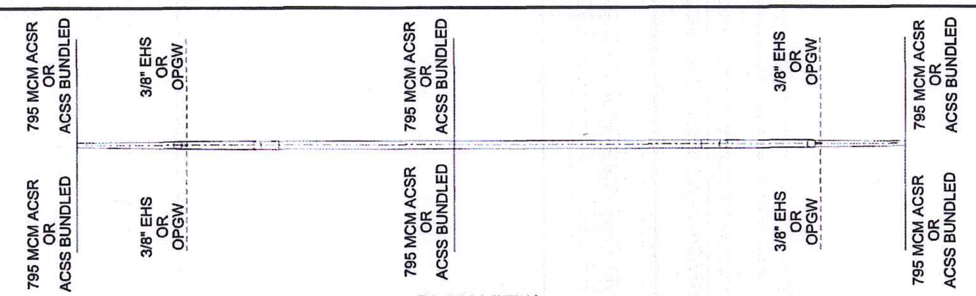
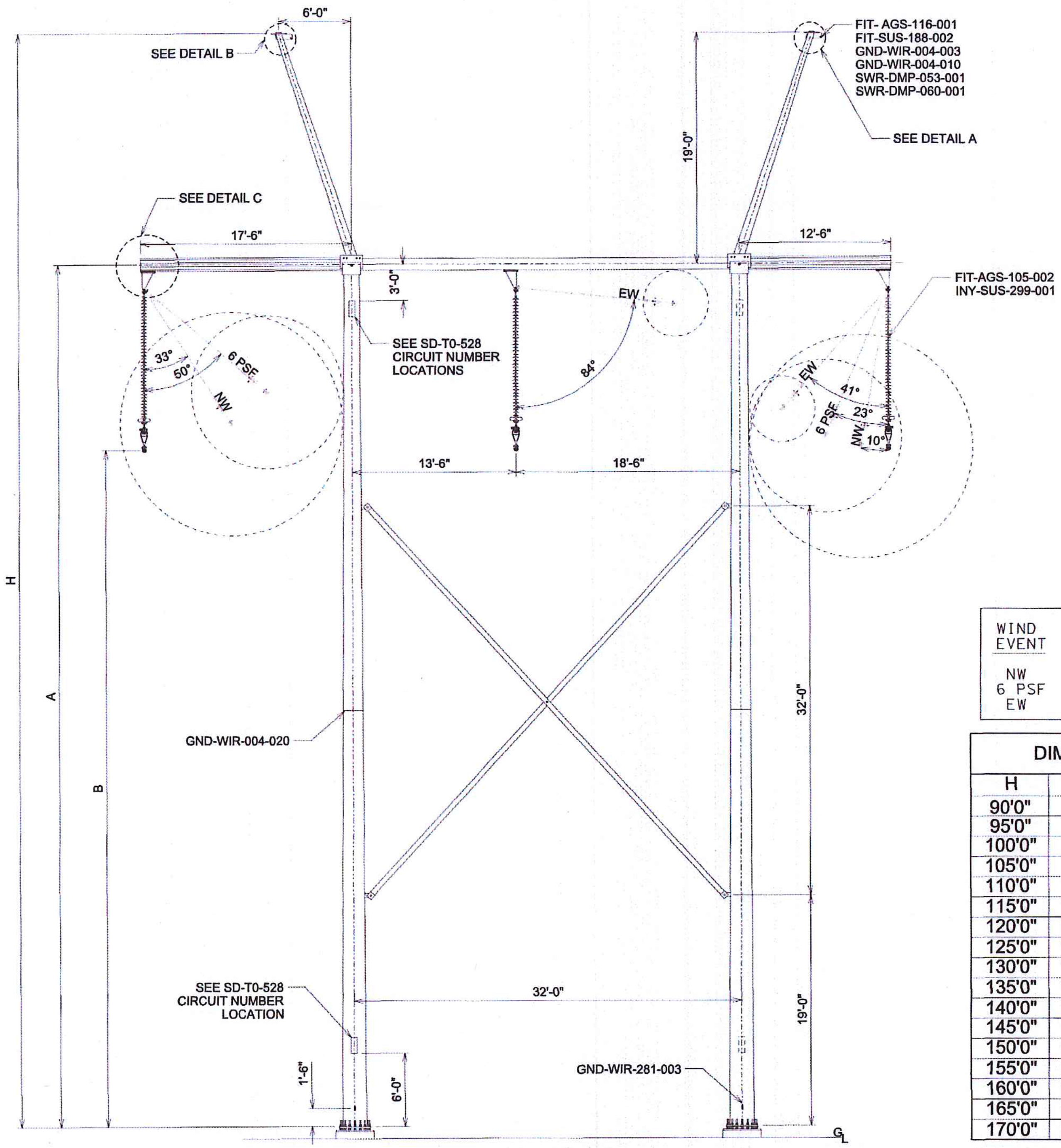
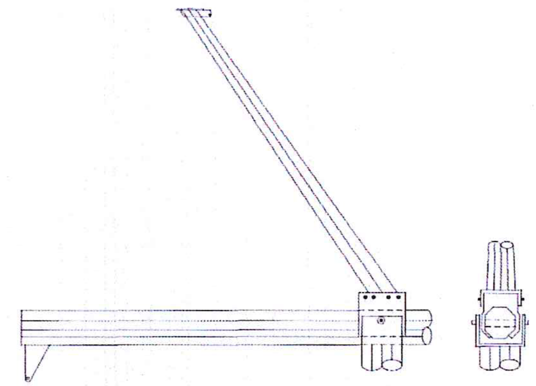


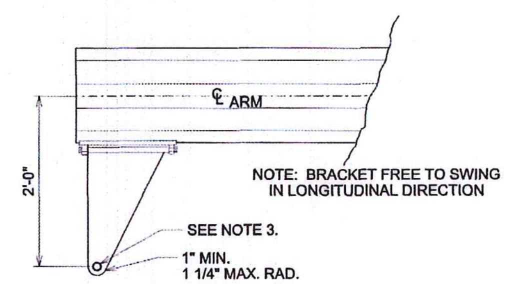
PLAN VIEW



PROFILE VIEW



ARM CONNECTION DETAIL



DETAIL "C"

NOTES

1. STRUCTURE SHOULD BE WEATHERING STEEL AND DESIGNED IN ACCORDANCE WITH SPS DRAWING REFERENCED BELOW.
2. STRUCTURE DESIGN SHOWN IS FOR CONFIGURATION ONLY. ENGINEERING STRENGTH CALCULATIONS AND STRUCTURE DESIGN DETAILS MUST BE PERFORMED FOR EACH PROJECT.
3. 1" DIAMETER HOLE WITH 1/8" CHAMFER BOTH SIDES.
4. POLE NUMBER SHALL BE INSTALLED ON EACH POLE AS REQUIRED.
5. SUSPENSION INSULATORS TO BE 345KV POLYMER INSULATORS.

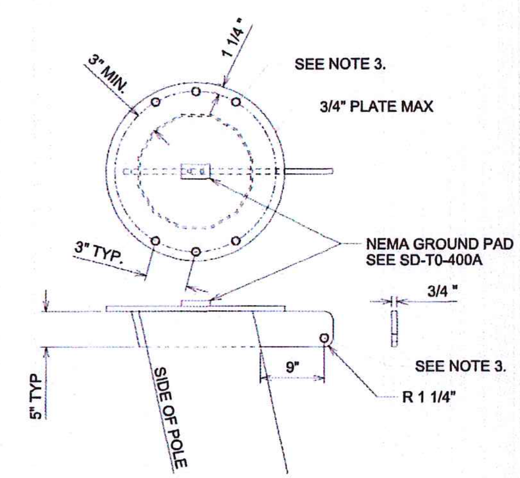
REFERENCE DRAWINGS

1. SEE SHEET SD-T0-400 FOR GENERAL DETAILS.
2. SEE SHEET SD-T0-400A FOR ARM END PLATE DETAILS.
3. SEE SHEET SD-T0-400E FOR NUMBER PLATE DETAILS.
4. SEE SHEET SD-T0-400I FOR STRUCTURE GROUNDING.
5. SEE SHEET SD-T0-528 FOR CIRCUIT & POLE NUMBERING SCHEME.
6. SEE SHEET LD-T0-672 FOR STRUCTURE LOADING.
7. FIT- AGS-116-001 - FITTING, SUSPENSION, ARMOR GRIP, W/ Y-CLEVIS BALL, SOCKET EYE, RANGE 0.537"-0.559" OPGW (BY PHASE)
8. FIT-SUS-188-002 - FITTING, SUSPENSION, CLAMP, W/ ARMOR ROD AND SHACKLE, 3/8" EHS STEEL
9. FIT-AGS-105-002 - FITTING, SUSPENSION, ARMOR GRIP, W/ SOCKET EYE, YOKE PLATE, 25 K ULT, 795 KCMIL 26/7 ACSS (DRAKE), PARROT BILL (BY PHASE)
10. GND-WIR-004-003 - GROUNDING, SUSPENSION, STEEL POLE, SHIELD WIRE, FOR VANG OR ARM ON STEEL POLE
11. GND-WIR-004-010 - GROUNDING, SUSPENSION, STEEL POLE, OPGW SHIELD WIRE, FOR VANG OR ARM ON STEEL POLE
12. GND-WIR-004-020 - GROUNDING, STEEL SHAFTS, JOINT BONDING CONNECTIONS, TO GROUND PAD, W/ 5/32" DIAMETER WIRE, 7/19 STRAND
13. GND-WIR-281-003 - GROUNDING, STEEL POLE TO GROUND ROD
14. INY-SUS-299-001 - INSULATOR, POLYMER, SUSPENSION, Y-CLEVIS BALL, W/ SHACKLE, 345 KV, 30 K SPECIFIED MECHANICAL LOAD, MACLEAN
15. SWR-DMP-053-001 - SHIELD WIRE, DAMPER, VIBRATION, SPIRAL, OPGW & SHIELD, DIAMETER RANGE 0.463" TO 0.563"
16. SWR-DMP-060-001 - SHIELD WIRE, DAMPER, SPIRAL, 51" LONG, RANGE 0.327" TO 0.461"

