STATE OF MINNESOTA
OFFICE OF ADMINISTRATIVE HEARINGS
FOR THE PUBLIC UTILITIES COMMISSION

In the Matter of the Route Permit Application by Xcel Energy, Dairyland Power Cooperative, Souther Minnesota Municpal Power Agency, Rochester Public Utilities , and WPPI Energy for a 345 kV Transmission Line from Hampton, Minnesota, to Rochester, Minnesota, to La Crosse, Wisconsin	OAH DOCKET NO. 3-2500-21181-2 PUC DOCKET NO. E002/TL-09-1448

AFFIDAVIT OF BRUCE McKAY, P.E.

Bruce McKay, P.E., after affirming or being duly sworn on oath, states and deposes as follows:

1. My name is Bruce McKay. I am an electrical engineer, and licensed Professional Engineer, in the state of Minnesota.

2. My experience is primarily in the areas of industrial power distribution and industrial automation and control. I have 16 years experience in these areas as a licensed Master Electrician, followed by 14 years as a licensed Professional Engineer to date.

3. I am a landowner near Henderson, MN, and therefore am not directly affected by the proposed Hampton-Rochester-La Crosse 345 kV Transmission Project.

4. I have participated in CapX2020 Task Force meetings held in Henderson, attended one day of PUC hearings in St. Paul, and attended, including making comments and submitting statements, all but one of the Public Hearings held in the Le Sueur-Henderson area over the last few years.

5. Attached as Exhibit A is a true and correct copy of the CapX2020 Engineering, Design, Construction, and Operational Characteristics, Section 3.1.1 Hampton-Rochester-La Crosse 345 kV Transmission Line, found on page 3-3 of the January 15, 2010, Route Permit Application for the Hampton-Rochester-La Crosse 345 kV Transmission Project, wherein it states that "Two 954 Aluminum Conductor Steel Supported (ACSS) conductors will be used per phase."

6. Attached as Exhibit B is a true and correct copy of Direct Testimony of Larry L. Schedin, Attachment J, showing various conductor specifications, including:

   a. In the chart on page 3, Summer Thermal Ratings for a Twin bundled 954 kcm 54/19 ACSS, 345 KV, of 3700 amps and 2211 MVA.
   b. In the chart on page 5, Winter Thermal Ratings for a Twin bundled 954 kcm 54/7 ACSS, 345 KV, of 4064 amps and 2428 MVA.

c. For the purposes of this Affidavit, I am using the Summer Ratings, but it should be noted that Winter Ratings are approximately an additional 9.8% higher than the Summer Ratings.

7. The first purpose of this statement is to point out the fact that the CapX2020 Magnetic Field tables and charts that I've been able to find in Hampton-Rochester-La Crosse 345 kV Transmission Project documents all fail to address the full potential Magnetic Field along the transmission lines. Each table and chart that I've seen displays Magnetic Field data calculated from estimated Peak and estimated Average System Conditions (Current (Amps)) rather than from transmission line design capacities. An example of such a table is presented in the attached Exhibit C, a true and correct copy of the CapX2020 Engineering, Design, Construction, and Operational Characteristics, Table 3.6-2: Calculated Magnetic Fields (mG) for Proposed 345 kV Transmission Line Designs (3.28 Feet Aboveground), found on pages 3-28 and 3-29 of the January 15, 2010, Route Permit Application for the Hampton-Rochester-La Crosse 345 kV Transmission Project.

8. The second purpose of this statement is to point out the fact that a table such as Exhibit C underestimates the Magnetic Field that would be created if the transmission line was utilized to its full potential capacity, or to 80% of its full potential capacity. The attached Exhibit D is a true and correct copy of "McKay Magnetic Field Calculations" which presents an example of Magnetic Field calculations based on estimated transmission line currents as compared to Magnetic Field calculations based on future potential (design) transmission line currents.

a. By following through STEPS 1, 2, 3-Single Circuit, and 4-Single Circuit in Exhibit D, you can see that with one Circuit in Service, for 2015 PEAK, the Calculated PEAK MAGNETIC FIELDS increase by 1323% and for 2015 AVERAGE, the Calculated AVERAGE MAGNETIC FIELDS increase by 1323% when design capacities are used for the calculations rather than using estimated load currents.
b. By following through STEPS 1, 2, 3-Double Circuit, and 4-Double Circuit in Exhibit D, you can see that with two Circuits in Service, for 2015 PEAK, the Calculated PEAK MAGNETIC FIELDS increase by 2646% and for 2015 AVERAGE, the Calculated AVERAGE MAGNETIC FIELDS increase by 2646% when design capacities are used for the calculations rather than using estimated load currents.
c. Please Note: Exhibit D is presented as a conceptual example. Actual design capacities and associated Magnetic Field calculations would need to be and should be provided by the Applicants.

