

20170214 - ENG - NKL Phase 1 - Patent Gate to Kummer Ridge - 345kV Transmission Line Project Design Criteria Report

Design Criteria Report

June 2015

BASIN ELECTRIC POWER COOPERATIVE

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TRANSMISSION LINE DESIGN DATA SUMMARY		I. GENERAL INFORMATION							
		BORROWER:						DATE:	
		LINE IDENTIFICATION: North Killdeer Loop Phase 1 345 kV Transmission Line Project							
		VOLTAGE				LENGTH			
		TRANSMISSION		ADD'L CIRCUIT		TRANSMISSION		ADD'L CIRCUIT	
		345 kV				28.69 miles			
		TYPE OF TANGENT STRUCTURE: Single Steel Pole				BASE POLE: 115 HT. CL			
DESIGNED BY: Basin Electric Power Cooperative									
II. CONDUCTOR DATA		TRANSMISSION	OHGW	OPGW	ADD'L CIRCUIT				
Note: Add'l circuit by Mountrail Williams Electric Cooperative	SIZE (kcmil or IN.)	2312.0	7/16 EHS	71/571					
	STRANDING	76/19	7	15					
	MATERIAL	ACSR	EHS	Alum. Clad Steel					
	DIAMETER (IN)	1.802	0.435	0.571					
	WEIGHT (LB/FT.)	2.526	0.399	0.411					
	ULTIMATE STRENGTH (LBS.)	56,700	20,800	20,546					
III. DESIGN LOADS (Wire)		TRANSMISSION (LBS/FT)	OHGW (LBS/FT)	OPGW (LBS/FT)	ADD'L CIRCUIT (LBS/FT)				
NESC: <u>HEAVY</u> LOADING DISTRICT									
a. ICE: <u>1/2</u> IN.	Vertical.	3.958	0.981	1.075					
b. WIND ON ICED CONDUCT. <u>4</u> PSF	Transverse	0.934	0.478	0.524					
c. CONSTANT K <u>0.3</u>	Resultant + K	4.367	1.391	1.496					
HEAVY ICE (NO WIND) <u>1.25</u> IN.	Vertical.	7.272	3.019	3.241					
HIGH WIND (NO ICE) <u>31</u> PSF	Transverse	4.660	1.124	1.475					
EXTREME HIGH WIND/ICE									
ICE: <u>1/2</u> IN.	Vertical.	3.958	0.981	1.075					
WIND ON ICED CONDUCT. <u>9.2</u> PSF	Transverse	2.148	1.100	1.204					
IV. SAG & TENSION DATA									
SPANS		AVERAGE (EST) <u>800-950</u> FT.		MAXIMUM (EST). <u>1200</u> FT.		RULING (EST.) <u>950</u> FT			
SOURCE OF SAG-TENSION DATA: ALCOA SAG 10		TRANSMISSION		OHGW		OPGW		(ESTIMATED)	
TENSIONS (% RATED STRENGTH)		INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
NESC HEAVY (0°F, 1/2 IN, 4.00 PSF, 0.30 LB/F)		39.2	34.5	28.5	27.7	32	30.4		
MAXIMUM ICE 1.25 IN (32°F)		53.3		47.1		51.3			
HIGH WIND 31 PSF (60°F, 0 IN)		39.3		24.2		30			
UNLOADED LOW TEMPERATURE (-40°F)		32.7		14.0		17.3			
SAGS (FT)									
NESC DISTRICT LOADED (0°F)			25.3		27.37		27.17		
UNLOADED HIGH TEMP (212°F) (120°F FOR OHGW & OP)			35.5		23.63		24.49		
MAXIMUM ICE 1.25 IN (0°F)			28.6		35.0		34.92		
LOADED 1/2" ICE, NO WIND (32°F)			26.7		25.55		25.74		
V. CLEARANCES									
MINIMUM CLEARANCES TO MAINTAINED AT: 212°F, FINAL SAG									
CLEARANCES IN FEET	RAILROADS	HIGHWAY	CULTIVATED FIELDS	RURAL ROADS				ADD. ALLOW. FOR TEMPLATE	
TRANSMISSION	38	30	30	30				--	
ADD'L CIRCUIT								--	
VI. RIGHT OF WAY									
WIDTH	150 FT (MIN.)			150 FT. (MAX.)					