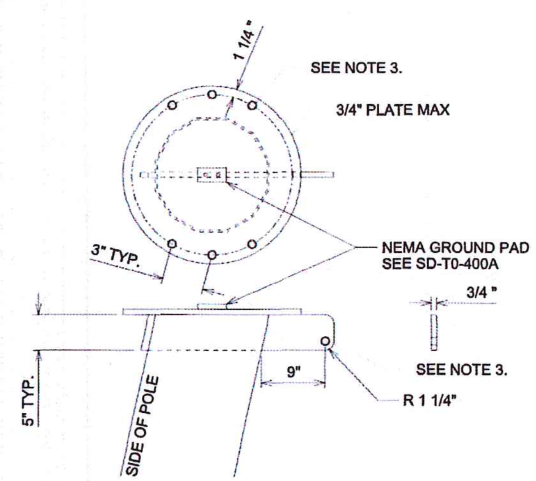
WIND EVENT	RADIAL CLEARANCE
NW	9'-2"
6 PSF	6'-3"
EW	2'-7"

DIMENSIONS

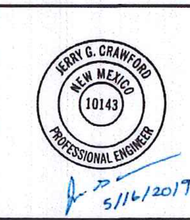
H	A	B
90'0"	71'-0"	57'-8"
95'0"	76'-0"	62'-8"
100'0"	81'-0"	67'-8"
105'0"	86'-0"	72'-8"
110'0"	91'-0"	77'-8"
115'0"	96'-0"	82'-8"
120'0"	101'-0"	87'-9"
125'0"	106'-0"	92'-8"
130'0"	111'-0"	97'-8"
135'0"	116'-0"	102'-8"
140'0"	121'-0"	107'-8"
145'0"	126'-0"	112'-8"
150'0"	131'-0"	117'-8"
155'0"	136'-0"	122'-8"
160'0"	141'-0"	127'-8"
165'0"	146'-0"	132'-8"
170'0"	151'-0"	137'-8"



DETAIL "B"
STATIC SUSPENSION OR DEADEND



DETAIL "A"
STATIC SUSPENSION OR DEADEND

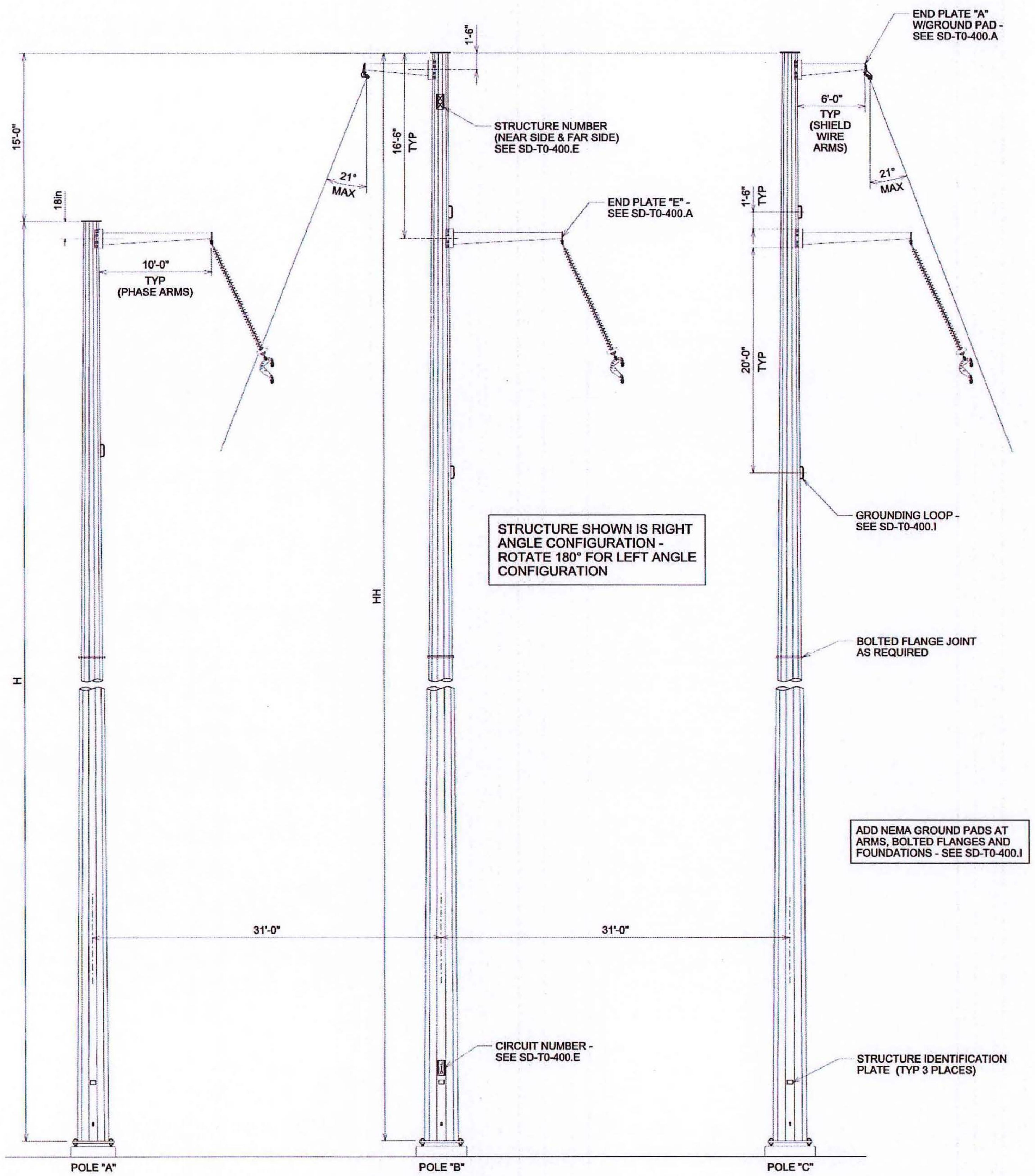


ISSUED BY ENGINEERING DEPT FOR: CONSTRUCTION

J-24 EDDY COUNTY SUB-KIOWA SUB 345kV
STRUCTURE DRAWING - T0 - STEEL
345KV STEEL H-FRAME 2° - 4° ANGLE STRUCTURE

Xcel Energy SD-T0-690 SCALE NONE REV 0

REV	DATE	WBS #	REVISION DESCRIPTION
0	04/30/2019	A.0000424.108.001.002	J24 EDDY-KIOWA 345KV



ELEVATION VIEW

GENERAL NOTES

1. STRUCTURE SHALL BE WEATHERING STEEL AND DESIGNED IN ACCORDANCE WITH SPS DESIGN DRAWINGS REFERENCED BELOW.
2. STRUCTURE DESIGN SHOWN IS FOR CONFIGURATION ONLY. ENGINEERING STRENGTH CALCULATIONS AND STRUCTURE DESIGN DETAILS MUST BE PERFORMED FOR EACH PROJECT.

REFERENCE DRAWINGS:

1. SEE SHEET T0-400 FOR GENERAL DETAILS.
2. SEE SHEET T0-400.A FOR ARM END PLATE & STATIC VANG.
3. SEE SHEET T0-400.C FOR ANCHOR BOLT CAGES.
4. SEE SHEET T0-400.E FOR NUMBER PLATE DETAILS.
5. SEE SHEET T0-400.I FOR STRUCTURE GROUNDING DETAILS.
6. SEE SHEET T0-528 FOR CIRCUIT & POLE NUMBERING SCHEME.