9. The third purpose of this statement is to stress that right-of-way widths to protect the health and safety of those along the proposed transmission line need to be based on Calculated Magnetic Field's derived from design capacities, NOT on Calculated Magnetic Field's derived from estimated transmission line currents. A right-of-way based on the Applicant's low transmission line current estimates does not sufficiently protect people near the transmission lines.

10. Please feel free to contact me with any comments or questions you have.

Further your affiant sayeth naught.

Dated: April 20, 2011

Bruce McKay

Bruce McKay, PE
e-mail: bmckay.aces@gmail.com
cell: 612-386-5983

Signed and sworn to before me this
20 day of April, 2011.

Notary Public

WERNER H. GIESEN
Notary Public
State of Minnesota
My Commission Expires
January 31, 2015

EXHIBIT A

Line Configurations and Specifications

Hampton-LaCrosse Application

Section 3 Project Description

p. 3-3

3.1.1 Hampton–Rochester–La Crosse 345 kV Transmission Line

For the Project's proposed 345 kV line, the Applicant proposes primarily to use single-pole, self-weathering steel, double-circuit capable structures. Self-weathering steel alloys were developed to eliminate the need for painting and are commonly used by the Applicant and throughout the industry. The steel alloy develops a stable, rust-like appearance (dark reddish-brown color) when exposed to the weather for several years. The wetting and drying cycles cause rust to form a protective layer on its surface, preventing further rusting. The layer develops and regenerates continuously when subjected to the influence of the weather.

These single-pole steel structures would range from 130 to 175 feet in height. Spans could range from 600 to 1,000 feet, but would typically be 700 to 1,000 feet. In some areas, only one circuit would be strung and the other side of the pole would be available for adding a second circuit in the future, when conditions warrant. In other areas, the unused side of the 345/345 kV structure would be used to carry a lower voltage line on the second set of arms until a second 345 kV circuit is needed. Tubular steel pole structures are typically placed on large pier foundations of cast-in-place, reinforced concrete.

Two 954 Aluminum Conductor Steel Supported (ACSS) conductors will be used per phase. One or two shield wires will be used to protect the conductors from lightning strikes. One of these shield wires will incorporate fiber optic to facilitate relay control communications between substations and between substations, utility offices such as control centers. Fiber optics will be used only for utility purposes.

Figure 3.1-1 depicts a representative double-circuit 345 kV single pole structure.

The Mississippi River presents unique considerations that will require the use of multiple-circuit, specialty structures. A portion of this crossing is on Upper Mississippi River Wildlife Refuge lands managed by the USFWS. A Special Use Permit will be required to cross the Refuge and the Applicant will work closely with the USFWS to identify the most appropriate structure design.

An existing double-circuit transmission line crosses the Mississippi River and Refuge at the Project's proposed crossing location. The existing line crosses approximately 0.5 mile of Refuge lands and includes two structures on Refuge property. The line is constructed on a 180-foot-wide permitted ROW. An area approximately 125 feet wide and 1,900 feet long is maintained cleared of trees. The two main river crossing structures are 180 feet tall.

EXHIBIT B

Amps and MVA for Line Configurations and Specifications

Direct Testimony of Larry L. Schedin, Attachment J
CapX 2020 Certificate of Need
PUC Docket E002, ET2/CN-06-1115

☐ **Non Public Document – Contains Trade Secret Data**
☐ **Public Document – Trade Secret Data Excised**
☒ **Public Document**

Xcel Energy
Docket No.: E002, ET2/CN-06-1115
Response To: Elizabeth Goodpaster and Mary Marrow MCEA/Wind on the Wires — Information Request No. 3
Date Received: March 27, 2008

Question:

With reference to the Application Volume I, Sec. 2.4 (pages 2.9) entitled "Transmission Line Characteristics" and Applicants' response to DOC/OES Information Rquest No. 2, please provide thermal MVA ratings, surge impedance loadings (SIL), MVA and thermal ampere capacity ratings (amplacities) under summer normal, summer emergency, winter normal and winter emergency conditions for the following conductors and voltages:

(a) Single 795ACSR, 115 KV
(b) Single 795 ACSS, 115 KV
(c) Twin bundled 795 ACSR, 115 KV
(d) Twin bundled 795 ACSS, 115 KV
(e) Single 954 ACSS, 115 KV
(f) Single 795 ACSS, 161 KV
(g) Single 954 ACSS, 161 KV
(h) Single 795 ACSR, 230 KV
(i) Single 795 ACSS, 230 KV
(j) Single 954 ACSS, 230 KV
(k) Twin bundled 795 ACSR, 345 KV
(l) Twin bundled 954 ACSS, 345 KV
(m) Triple bundled 954 ACSS, 500 KV
(n) Triple bundled conductor as used on the Forbes – Chisago 500 KV line

In your response, please define the conditions for summer normal, summer emergency, winter normal and winter emergency conditions (ambient temp, wind speed, degree rise, allowable sag. etc.), and specify the regulatory authority setting the foregoing standards and the reference to applicable rules.

Response:

The thermal ratings of the requested conductors and voltages are noted in the table below. Conductor ratings are based on the "IEEE Standard for calculation of Bare Overhead Conductor Temperature and Ampacity Under Steady-State Conditions," ANSI/IEEE Standard 738. Alcoa SAG10 Ratekit was used to calculate conductor ratings.

A regulatory authority does not set the conductor steady state thermal rating variables. The CapX2020 Member Utilities Transmission Line Standards Committee ("Committee") developed the conductor steady state thermal rating variables for summer ratings based upon member utilities' standard of practice..

The summer steady state thermal rating variables are as follows:

- Conductor orientation relative to north: 90 degrees
- Atmosphere: Clear
- Air Temperature: 40 degrees C for Summer
- Wind Speed: 2 ft/sec
- Wind angle relative to conductor: 90 degrees
- Elevation above sea level: 1000 ft
- Latitude: 45 degrees N
- Date: July 8
- Solar time: 12 hours
- Coefficient of emissivity: 0.7
- Coefficient of absorption: 0.9
- 200 degrees C maximum operating temperature for ACSS
- 100 degrees C maximum operating temperature for ACSR

The Committee defined the Emergency Line Rating as equal to the steady state thermal rating.

The Committee specified that conductors meet minimum clearances to ground based upon voltage and nature of surface under the conductor (*i.e.*, roads, interstate highway, railroads, etc.). The minimum specified clearances were chosen to assure that the final constructed lines meet or exceed the National Electrical Safety Code ("NESC") minimum clearances. Conductor sags are to be calculated based upon conductor size, conductor temperature, span length, design tension, structure heights and loading conditions. Vertical clearances shall be applied to the greatest sag resulting from either the maximum operating temperature of 200°C (for the ACSS conductor) and 100°C (for the ACSR conductor) or the maximum loaded condition (ice plus wind).

Conductor	**Summer Thermal Ampacity Rating**	**Summer Thermal MVA Rating**
Single 795 kcm 26/7 ACSR, 115 KV	965 amps	192 MVA
Single 795 kcm 26/7 ACSS, 115 KV	1655 amps	330 MVA
Twin bundled 795 kcm 26/7 ACSR, 115 KV	1930 amps	384 MVA
Twin bundled 795 kcm 26/7 ACSS, 115 KV	3310 amps	659 MVA
Single 954 kcm 54/19 ACSS, 115 KV	1850 amps	368 MVA
Single 795 kcm 26/7 ACSS, 161 KV	1655 amps	462 MVA
Single 954 kcm 54/19 ACSS, 161 KV	1850 amps	516 MVA
Single 795 kcm 26/7 ACSR, 230 KV	965 amps	384 MVA
Single 795 kcm 26/7 ACSS, 230 KV	1655 amps	659 MVA
Single 954 kcm 54/19 ACSS, 230 KV	1850 amps	737 MVA
Twin bundled 795 kcm 26/7 ACSR, 345 KV	1930 amps	1153 MVA
Twin bundled 954 kcm 54/19 ACSS, 345 KV	3700 amps	2211 MVA
Triple bundled 954 kcm 54/19 ACSS, 500 KV	5550 amps	4806 MVA
Triple bundled conductor as used on the Forbes – Chisago 500 KV line (Triple bundled 1192.5 kcm 45/7 ACSR)	3648 amps	3159 MVA

The Committee did not develop steady state thermal rating variables for winter ratings. Xcel Energy – NSP Operating Territory uses 0°C for the winter rating air temperature for calculating the rating during the winter operating season of November 1 to April 30. The April 30 date produces the lowest allowable line rating of the winter rating period, so it is used in the following table. The April 30 date and 0°C air temperature were used in conjunction with the other steady state thermal rating variables developed by the Committee to develop the following winter rating table.

