

## **APPENDIX G**

# **BIG STONE SOUTH – ELLENDALE TP 477 HAWK ACSR CORONA & EMF MEMO**

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## MEMORANDUM

**DATE:** October 10, 2013

**TO:** Mr. Danny Frederick (POWER-JAC)

**C:** Mark Shaw (POWER-FTW), Jon Leman (POWER-CLK), DMS SR-06

**FROM:** Andrea Wood (POWER-FRE)

**SUBJECT:** 127156: Big Stone South - Ellendale TP 477 Hawk ACSR Corona & EMF

### MESSAGE

Dear Mr. Frederick,

This memo provides TP 477 Hawk ACSR conductor corona and field effects studies results for the Otter Tail Power (OTP) and Montana/Dakota Utility (MDU) Big Stone South – Ellendale (BSSE) proposed 345 kV transmission line.

POWER’s engineering service for this study was to analyze the corona and field effects for the proposed structures using a two conductor bundle (2X) TP 477 Hawk ACSR conductor.

### Corona and Field Effects Analysis

A study was performed on the proposed conductor to estimate audible noise and electric and magnetic fields near ground levels for typical H-Frame tangents and Delta Monopole tangent structures (see structure drawings in Appendix B). The field effects study was performed using version 3.0 of the Bonneville Power Administration’s Corona and Field Effects Program.

The field effects results are summarized in Table 1 through Table 4. Plots of the results for each structure type throughout the Right-of-Way can be found in Appendix C.

**Table 1: Maximum Calculated EMF Levels on the ROW**

Project Load Conditions	Electric Field (kV/m) <sup>1</sup>		Magnetic Field (mG)	
	H-Frame Structure	Monopole Structure	H-Frame Structure	Monopole Structure
Normal Operating Condition <sup>2</sup>	6.72 kV/m	5.85 kV/m	55.69 mG	39.29 mG
Maximum Operating Condition <sup>3</sup>	6.72 kV/m	5.85 kV/m	445.51 mG	314.31 mG

<sup>1</sup> This value depends on voltage and is expected to be relatively constant (will vary slightly if the operating voltage changes). Results are calculated at the operating voltage of 1.05 per unit.

<sup>2</sup> Normal Operating Condition value is for predicted flow of ~250 Amps

<sup>3</sup> Maximum Operating Condition value is based on ~2,000 Amps

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**Table 2: Maximum Calculated EMF Levels for the H-Frame**

Project Load Conditions	Electric Field (kV/m) <sup>1</sup>		Magnetic Field (mG)	
	On ROW	Edge ROW	On ROW	Edge ROW
Normal Operating Condition <sup>2</sup>	6.72 kV/m	1.93 kV/m	55.69 mG	15.34 mG
Maximum Operating Condition <sup>3</sup>	6.72 kV/m	1.93 kV/m	445.51 mG	122.74 mG

<sup>1</sup> This value depends on voltage and is expected to be relatively constant (will vary slightly if the operating voltage changes). Results are calculated at the operating voltage of 1.05 per unit.

<sup>2</sup> Normal Operating Condition value is for predicted flow of ~250 Amps

<sup>3</sup> Maximum Operating Condition value is based on ~2,000 Amps

**Table 3: Maximum Calculated EMF Levels for the Monopole**

Project Load Conditions	Electric Field (kV/m) <sup>1</sup>		Magnetic Field (mG)	
	On ROW	Edge ROW	On ROW	Edge ROW
Normal Operating Condition <sup>2</sup>	5.85 kV/m	1.25 kV/m	39.29 mG	8.47 mG
Maximum Operating Condition <sup>3</sup>	5.85 kV/m	1.25 kV/m	314.31 mG	67.72 mG

<sup>1</sup> This value depends on voltage and is expected to be relatively constant (will vary slightly if the operating voltage changes). Results are calculated at the operating voltage of 1.05 per unit.

<sup>2</sup> Normal Operating Condition value is for predicted flow of ~250 Amps

<sup>3</sup> Maximum Operating Condition value is based on ~2,000 Amps

**Table 4: Calculated Audible Noise (L<sub>50</sub>) at the Edge of the ROW for the Transmission Line**

Structure Type	Fair Weather <sup>1</sup>	Foul Weather <sup>1</sup>
H-Frame	17.0 dBA	42.0 dBA
Monopole	18.2 dBA	43.2 dBA

<sup>1</sup> Results shown are the maximum at the edge of the Right-of-Way for a current of 500 amps which is about twice the expected initial loading of the facility.

### Conclusion

It was found for the 2X bundled TP 477 Hawk ACSR conductor that the H-Frame structure produced the highest levels of Electric and Magnetic Fields while the Delta structure produced the highest levels of Audible Noise. Corona and field effects performance results should be re-verified if structure geometries change.

Thank you.



Andrea Wood



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**APPENDIX A – SWRATE RESULT**



Version 3.02  
Run Date: 4/22/2013

SWRate Conductor Ampacity and Temperature

**477.0 kcmil, 26/7, ACSR "Hawk"**

Construction Information:

Construction: Single  
Overall diameter: 0.858 in.  
Trap Wire Type: N/A  
Trap Wire Layers: N/A

Calculation Conditions:

Ambient: 40 °C  
Wind: 2.0 FPS  
Wind Angle: 90°

Aluminum Info:

Material: 1350 Al.  
Conductivity: 61.2% IACS  
Number of strands: 26  
Strand Diameter: 0.1354 in.  
Diameter over Aluminum: 0.858 in.