DIMENSIONS	
H	HH
85'-0"	100'-0"
90'-0"	105'-0"
95'-0"	110'-0"
100'-0	115'-0"
105'-0"	120'-0"
110'-0"	125'-0"
115'-0"	130'-0"

REV	DATE	WBS 4	REVISION DESCRIPTION
0	03/28/2019	A.0000424.105.001.002	J24 EDDY-KIOWA 345KV

JERRY G. CRAWFORD
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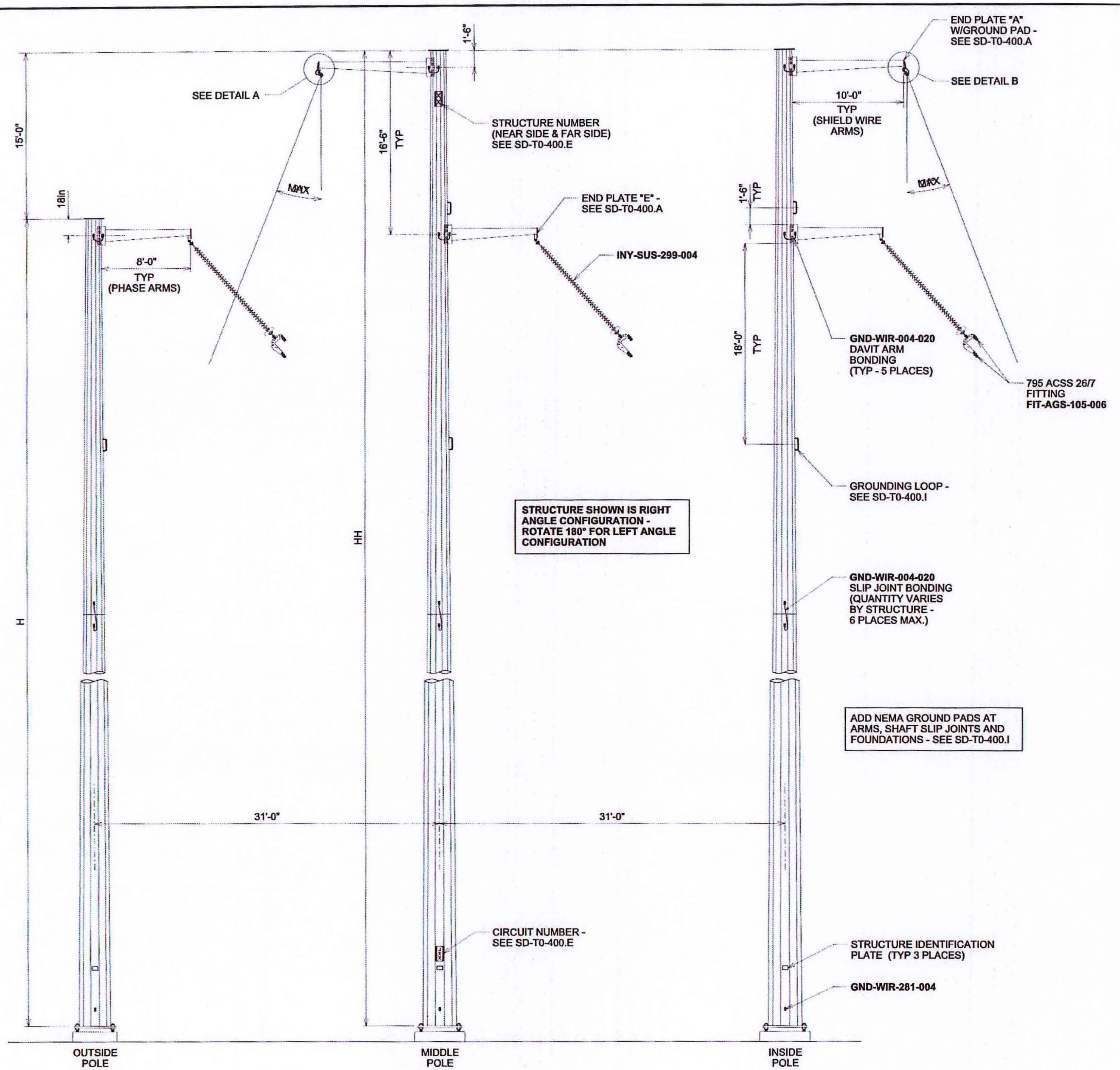
10143
PROFESSIONAL ENGINEER
3/28/2019

ISSUED BY ENGINEERING DEPT FOR: CONSTRUCTION

J24, J-24 EDDY COUNTY SUB-KIOWA SUB 345kV
STRUCTURE DRAWING - T0 - STEEL
STEEL - 3 POLE - 4 TO 9 DEGREE RUNNING ANGLE STRUCTURE

Xcel Energy | SD-T0-676 | SCALE: NONE | REV: 0

3/28/2019 10:53:28 AM



ELEVATION VIEW

GENERAL NOTES

1. STRUCTURE SHALL BE WEATHERING STEEL AND DESIGNED IN ACCORDANCE WITH SPS DESIGN DRAWINGS REFERENCED BELOW.
2. STRUCTURE DESIGN SHOWN IS FOR CONFIGURATION ONLY. ENGINEERING STRENGTH CALCULATIONS AND STRUCTURE DESIGN DETAILS MUST BE PERFORMED FOR EACH PROJECT.

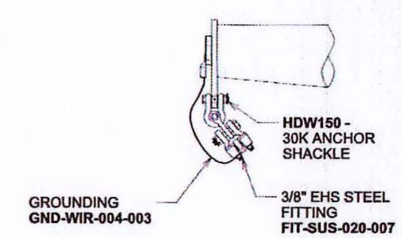
REFERENCE DRAWINGS:

1. SEE SHEET T0-400 FOR GENERAL DETAILS.
2. SEE SHEET T0-400.A FOR ARM END PLATE & STATIC VANG.
3. SEE SHEET T0-400.C FOR ANCHOR BOLT CAGES.
4. SEE SHEET T0-400.E FOR NUMBER PLATE DETAILS.
5. SEE SHEET T0-400.I FOR STRUCTURE GROUNDING DETAILS.
6. SEE SHEET T0-528 FOR CIRCUIT & POLE NUMBERING SCHEME.

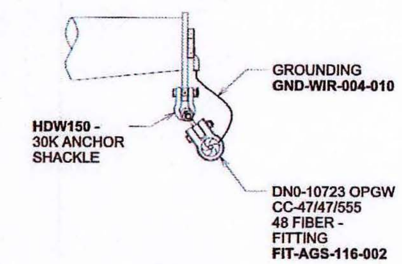
ASSEMBLY STR SD-T0-674 FOR STEEL POLES	
QTY	SUBASSEMBLIES
6	FIT-AGS-105-006
1	FIT-AGS-116-002
1	FIT-SUS-020-007
1	GND-WIR-004-003
1	GND-WIR-004-010
11	GND-WIR-004-020
1	GND-WIR-281-004
3	INY-SUS-299-004
2	HDW150 ANCH SHACKLE

SD-T0-674.DG

LOCATION OF OPGW & STEEL SHIELD WIRES VARY BY PROJECT - SEE PLAN & PROFILE OR PHASING DIAGRAM.



DETAIL A
STEEL SHIELD WIRE



DETAIL B
OPGW SHIELD WIRE

DIMENSIONS	
H	HH
85'-0"	100'-0"
90'-0"	105'-0"
95'-0"	110'-0"
100'-0	115'-0"
105'-0"	120'-0"
110'-0"	125'-0"
115'-0"	130'-0"

JERRY G. CRAWFORD NEW MEXICO 10143 PROFESSIONAL ENGINEER
3/28/2019

ISSUED BY ENGINEERING DEPT FOR:

J24, J-24 EDDY COUNTY SUB-KIOWA SUB 345kV
STRUCTURE DRAWING - T0 - STEEL
3 POLE - 9 TO 15 DEGREE RUNNING ANGLE STRUCTURE

Xcel Energy | SD-T0-674 | SCALE NONE | REV 0

3/28/2019 8:47:04 AM

REV	DATE	WBS 4	REVISION DESCRIPTION	REV	DATE	WBS 4	REVISION DESCRIPTION	REV	DATE	WBS 4	REVISION DESCRIPTION
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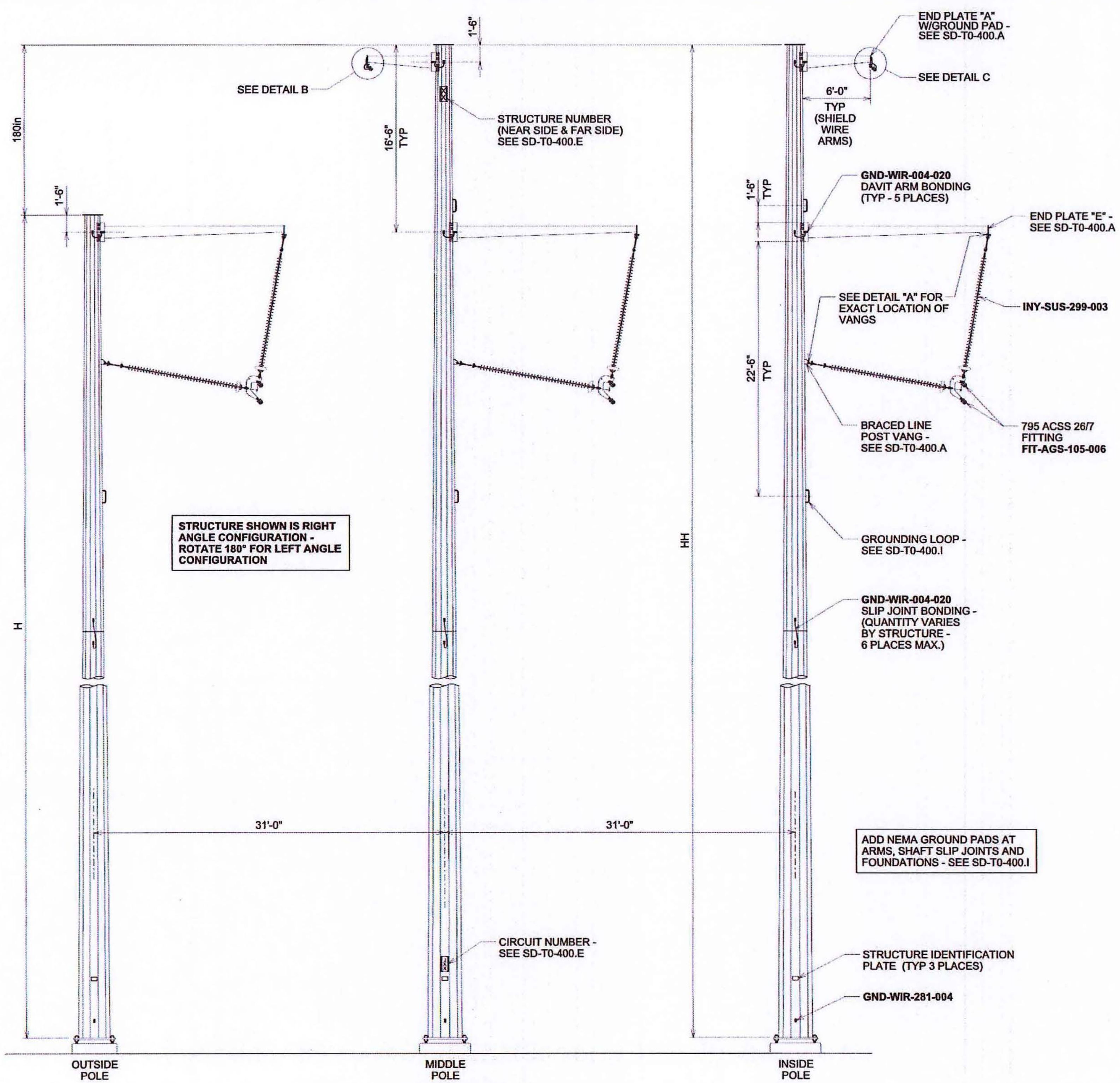