VII. CONDUCTOR MOTION DATA						
HISTORY OF CONDUCTOR GALLOPING: MINIMAL TO RARE						
HISTORY OF AEOLIAN VIBRATION: YES – DAMPER REQUIRED						
a. TYPE OF VIBRATION DAMPERS USED (IF ANY)			STOCKBRIDGE (conductor) SPIRAL (OHGW and OPGW)			
b. TYPE OF ARMOR RODS USED (IF ANY)			PERFORMED AGS			
VIII. INSULATION						
NO. OF THUNDERSTORM DAYS/YR ~ <u>30</u> ELEV.ABOVE SEA LEVEL (MIN, MAX, FT) <u>2000 - 2500</u>						
CONTAMINATION EXPECTED? <u>minimal</u> MAX EST. FOOTING RESISTANCE <u>25</u> Ω SHIELD ANGLE <u>20</u> °						
STRUCTURE TYPE	STRUCTURE DESIGNATION	NO. OF BELLS PIN OR POST	60 HZ DRY FLASHOVER	INSULATOR SIZE	M&E RATING / CANTILEVER STR	OTHER
TANGENT		18	965 kV	5-3/4 X 10	30K M&E	
STRAIN STRUC		19 (double string)	1050 kV	5-3/4 X 10	30K M&E	
IX. INSULATOR SWING						
CRITERIA: (1) <u>6</u> PSF ON BARE CONDUCTOR AT <u>-40°F</u> (6 psf MIN) FOR <u>76</u> IN. CLEARANCE						
(2) <u>31</u> PSF HIGH WIND ON BARE CONDUCTOR AT <u>60°F</u> FOR <u>30</u> IN. CLEARANCE						
(3) <u>0</u> PSF ON BARE CONDUCTOR AT <u>60°F</u> FOR <u>104</u> IN. CLEARANCE						
(4) <u>9</u> PSF ON BARE CONDUCTOR AT <u>60°F</u> FOR <u>76</u> IN. CLEARANCE						
ALLOWABLE SWING ANGLE			ANGLE IN DEGREES			
NAME OF STR.	STRUCTURE TYPE	NO. OF INSULATORS.	(1) 6 PSF MIN WIND	(2) HIGH WIND	(3) 0 PSF WIND, 60°F	(4) 9 PSF WIND, 60°F
3ST	TANGENT	18	47° Max	72° Max	24° Max	47° Max
3SA	ANGLE	19				
3SDA	DEADEND	19 (38)				
X. ENVIRONMENTAL AND METEOROLOGICAL DATA						
TEMPERATURE: MIN <u>-50°</u> MAX. <u>110°</u> AVERAGE YEARLY LOW <u>-30°</u>			EXTREME WIND VELOCITIES (MPH): 10 YR. <u>60</u> 50 YR. <u> </u> 100 YR <u>80</u> 90 mph 3-second gust (maximum recorded)			
MAXIMUM HEIGHT OF SNOW ON THE GROUND UNDER THE CONDUCTOR(FT): <u>2.0</u>			DESCRIBE TERRAIN AND CHARACTERISTICS OF SOIL:			
CORROSIVENESS OF ATMOSPHERE: MINIMAL			1. Rolling hills and plains dissected by streams. 2. Soils comprised of lean clays, silt soils, and sandy clays/silts overlaying sandy lean clay glacial till with cobbles and boulders.			
XI. STRUCTURE DATA						
SPECIES OF WOOD: <u>N/A</u>			DESIGNATED BENDING FIBER STRESS <u>N/A</u>			
SPANS (FT) FOR TANGENT TYPE <u>3ST</u>			BASE POLE <u>115</u> FT	OTHER HEIGHTS/CLASSES AND BRACING		
LEVEL GROUND SPAN			950'			
MAX. HORIZON. SPAN LIMITED BY STRUCTURE STRENGTH			1200'			
MAX. VERTICAL SPAN LIMITED BY STRUCTURE STRENGTH			1400'			
MAX. HORIZONTAL SPAN LIMITED BY COND. SEPARATION			>1200'			
MAX. SPAN LIMITED BY UNDERBUILD			---			
MAX. SPAN LIMITED BY GALLOPING			>1200'			
EMBEDMENT DEPTH: Concrete Pier Foundations				PRESERVATIVE: <u>N/A</u> (TYPE & RETENTION) <u>N/A</u>		
GUYING: TYPE OF ANCHORS: <u>n/a</u> GUY SIZE AND R.B.S.: <u>n/a</u>						
XII. LINE DESCRIPTION						
TANGENTS <u>70%</u>		LIGHT ANLES <u>5%</u>		AVERAGE NUMBER OF LINE ANGLES PER MILE <u>0.3</u>		
MEDIUM ANGLES <u>15%</u>		DEADEND & HEAVY ANGLES <u>10%</u>		MAXIMUM DISTANCE BETWEEN FULL DEADENDS (IN MILES) <u>.5 MILES</u>		