Coef of Emissivity: 0.7  
Coef of Absorption: 0.9  
Atmosphere: Clear

Local Time: 12:00 Hrs  
Date for Local Time: Jul. 8

Core Information:

Material: Coated Steel  
Conductivity: 8% IACS  
Number of strands: 7  
Strand diameter: 0.1053 in.  
Core diameter: 0.3159 in.

North Latitude: 46°  
Azimuth of Line: 90° (E-W)  
Altitude (Above Sea Level): 2000 ft.

Resistance Information:

Reference Low Temperature: 25 °C  
Reference Low Resistance: 0.1928 Ohms/mi  
Reference High Temperature: 75 °C  
Reference High Resistance: 0.2305 Ohms/mi

Given a maximum steady state temperature of: 90°C (194°F)

The steady-state current rating is: 620 amperes

Loss Variables:

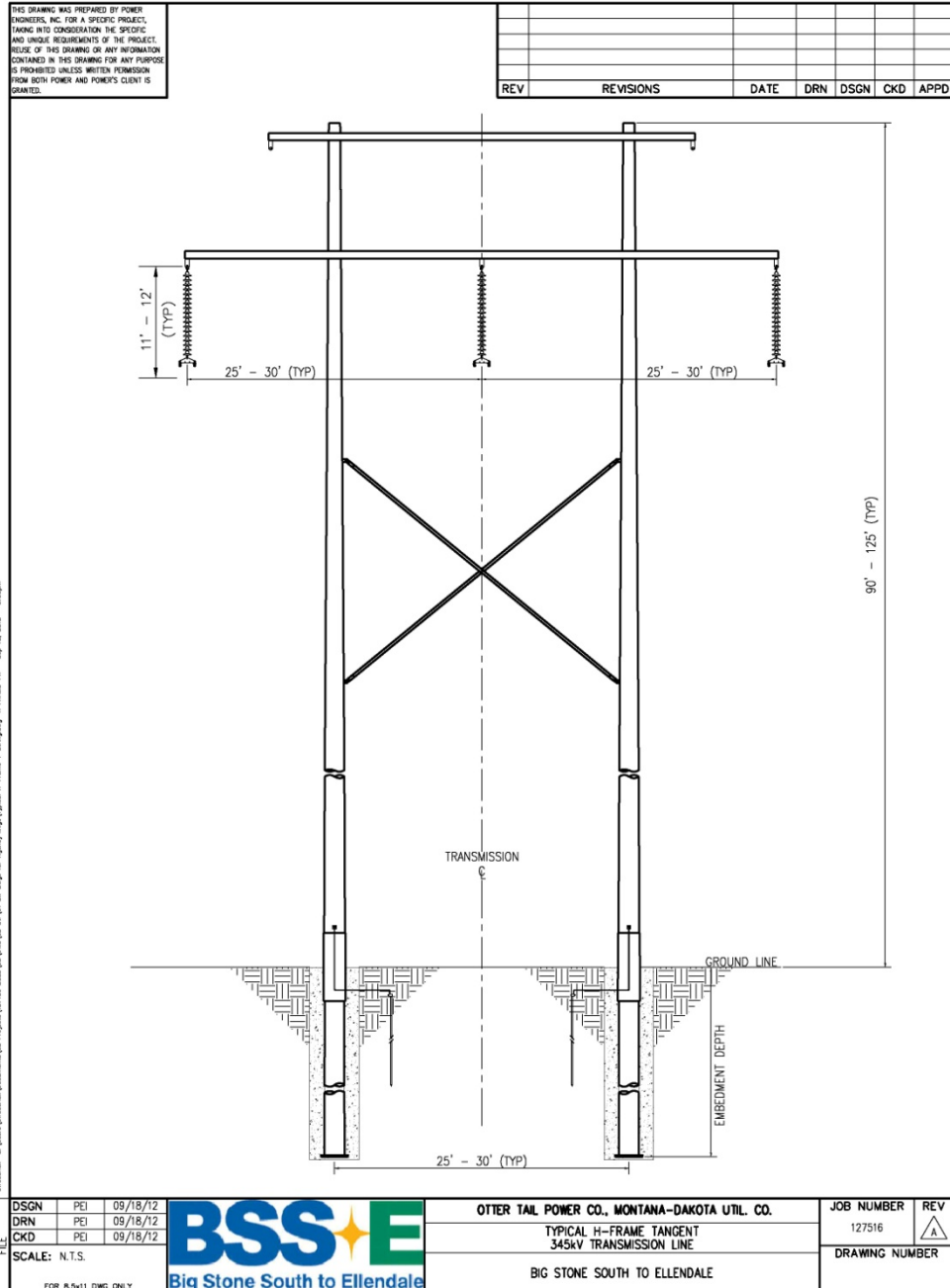
Qs: 6.47 Watts/ft  
Qc: 17.66 Watts/ft  
Qr: 6.44 Watts/ft  
Rac: 0.2418 Ohms/mi

Note: 477 ACSR/TP Hawk Rating = (620\*2) = 1,240 A per sub-conductor (doubling the fault current rating of a single conductor is an approximation for the TP conductor)

FRE 112-1380 127156 (10/10/13) AW



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## Appendix C – Corona and Field Effects Performance Plots