ELEVATION VIEW

GENERAL NOTES

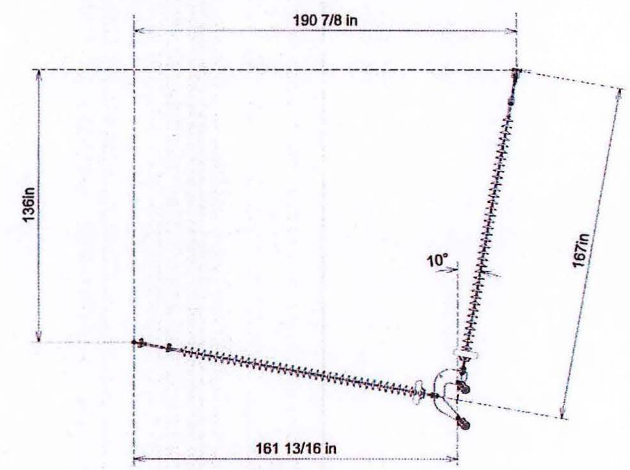
1. STRUCTURE SHALL BE WEATHERING STEEL AND DESIGNED IN ACCORDANCE WITH SPS DESIGN DRAWINGS REFERENCED BELOW.
2. STRUCTURE DESIGN SHOWN IS FOR CONFIGURATION ONLY. ENGINEERING STRENGTH CALCULATIONS AND STRUCTURE DESIGN DETAILS MUST BE PERFORMED FOR EACH PROJECT.

REFERENCE DRAWINGS:

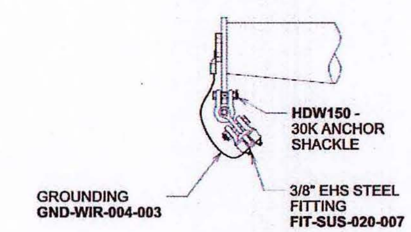
1. SEE SHEET T0-400 FOR GENERAL DETAILS.
2. SEE SHEET T0-400.A FOR ARM END PLATE & STATIC VANG.
3. SEE SHEET T0-400.C FOR ANCHOR BOLT CAGES.
4. SEE SHEET T0-400.E FOR NUMBER PLATE DETAILS.
5. SEE SHEET T0-400.I FOR STRUCTURE GROUNDING DETAILS.
6. SEE SHEET T0-528 FOR CIRCUIT & POLE NUMBERING SCHEME.

ASSEMBLY STR SD-T0-675 FOR STEEL POLES	
QTY	SUBASSEMBLIES
6	FIT-AGS-105-006
1	FIT-AGS-116-002
1	FIT-SUS-020-007
1	GND-WIR-004-003
1	GND-WIR-004-010
11	GND-WIR-004-020
1	GND-WIR-281-004
3	INY-SUS-299-003
2	HDW150 ANCH SHACKLE

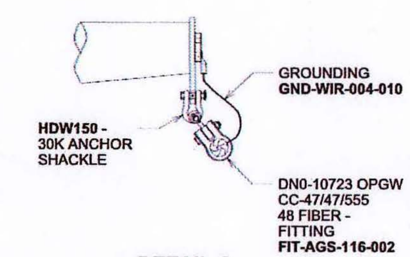
SD-T0-675.DGN



DETAIL A
INSULATOR ASSEMBLY



DETAIL B
STEEL SHIELD WIRE



DETAIL C
OPGW SHIELD WIRE

LOCATION OF OPGW & STEEL SHIELD WIRES VARY BY PROJECT - SEE PLAN & PROFILE OR PHASING DIAGRAM.

DIMENSIONS	
H	HH
85'-0"	100'-0"
90'-0"	105'-0"
95'-0"	110'-0"
100'-0	115'-0"
105'-0"	120'-0"
110'-0"	125'-0"
115'-0"	130'-0"

JERRY G. CRAWFORD NEW MEXICO 10143 PROFESSIONAL ENGINEER
3/28/2019

ISSUED BY ENGINEERING DEPT FOR: CONSTRUCTION

J24, J-24 EDDY COUNTY SUB-KIOWA SUB 345kV
STRUCTURE DRAWING - T0 - STEEL
3-POLE - 15 TO 30 DEGREE RUNNING ANGLE STRUCTURE

Xcel Energy | SD-T0-675 | SCALE NONE | REV 0

3/28/2019 9:37:52 AM

REV	DATE	WBS #	REVISION DESCRIPTION	REV	DATE	WBS #	REVISION DESCRIPTION	REV	DATE	WBS #	REVISION DESCRIPTION
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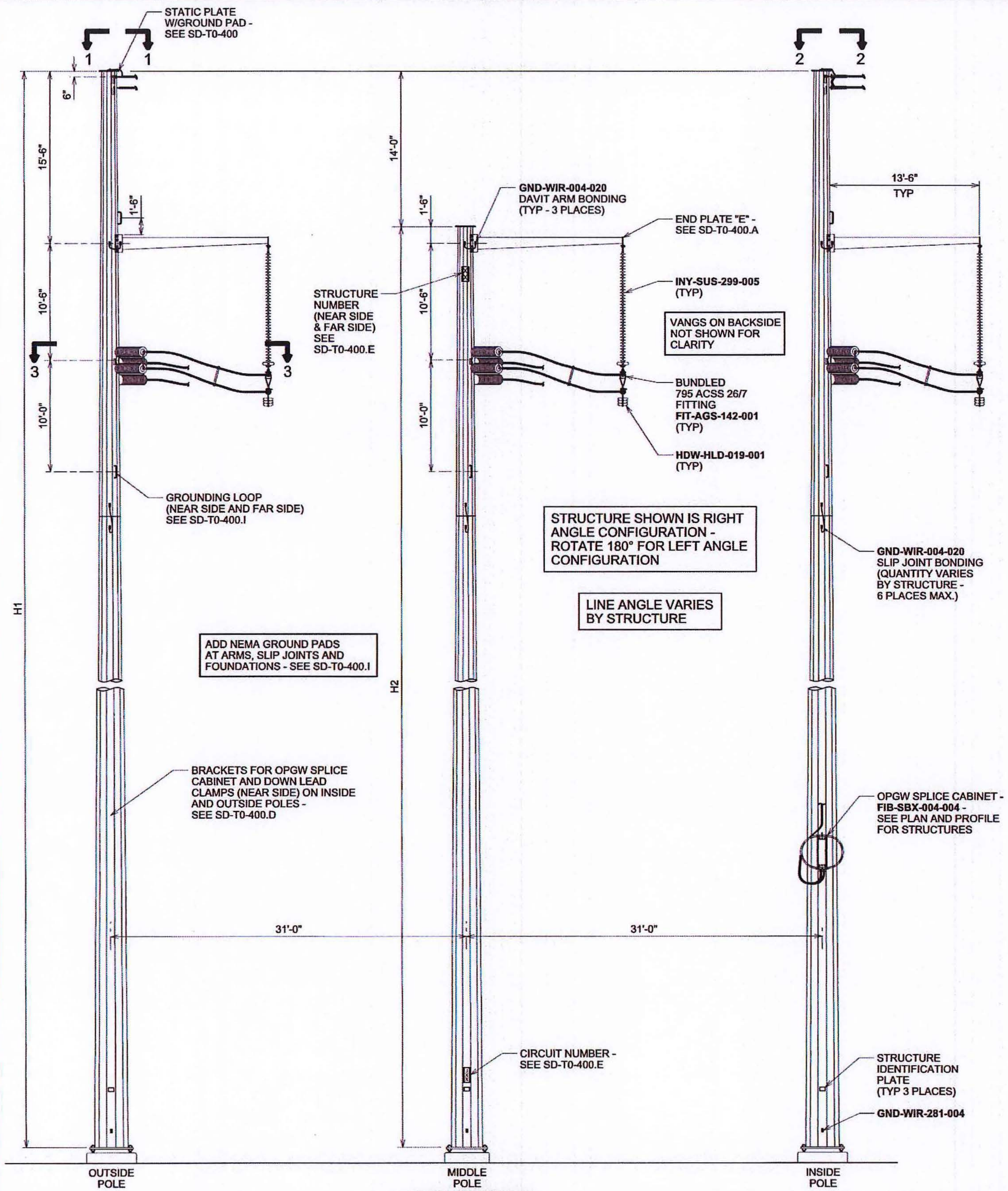


ELEVATION VIEW

GENERAL NOTES

1. STRUCTURE SHALL BE WEATHERING STEEL AND DESIGNED IN ACCORDANCE WITH SPS DESIGN DRAWINGS REFERENCED BELOW.
2. STRUCTURE DESIGN SHOWN IS FOR CONFIGURATION ONLY. ENGINEERING STRENGTH CALCULATIONS AND STRUCTURE DESIGN DETAILS MUST BE PERFORMED FOR EACH PROJECT.