A. INTRODUCTION

Basin Electric Power Cooperative is a consumer-owned, regional cooperative headquartered in Bismarck, North Dakota. Basin Electric is proposing construction of a 345kV transmission line in northwest North Dakota that will run approximately 30 miles from the Patent Gate Substation near Arnegard, North Dakota to the Kummer Ridge Substation near Johnson's Corner, North Dakota.

The proposed transmission line will be constructed using steel single-pole structures.

A location map is shown in the Appendix.

B. CLIMATE

The semi-arid climate for the transmission line is characterized by cold, dry winters and moderately hot summers. The area is subject to large annual variations in temperature because it is near the center of the North American land mass. Arctic air moves into the region from the north and northwest during the winter, causing periods of extreme cold alternating with milder temperatures. Summer temperatures are usually warm, but some hot spells and occasional cool days can be expected. The transmission line design will incorporate the following climate conditions.

1. Temperature

Temperature extremes: Lowest: -50°F (12/23/1983) Highest: 110°F (07/05/1936)

Mean lowest daily minimum temperature: -6.1°F

Mean annual temperature: 41.9°F

2. Wind

Basic Wind Speed: 90 mph (from NESC Figure 250-2)

Coldest month mean wind velocity: 9.7 mph (December)

Prevailing wind direction for coldest month: NW

3. Precipitation

Average annual precipitation: 14.3 inches

Expected maximum 24-hour snow accumulations: 15 inches

4. Isokeraunic Level

The Isokeraunic level for the area is 30.

5. Frost Depth

The average depth for frost penetration is 5 feet.

C. ELEVATION

Elevation ranges from 2000 feet to 2500 feet above sea level.

D. CODES AND STANDARDS

This transmission line will be constructed in accordance with Rural Utilities Service (RUS) Standards. In addition, design, materials, and construction will conform to the latest revision of the following:

1. NESC – National Electrical Safety Code

2. ASTM – American Society for Testing and Materials

3. ANSI – American National Standards Institute

4. AISC – American Institute of Steel Construction
5. IEEE – Institute of Electrical and Electronic Engineers
6. ASCE – American Society of Civil Engineers
7. AWS – American Welding Society
8. NEMA – National Electrical Manufacturers Association
9. OSHA – Occupational Safety and Health Act
10. ASME – American Society of Mechanical Engineers

All federal, state, local, and municipal government requirements will also be adhered to.

E. GENERAL CRITERIA

1. Nominal Voltage

The nominal phase-to-phase voltage is 345 kV.

2. Structure Type

Steel single-pole structures on concrete foundations will be used. A comprehensive structure design criteria is contained in the Appendix.

3. Line Access and Structure Numbers

Special access may be required to some structures. Gates will be provided in existing fences. Structure numbers will be provided at the top of every 5th structure, in addition to deadends, angles, and crossings..

4. Thermal Capacity

Basin Electric Power Cooperative has had satisfactory electric operation using a single 2306.2 MCM ACSR conductor per phase at 345 kV. The electrical operating characteristic of this line will be similar with the single 2312 MCM ACSR conductor. The maximum summer current rating is 1810 amperes at 100°C and at 2 feet per second crosswind. The maximum winter current rating is 2525 amperes at 100°C and at 2 feet per second crosswind. Thermal capacity is not a limiting factor for this transmission line.