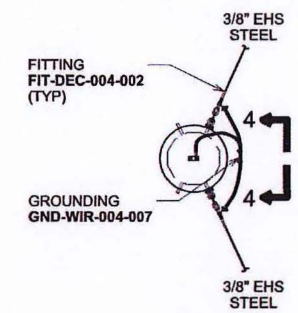
REFERENCE DRAWINGS:

1. SEE SHEET T0-400 FOR GENERAL DETAILS.
2. SEE SHEET T0-400.A FOR ARM END PLATE & STATIC VANG.
3. SEE SHEET T0-400.C FOR ANCHOR BOLT CAGES.
4. SEE SHEET T0-400.D FOR OPGW SPLICE MOUNTING.
5. SEE SHEET T0-400.E FOR NUMBER PLATE DETAILS.
6. SEE SHEET T0-400.I FOR STRUCTURE GROUNDING DETAILS.
7. SEE SHEET T0-528 FOR CIRCUIT & POLE NUMBERING SCHEME.

ASSEMBLY
STR SD-T0-677
FOR STEEL POLES

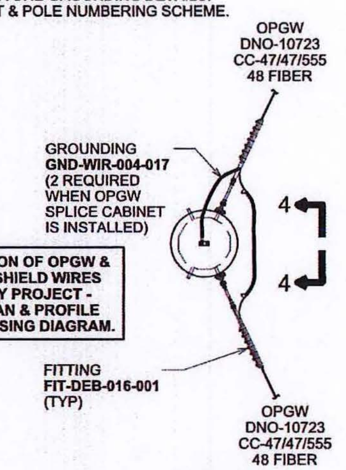
QTY	SUBASSEMBLIES
6	CND-SPA-002-001
3	FIT-AGS-142-001
2	FIT-DEB-016-001
2	FIT-DEC-004-002
12	FIT-DEC-071-007
1	GND-WIR-004-007
1	GND-WIR-004-017
9	GND-WIR-004-020
1	GND-WIR-281-004
3	HDW-HLD-019-001
6	ING-BEL-001-031
3	INY-SUS-299-005

OUTSIDE POLES "H1"	CENTER POLE "H2"
100'-00"	86'-00"
110'-00"	96'-00"
120'-00"	106'-00"
130'-00"	116'-00"

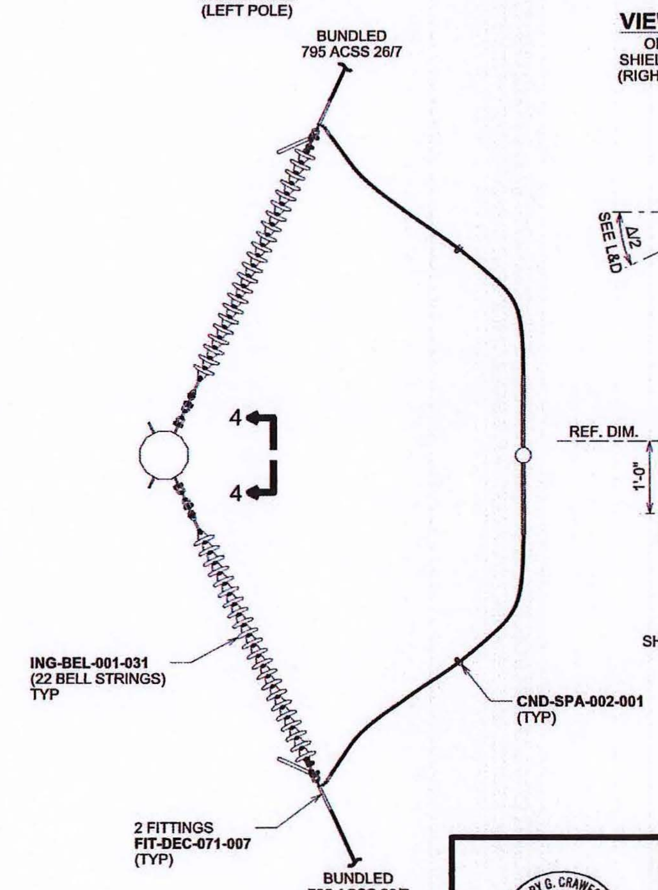


VIEW 1-1
STEEL SHIELD WIRE (LEFT POLE)

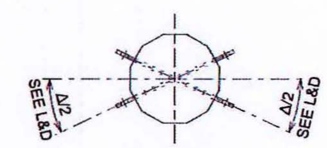
LOCATION OF OPGW & STEEL SHIELD WIRES VARY BY PROJECT - SEE PLAN & PROFILE OR PHASING DIAGRAM.



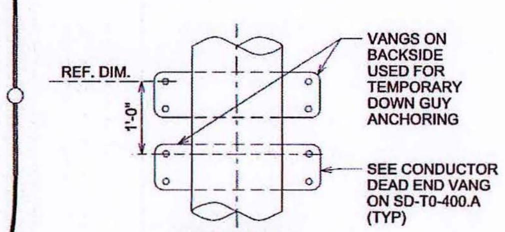
VIEW 2-2
OPGW SHIELD WIRE (RIGHT POLE)



SECTION 3-3
PHASE (TYP)



TOP VIEW



SECTION 4-4
CONDUCTOR AND SHIELD WIRE ATTACHMENT

REV	DATE	WBS 4	REVISION DESCRIPTION
0	03/28/2019	A.000424.108.001.002	J24 EDDY KIOWA 345KV

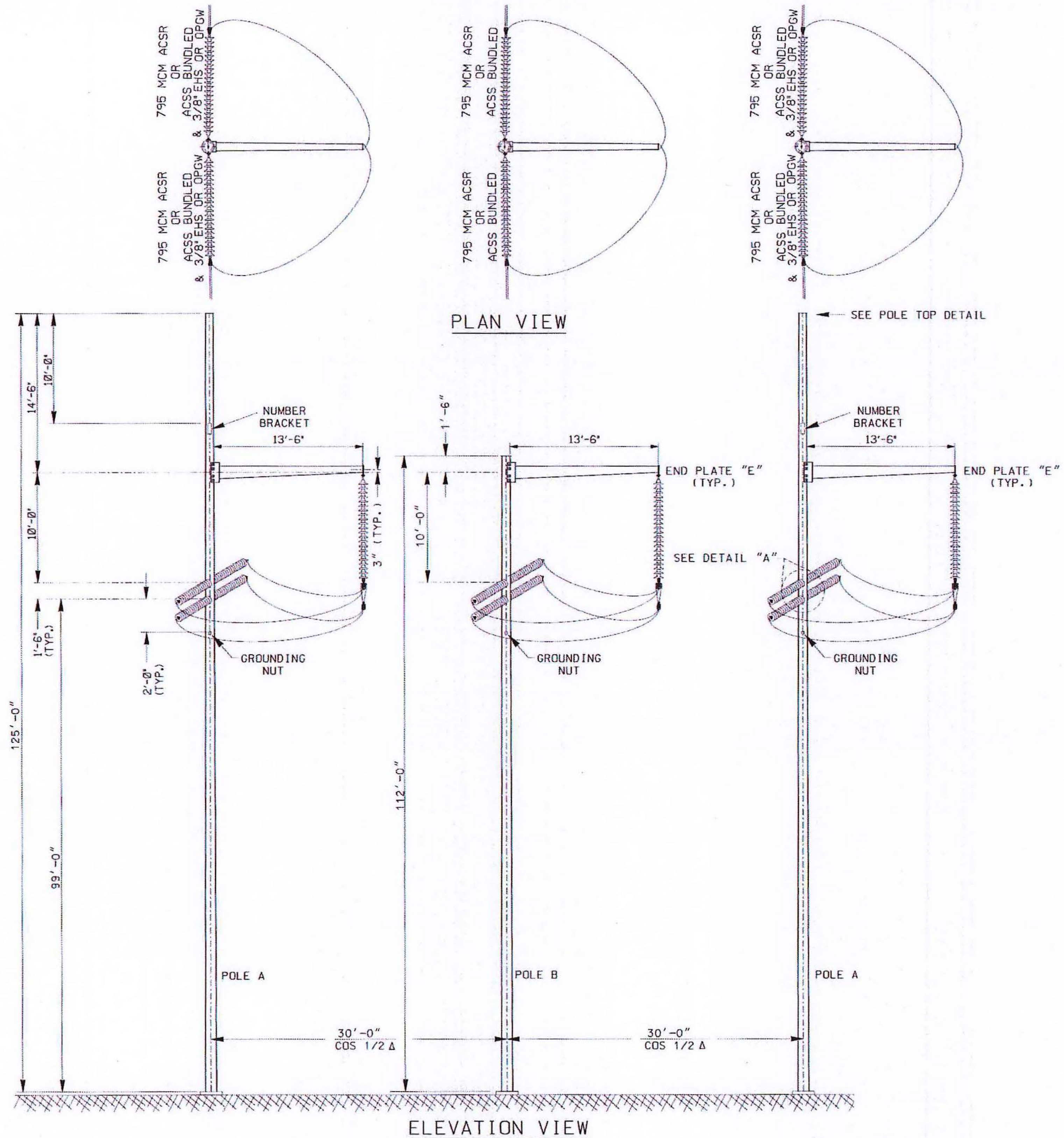
JERRY G. CRAWFORD NEW MEXICO 10143 PROFESSIONAL ENGINEER
3/28/2019

ISSUED BY ENGINEERING DEPT FOR: RECORD

J24, J-24 EDDY COUNTY SUB-KIOWA SUB 345kV
STRUCTURE DRAWING - T0 - STEEL
TERMINAL DEAD END - 3-POLE - ANLE STRUCTURE

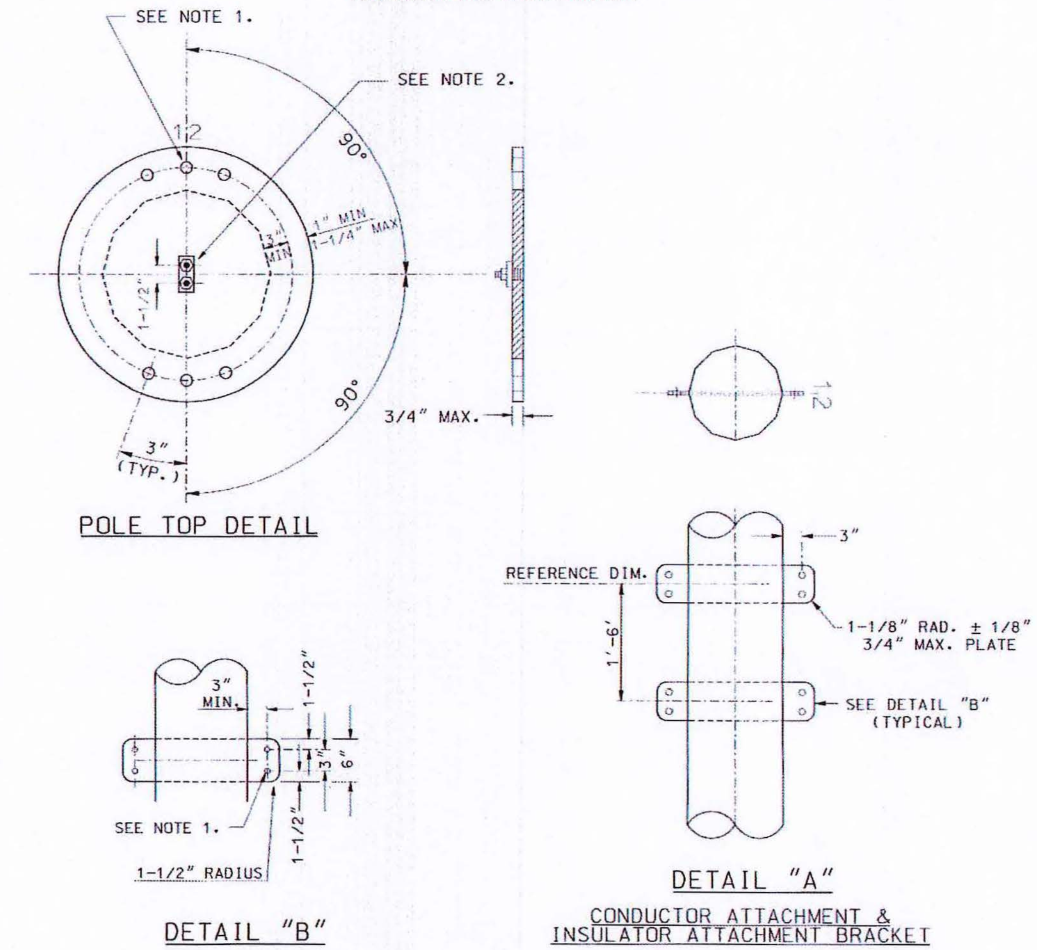
Xcel Energy | SD-T0-677 | SCALE: NONE | REV: 0

3/28/2019 10:50:44 AM



GENERAL NOTES

1. 1" DIAMETER HOLE WITH 1/8" CHAMFER BOTH SIDES, TYPICAL.
2. (2)1/2" ALL THREAD STUDS, 1-1/2" APART, 1" MINIMUM PROTRUSION. INSTALL 3" x 1-1/4" COVER PLATE WITH NUTS. FOR PAINTED POLES, PRIME, BUT DO NOT PAINT AREA UNDER COVER PLATE. COVER PLATE SHALL BE INSTALLED WHEN WEATHERING STEEL IS SPECIFIED.
3. INSTALL STEP LUGS FROM 85' ABOVE BASE PLATE TO TOP OF POLE.
4. POLE NUMBER SHALL BE INSTALLED ON EACH POLE AS REQUIRED.
5. SEE SHEET T-0-400 FOR GENERAL DETAILS.
6. SEE SHEET T-0-400A FOR END PLATE DETAILS.
7. SEE SHEET T-0-400C FOR ANCHOR BOLT CAGE DETAILS.
8. STRAIN INSULATORS ARE TO BE 345kV TOUGHENED GLASS INSULATORS. SUSPENSION INSULATORS ARE TO BE 345kV TOUGHENED GLASS INSULATORS.
9. STRUCTURE DESIGN SHOWN IS FOR CONFIGURATION ONLY. ENGINEERING STRENGTH CALCULATIONS AND STRUCTURE DESIGN DETAILS MUST BE PERFORMED FOR EACH PROJECT.



JERRY G. CRAWFORD, NEW MEXICO, 10143, PROFESSIONAL ENGINEER — 3/28/2019

ISSUED BY ENGINEERING DEPT FOR: CONSTRUCTION

THIS MAP/DOCUMENT IS A TOOL TO ASSIST EMPLOYEES IN THE PERFORMANCE OF THEIR JOBS. YOUR PERSONAL SAFETY IS PROVIDED FOR BY USING SAFETY PRACTICES, PROCEDURES AND EQUIPMENT AS DESCRIBED IN THE SAFETY TRAINING PROGRAMS, MANUALS AND SPARS.

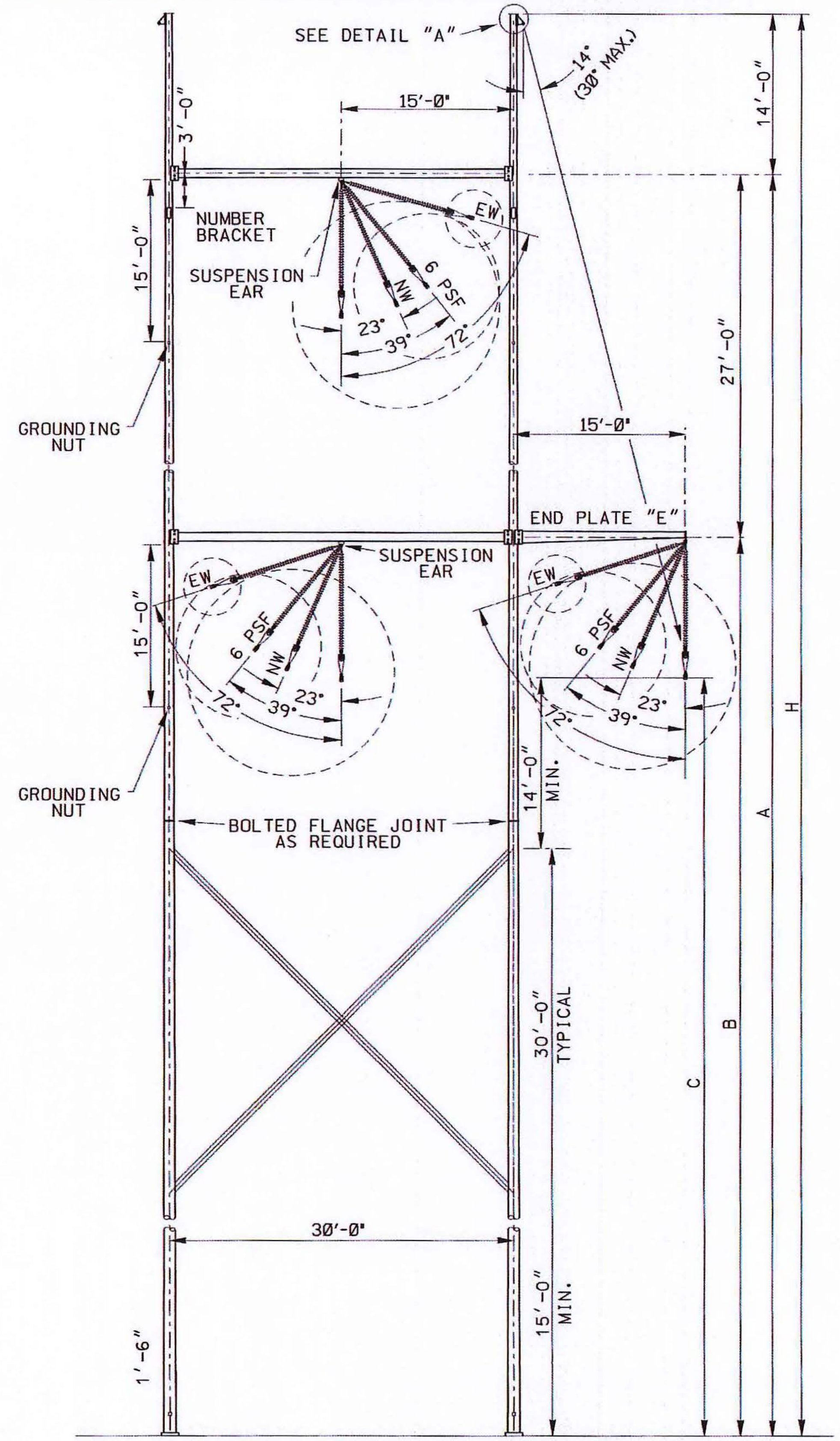
INTERNAL INFORMATION: DO NOT COPY OR DISTRIBUTE WITHOUT EXPRESS WRITTEN CONSENT FROM XCEL ENERGY