5. Electrical Effects Analysis

Basin Electric's experience with 345 kV transmission lines indicates that they do not produce objectionable levels of audible noise, television interference, electric or magnetic fields off the right-of-way. Therefore, no specific study for such electrical effects is planned for this project.

6. Transposition Structures

Due to the delta configurations on tangents and deadends, and the stacked configurations from the angles, transposition structures will not be necessary.

F. INSULATION COORDINATION

1. Insulation Requirements for Power Frequency

Power frequency voltages rarely control insulation design except in highly contaminated conditions. For this 345 kV line, the 60 hertz wet line crest voltage is (1.05 x 345 kV):

$$\frac{362}{\sqrt{3}} \times \sqrt{2} = 295 \text{ kV}$$

Seven (7) standard 5¾" x 10" suspension insulators would be sufficient. However, a reduction in flashover voltage is caused by rain and is further decreased by contaminants within the rainwater. To compensate for the contaminated conditions, the leakage distance (the distance along the surface of the insulator) has to be increased. Even for very lightly contaminated areas, RUS recommends a total leakage distance of up to 1 inch per kV (RMS line to ground). On that basis, a leakage distance of 209 inches or a minimum of 18 insulators would be required. The insulation design must obviously withstand the power frequency voltage during all weather conditions including the high wind condition. A power frequency air gap of 30 inches shall be maintained during maximum insulator swing condition.

2. Insulation for Switching Surge

It is assumed that the maximum per unit switching surge for the 345 kV line will be kept below a level of 2.8 by using surge arresters. For design purposes the switching surge voltage is:

$$\frac{262}{\sqrt{3}} \times \sqrt{2} \times 2.8 = 826 \text{ kV to ground}$$

The basic insulation level of the line is the withstand value of the impulse voltage of the insulator string which can successfully withstand the expected switching surge.

3. Insulation for Lightning Surges

Insulator strings with 18 units on steel and wood structures have proven satisfactory lightning performance. Angle structures may have additional units to maintain clearance. Angle and Deadend Structures will have 19 (38) units per string. To prevent the near certainty of flashover due to a lightning strike, the following criteria will be maintained:

Minimum OHGW Shielding Angle	20 degrees
Maximum Grounding Resistance	25 ohms

4. Insulator-Hardware Assemblies

The hardware and components of insulator assemblies shall withstand the following loading conditions based upon the appropriate conductor tensions.

	<u>MAXIMUM PERCENT OF RATED STRENGTH</u>
NESC	40
1¼" Ice	70

Tangent and small angle suspensions will use 30,000 lb single-string insulators. For medium angles, 30,000 lb single-string insulators will be used. For large running angles and deadends, 30,000 lb double-string insulators will be used. Single-string assemblies may also need to be doubled at significant crossings. Insulators will be standard 5¾-inch x 10-inch glass

Armor grip suspension (AGS) units will be used for conductor and OPGW. Suspension shoes with armor rod will be used for OHGW. Hardware for assemblies will be suitable for hot line maintenance. Corona free clamps and armor rods will be used. Corona rings will not be needed.

Internally fired dead-ends and mid-span splices (AMP Type) will not be considered.

G. CLEARANCES

1. Phase Spacing

Phase spacing for design ruling span will be 28 feet, but may vary for special ruling spans and specific cases.

2. Crossing Clearances (Vertical)

The following minimum clearances will be used for the line design:

CROSSING TYPE	CLEARANCE @ 100°C (ft)
A. Agricultural Land	30.0
b. Rural Roads	30.0
c. Highways and Paved County Roads	30.0
d. Railroads	38.0
e. Communication Lines	15.0
f. Waterways, lakes, ponds, rivers, and streams	34.0 or as required by the Corps of Engineers or other agency
g. Power Lines:	
0 to 69 kV	15.0
to 138 kV	16.0
to 161 kV	17.0
to 230 kV	18.0
to 345 kV	19.0
h. Buildings	18.0

Vertical clearances over special crossings should be provided as the situation demands. The sag of existing conductors and wires will be neglected in order to allow adequate clearances during galloping conductor conditions.