J24, J-24 EDDY COUNTY SUB-KIOWA SUB — 345kV
STRUCTURE DRAWING - T0 - STEEL
3-POLE - 0° TO 2° - DE - DIFFERENTIAL LOADS

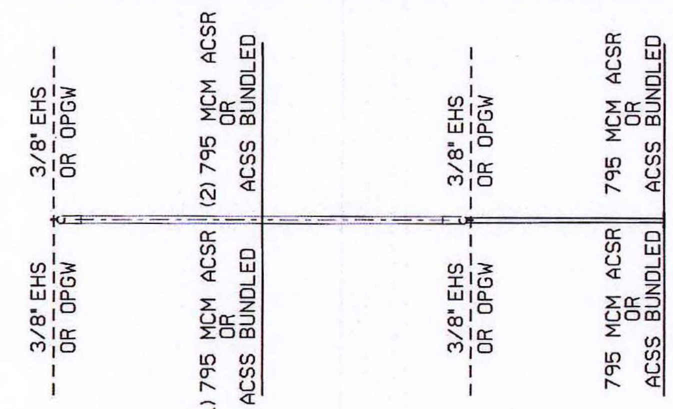
Xcel Energy — SD-T0-679 — SCALE: NONE — REV: 0

REV	DATE	WBS #	REVISION DESCRIPTION
0	03/28/2019	A.0002424.108.001.002	J24 EDDY-KIOWA 345KV

3/28/2019 1:44:23 PM



ELEVATION VIEW



PLAN VIEW

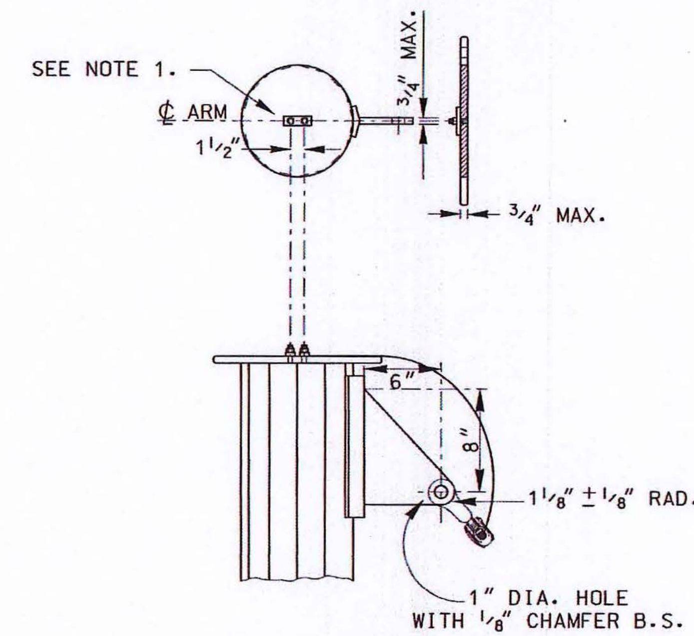
GENERAL NOTES

1. (2)1/2" ALL THREAD STUDS, 1-1/2" APART, 1" MINIMUM PROTRUSION. INSTALL 3" x 1-1/4" COVER PLATE WITH NUTS. FOR PAINTED POLES, PRIME, BUT DO NOT PAINT, AREA UNDER COVER PLATE. COVER PLATE SHALL BE INSTALLED WHEN WEATHERING STEEL IS SPECIFIED. SEE END PLATES A THROUGH D FOR STUD DETAILS.
2. 1" DIAMETER HOLE WITH 1/8" CHAMFER BOTH SIDES.
3. INSTALL STEP LUGS FROM 85' ABOVE BASE PLATE TO TOP OF POLE.
4. POLE HOLE DEPTH SHALL BE ACCURATE. WHEN HOLES DO NOT ALLOW STRUCTURE TO BE EVEN AND LEVEL. THE DEEP HOLE SHALL BE BACKFILLED AND THOROUGHLY TAMPED TO PROPER DEPTH.
5. POLE NUMBER SHALL BE INSTALLED ON EACH POLE AS REQUIRED.
6. SEE SHEET T-Ø-400 FOR GENERAL DETAILS.
7. SEE SHEET T-Ø-400A FOR ARM END PLATE DETAILS.
8. SEE SHEET T-Ø-400C FOR ANCHOR BOLT CAGE DETAILS.
9. SUSPENSION INSULATORS TO BE 345kV POLYMER INSULATORS.
10. STRUCTURE DESIGN SHOWN IS FOR CONFIGURATION ONLY. ENGINEERING STRENGTH CALCULATIONS AND STRUCTURE DESIGN DETAILS MUST BE PERFORMED FOR EACH PROJECT.

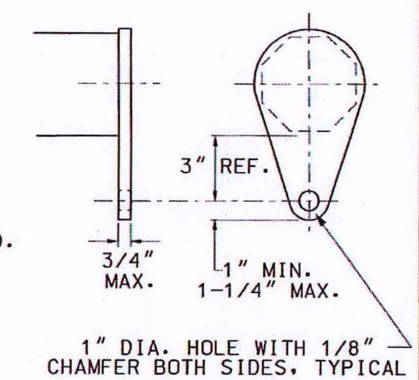
WIND EVENT	RADIAL CLEARANCE
NW	9'-0"
6 PSF	6'-4"
EW	2'-6"

DIMENSIONS

H	A	B	C
95'	81'0"	54'0"	41'6"
100'	86'0"	59'0"	46'6"
105'	91'0"	64'0"	51'6"
110'	96'0"	69'0"	56'6"
115'	101'0"	74'0"	61'6"
120'	106'0"	79'0"	66'6"
125'	111'0"	84'0"	71'6"
130'	116'0"	89'0"	76'6"
135'	121'0"	94'0"	81'6"
140'	126'0"	99'0"	86'6"
145'	131'0"	104'0"	91'6"
150'	136'0"	109'0"	96'6"



STATIC CONNECTION DETAIL "A"



END PLATE "E"