3. Minimum Horizontal Clearances at Crossings

No structure will be located within the right-of-way of another utility, except under special circumstances as approved by the utility. Horizontal clearances from transmission structures are given below:

<u>Distance From</u>	<u>Recommended Clearance (ft)</u>
Communication lines	50.0
Distribution line	50.0
Pipelines	50.0
Railroad Centerline	Structures to be located off right-of-way
Roads & Highways	Structures to be located off right-of-way

4. Right-of-Way Width

A right-of-way width of 150 feet has been chosen per the requirements of NESC Rule 234, which governs clearance requirements from the conductor to structures (buildings, towers, antenna, etc.) directly on the edge of the right-of-way. The right-of-way width provides additional room for construction and maintenance. Additional temporary construction easements may be obtained to provide working space at deadend and angle structure locations, as required to install conductor.

5. Clearance Between Conductor and Overhead Ground Wire

The OHGW vertical separation will be about 25 feet at the structure attachment points. Initial unloaded tension shall not exceed 25 percent of rated strength at 0°F and OHGW sags shall not exceed 80 percent of the final conductor sag at 60°F with no wind. During iced conductor and OHGW conditions, the conductor has a tendency to drop its ice first. If the OHGW has not dropped its ice, the reduced separation may result in a flashover from the conductor. To ensure adequate phase-to-ground clearance, the minimum vertical separation between conductor and OHGW during differential ice (½" ice at 32°F) conditions shall be 5 feet.

6. Insulator Swing

All tangent and angle structures for this project will utilize suspension insulators which are free to swing about their points of support. The amount of swing varies with such factors as conductor tension, temperature, wind velocity, and the ratio of the vertical to horizontal spans.

Insulator swing charts will be developed which show the allowable vertical span to horizontal span ratio for the tangent structures under the following three conditions (per RUS Bulletin 1724E-200, Table 7-1):

- a. The normal, no wind clearance at 60°F (final) shall be no less than 104 inches. Angle structures will be checked to verify the above criteria is maintained during minimum and maximum insulator swing conditions.
- b. A 9-pound wind at 60°F (Final) while maintaining a 76-inch lightning surge clearance.

- c. A 6-pound per square foot transverse wind (≈ 48 mph) at -40°F (Initial) while maintaining a 76-inch switching surge clearance to ground.
- d. A 31-pound per square foot transverse wind (≈ 90 mph) at 60°F (Final) and maintaining the power frequency clearance of 30 inches.

H. CONDUCTOR

1. Selection

Conductor selection is based on load flow data and Basin Electric's past operating experience with 345 kV lines. A Thrasher 2312.0 MCM 76/19 ACSR conductor will meet the electrical load requirements for this project. The physical and electrical characteristics of the conductor are listed below:

2312.0 MCM 76/19 ACSR

Code Name	Thrasher
Overall Minimum Diameter	1.802 in.
Cross Sectional Area	1.9144 sq. in.
Weight Per 1,000 Feet	2.526 lbs.
Rated Strength, Standard	56,700 lbs.

Resistance (Ohm/Mile)

AC at 25°C	0.0457
AC at 75°C	0.0529

2. Tension Limitations

Sag-tension data for the conductor is based on the following limitations:

- a. Initial tension at the NESC heavy load shall not exceed 40 percent of rated strength.
- b. Initial bare tension at 0°F shall not exceed 28 percent of rated strength.
- c. Final bare tension at 0°F shall not exceed 23 percent of rated strength.
- d. Initial tension at $1\frac{1}{4}$ " ice at 0°F shall not exceed 54 percent of rated strength.

Sag-tension data is provided for the NESC heavy loading condition as well as special loadings including the heavy ice load of $1\frac{1}{4}$ inch at 0°F , Initial, and a 100 mph wind at 60°F , Final.

Ground clearance will be checked at a maximum temperature of 100°C . Uplift on suspension insulators will be checked at -40°F .

3. Galloping Conductors

Galloping conductors have occurred within the project area and will be accounted for in the design. Fortunately, single-loop galloping rarely occurs in spans over 600 to 700 feet (Design Manual for High Voltage Transmission Lines, RUS 1724E-200). Galloping will be checked under a weather condition consisting of 32°F , $\frac{1}{2}$ " radial

ice, 2 psf wind, and final sag. Lissajous ellipses, which show the theoretical envelop of the galloping conductor, will be prepared for both conductor's designs as follows:

- a. Full loop analysis for spans up to 700 feet.
- b. Double loop analysis for spans 700 feet to maximum.

4. Vibration Protection

Conductor tension limitations have been selected to limit aeolian vibrations and conductor oscillation on the line. Stockbridge type dampers will be used to limit vibration and protect the conductors. Sprial type dampeners will be used for overhead groundwire and optical groundwire.

I. OVERHEAD GROUND WIRE AND GROUNDING

1. Selection

The overhead ground wire will be extra high strength (EHS) galvanized steel, strand, 7/16 inch, and 20,800 pounds minimum breaking strength.

The optical ground wire (OPGW) will be used to establish a fiber optic path for the entire line. Therefore, the single pole steel structures will have one OPGW and one galvanized steel wire. The OPGW sags will match those of the OHGW under normal loads.

2. Tension Limitations

a. Sag-tension data for the OHGW is based on the following limitations:

- 1) Not greater than 80 percent of conductor sag at 60°F, Final.
- 2) Initial bare tension at 0°F shall not exceed 15 percent of minimum breaking strength.
- 3) Initial 1¼-inch ice at 0°F .

b. Sag-tension data (not limiting conditions) is provided for the NESC heavy loading condition as well as the following special loadings:

- 1) 1¼ inch ice at 0°F
- 2) 110 mph wind at 60°F

c. Uplift on OHGW attachments will be checked at -40°F. Clearance between the ½" iced OHGW and bare conductor at 32°F will also be verified.

3. Shielding Angle

A shielding angle of 20 degrees will provide an adequate shielding angle to prevent lightning strikes to the conductor. Standard practice and calculated trip out rates substantiate the selected shield angle. Using an average span of 950 feet, an isokeraunic level of 30 and footing resistance of 25 ohms, calculations show the outage rate due to lightning will be under 0.5 per 100 miles per year for this project, well below the generally accepted limit.

4. Grounding

The lightning performance of the line is dependent upon the structure footing resistance. Since the lines lie in an area where the isokeraunic level is fairly high, a

25-ohm maximum design ground resistance has been chosen. Ground rods will be installed, as required, to provide a maximum resistance of 25-ohms.

Fences and gates within the transmission line right-of-way will be grounded to prevent electrostatic voltage build-up and electromagnetic shock hazards.

J. STRUCTURE LOADING CRITERIA

1. Structure Design Loads

The structures shall meet the strength requirements of the latest edition of the National Electric Safety Code (NESC). In addition, the structures will be designed to withstand a high wind condition and a heavy ice condition.

The extreme wind load was calculated per ASCE Manual 74, "Guidelines for Electrical Transmission Line Structural Loading." This standard is written for reliability-based design methods, and was updated in 2010.

The following table defines all load cases and overload factors to be applied:

Load Case	Overload Factors
<ul style="list-style-type: none"> NESC Heavy (0°F, ½" Ice, 4 psf wind, initial tension) NESC 250 B 	Vertical = 1.5 Transverse = 2.5 Tension = 1.65 Wind on structure = 2.5
<ul style="list-style-type: none"> Extreme Wind (60°F, bare, 31 psf wind, final tension) NESC 250 C 	Vertical = 1.1 Transverse = 1.1 Tension = 1.1 Wind on structure = 1.1
<ul style="list-style-type: none"> Extreme Ice with Concurrent Wind (15°F, ½" Ice, 9.2 psf wind, initial tension) NESC 250 D 	Vertical = 1.1 Transverse = 1.1 Tension = 1.1 Wind on structure = 1.1
<ul style="list-style-type: none"> Heavy Ice (0°F, 1 ¼" Ice, no wind, initial tension) 	Vertical = 1.1 Transverse = 1.1 Tension = 1.1 Wind on structure = 1.1
<ul style="list-style-type: none"> Camber (40°F, bare, 2 psf wind, final tension) 	Vertical = 1.0 Transverse = 1.0 Tension = 1.0

	Wind on structure = 1.0
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All load cases include tension components and insulator hardware. Some minor adjustment of load cases will be necessary based on type of structure used.