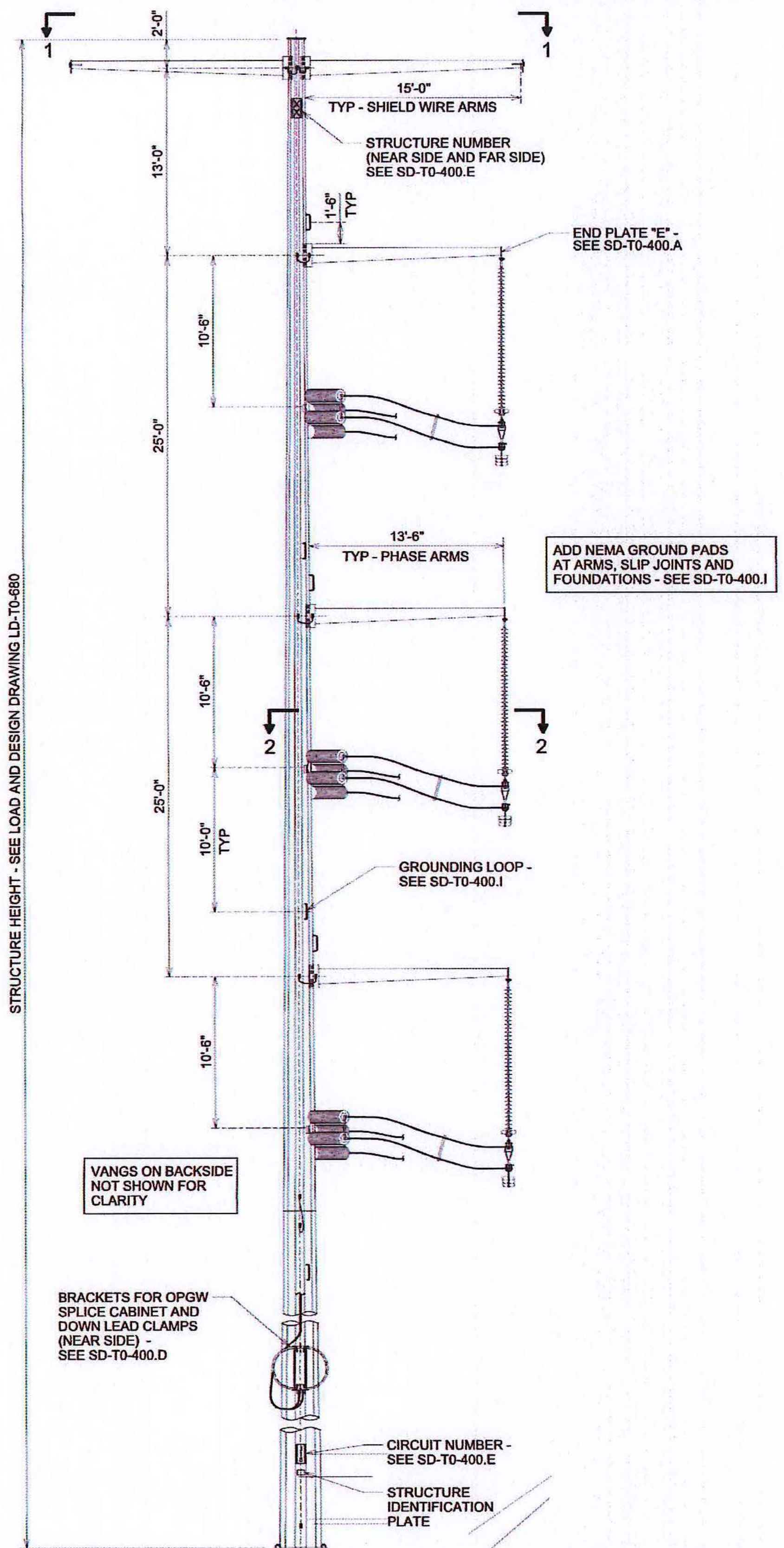
JERRY G. CRAWFORD NEW MEXICO 10143 PROFESSIONAL ENGINEER 3/28/2019

ISSUED BY ENGINEERING DEPT FOR: RECORD

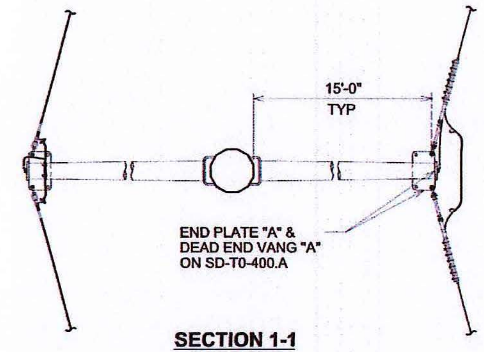
J24, J-24 EDDY COUNTY SUB-KIOWA SUB 345kV
STRUCTURE DRAWING - T0 - STEEL
345K STEEL H-FRAME FOUNDATION

Xcel Energy | SD-T0-678 | SCALE NONE | REV 0

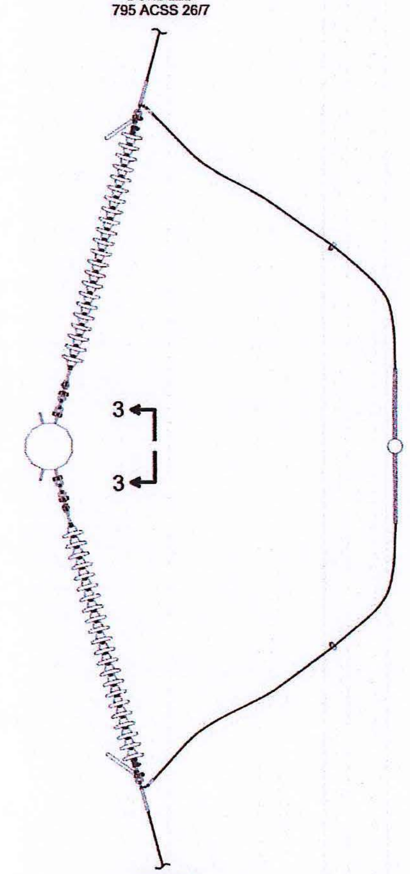
REV	DATE	WBS #	REVISION DESCRIPTION
0	03/28/2019	A.0000424.WB.001.002	J24 EDDY-KIOWA 345KV



ELEVATION VIEW



SECTION 1-1
SHIELD WIRE



SECTION 2-2
PHASE
(TYP)

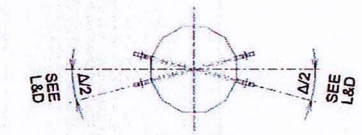
GENERAL NOTES

1. STRUCTURE SHALL BE WEATHERING STEEL AND DESIGNED IN ACCORDANCE WITH SPS DESIGN DRAWINGS REFERENCED BELOW.
2. STRUCTURE DESIGN SHOWN IS FOR CONFIGURATION ONLY. ENGINEERING STRENGTH CALCULATIONS AND STRUCTURE DESIGN DETAILS MUST BE PERFORMED FOR EACH PROJECT.

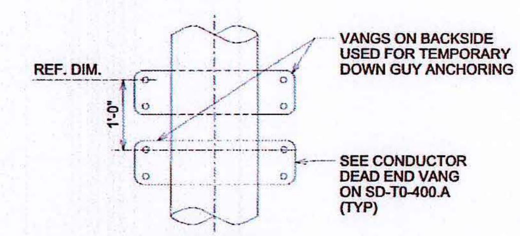
REFERENCE DRAWINGS:

1. SEE SHEET T0-400 FOR GENERAL DETAILS.
2. SEE SHEET T0-400.A FOR ARM END PLATE & STATIC VANG.
3. SEE SHEET T0-400.C FOR ANCHOR BOLT CAGES.
4. SEE SHEET T0-400.D FOR OPGW SPLICE MOUNTING.
5. SEE SHEET T0-400.E FOR NUMBER PLATE DETAILS.
6. SEE SHEET T0-400.I FOR STRUCTURE GROUNDING DETAILS.
7. SEE SHEET T0-528 FOR CIRCUIT & POLE NUMBERING SCHEME.

ASSEMBLY STR SD-T0-680 FOR STEEL POLES	
QTY	SUBASSEMBLIES
6	CND-SPA-002-001
3	FIT-AGS-142-001
2	FIT-DEB-016-001
2	FIT-DEC-004-002
12	FIT-DEC-071-007
1	GND-WIR-004-007
1	GND-WIR-004-017
8	GND-WIR-004-020
1	GND-WIR-281-003
3	HDW-HLD-019-001
6	ING-BEL-001-031
3	INY-SUS-299-005



TOP VIEW



SECTION 3-3
CONDUCTOR AND SHIELD WIRE ATTACHMENT

JERRY G. CRAWFORD NEW MEXICO 10143 PROFESSIONAL ENGINEER
3/28/2019

ISSUED BY ENGINEERING DEPT FOR: CONSTRUCTION

J24, J-24 EDDY COUNTY SUB-KIOWA SUB 345kV
STRUCTURE DRAWING - T0 - STEEL
TERMINAL DEAD END - VERTICAL TRANSPOSITION STR

XcelEnergy	SD-T0-680	SCALE NONE	REV 0

REV	DATE	WBS #		REVISION DESCRIPTION
0	03/28/2019	A.0000424.103.001.002		J24 EDDY-KIOWA 345KV

SD-T0-680.DGN
3/28/2019 1:32:53 PM

Eddy County to Kiowa
Estimated Cost Table

	Eddy to Kiowa Total Circuit Miles 33.9			Total
	Transmission Facilities	**Eddy Substation**	**Kiowa Substation**	
Right-of-way (Easements and Fees)	$1,109,910	$66,494	$58,060	**$1,234,464**
Material and Supplies	$17,327,543	$3,860,605	$2,221,317	**$23,409,465**
Labor and Transportation (Utility)	$557,584	$254,261	$82,217	**$894,062**
Labor and Transportation (Contract)	$13,615,658	$4,177,320	$2,246,407	**$20,039,385**
Stores	$313,969	$84,425	$44,928	**$443,322**
Engineering and Administration (Utility)	$490,667	$51,202	$36,976	**$578,845**
Engineering and Administration (Contract)	$541,000	$756,000	$566,000	**$1,863,000**
Other*	$5,166,526	$2,869,873	$1,664,621	**$9,701,020**
Cost to modify existing facilities**	$493,940			
Estimated Cost Subtotal	**$39,616,797**	**$12,120,180**	**$6,920,526**	**$58,657,503**
Total AFUDC	**$1,449,911**	**$448,191**	**$241,274**	**$2,139,376**
TOTAL COST	**$41,066,708**	**$12,568,371**	**$7,161,800**	**$60,796,879**

***Indicates (Overheads+Escalation+Contingency)**

**** Cost include raising, rerouting and re-terminating existing circuits**