K. FOUNDATIONS

Drilled-pier concrete foundations will constitute the typical foundation system for all structures. Transmission foundations for single pole structures are subjected to significant lateral forces and overturning moments. Drilled-pier concrete foundations will utilize the use of steel reinforcement.

REFERENCES

1. Electric Power Research Institute (EPRI): "Transmission Line Reference Book 345 kV and Above", Project UHV, Pittsfield, Mass. 19

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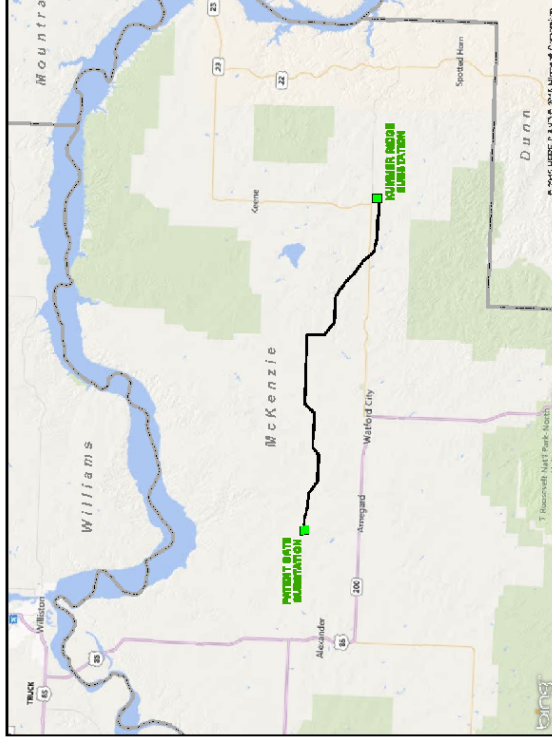
Appendix

Project Location Map

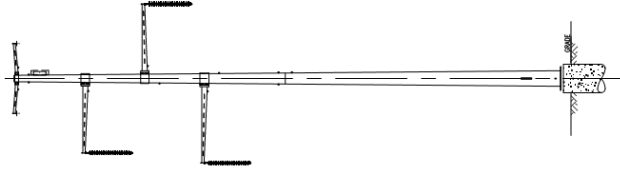
PATENT GATE SUBSTATION TO KUMMER RIDGE SUBSTATION 345KV TRANSMISSION LINE PROJECT

LINE FEATURES:

- LINE LENGTH PATENT GATE TO KUMMER RIDGE — 28.7 MILES
- RIGHT OF WAY WIDTH — 150 FEET
- STRUCTURE TYPE PATENT GATE TO KUMMER RIDGE — GALV. STEEL SINGLE POLES (TOTAL 151 STRUCTURES)
- DESIGN RULING SPAN — 1000 FEET
- CONDUCTOR — 2312 KOMIL 76/19 ACSR THRASHER
- OPTICAL GROUND WIRE — AC-71/571, .571 INCH DIAMETER, 36 FIBERS
- PERMITTING AUTHORITY — ND PUBLIC SERVICE COMMISSION
- EIS ENVIRONMENTAL IMPACT STATEMENT — WESTERN AND US FOREST SERVICE



VICINITY MAP



TANGENT STRUCTURE
SINGLE POLE - 35T2

FACILITY:	TRANSMISSION SYSTEM MAINTENANCE	DESIGN BY:	S. WASBINDER	6/25/15
LOCATION/UNIT:	368-PATENT GATE TO KUMMER RIDGE 345KV LINE	DRAWN BY:	S. BURGARD	6/25/15
CONTRACT/DESIGNATION:		CHECKED BY:	J. BEINHARDT	7/16/15
		APPROVED:		
		SCALE:	NONE	
		VENDOR/ORIGINATED FROM:		
TITLE SHEET		VENDOR DRAWING NO.		ORIGINAL REV.
		BASIN DRAWING NO.	368-090-T1-001	REV. NO.
		BASIN ELECTRIC POWER COOPERATIVE		0
		A Touchstone Energy Cooperative		

0	ISSUED	A. BURGARD, S. WASBINDER	7/16/15			
REV.	DESCRIPTION	DRWN	DSGN	APPD	DATE	