The winter steady state thermal rating variables used for the following Xcel Energy – NSP Operating Territory/ CAPX2020 Member Utilities Transmission Line Standards Committee rating table are as follows:

- Conductor orientation relative to north: 90 degrees
- Atmosphere: Clear
- Air Temperature: 0 degrees C for Winter
- Wind Speed: 2 ft/sec
- Wind angle relative to conductor: 90 degrees
- Elevation above sea level: 1000 ft
- Latitude: 45 degrees N
- Date: April 30
- Solar time: 12 hours
- Coefficient of emissivity: 0.7
- Coefficient of absorption: 0.9
- 200 degrees C maximum operating temperature for ACSS
- 100 degrees C maximum operating temperature for ACSR

Conductor	**Winter (April 30) Thermal Ampacity Rating**	**Winter (April 30) Thermal MVA Rating**
Single 795 kcm 26/7 ACSR, 115 KV	1286 amps	256 MVA
Single 795 kcm 26/7 ACSS, 115 KV	1819 amps	362 MVA
Twin bundled 795 kcm 26/7 ACSR, 115 KV	2572 amps	512 MVA
Twin bundled 795 kcm 26/7 ACSS, 115 KV	3638 amps	725 MVA
Single 954 kcm 54/7 ACSS, 115 KV	2032 amps	405 MVA
Single 795 kcm 26/7 ACSS, 161 KV	1819 amps	507 MVA
Single 954 kcm 54/7 ACSS, 161 KV	2032 amps	567 MVA
Single 795 kcm 26/7 ACSR, 230 KV	1286 amps	512 MVA

Conductor	**Winter (April 30) Thermal Ampacity Rating**	**Winter (April 30) Thermal MVA Rating**
Single 795 kcm 26/7 ACSS, 230 KV	1819 amps	725 MVA
Single 954 kcm 54/7 ACSS, 230 KV	2032 amps	809 MVA
Twin bundled 795 kcm 26/7 ACSR, 345 KV	2572 amps	1537 MVA
Twin bundled 954 kcm 54/7 ACSS, 345 KV	4064 amps	2428 MVA
Triple bundled 954 kcm 54/7 ACSS, 500 KV	6096 amps	5279 MVA
Triple bundled conductor as used on the Forbes – Chisago 500 KV line (Triple bundled 1192.5 kcm 45/7 ACSR)	4875 amps	4222 MVA

Surge Impedance

The following table shows typical ranges of surge impedances found on the CapX2020 member systems. Designs for the proposed CapX2020 transmission lines are not far enough along to provide more accurate surge impedances for these lines.

Conductor Configuration	**Surge Impedance**
Single Bundled Conductor – 115, 161 & 230 KV Configurations a, b, f & h	350 – 375 Ohms
Twin bundled Conductor - 115 KV Configurations c & d	250 - 300 Ohms
Twin bundled Conductor - 345 KV Configurations k & l	270 –285 Ohms
Triple bundled Conductor - 500 kV Configuration n	250 – 300 Ohms
Configurations e, g, i, j and m	Not Used

Response By:	Brad Hill/David K. Olson
Title:	Principal Specialty Engineer
Department:	Transmission Engineering/Substation Engineering
Company:	Xcel Energy
Telephone:	612-330-6826/612-330-5909
Date:	April 21, 2008

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EXHIBIT C

Applicant Magnetic Field Calculations

Table 3.6-2: Calculated Magnetic Fields for Proposed 345kV Transmission Line Designs
Hampton-LaCrosse Project RoutingApplication p. 3-28 - 3-29

Table 3.6-2:
Calculated Magnetic Fields (mG) for Proposed 345 kV Transmission Line Designs (3.28 Feet Aboveground)

Structure Type	Geographical Segment	System Condition	Current (amps)	-300	-200	-100	-75	-50	0	50	75	100	200	300
Single- Pole Davit Arm 345/345 kV Double-Circuit with one Circuit In Service	Preferred Route: Hampton to Cannon Falls; Non-US-52 segments Zumbrota area to North Rochester	2015 Peak	140 A	0.38	0.79	2.35	3.41	5.24	13.58	9.64	5.88	3.77	1.04	0.46
		2015 Average	112 A	0.30	0.63	1.88	2.73	4.19	10.87	7.71	4.71	3.01	0.83	0.37
	Alternate Route: Hampton to North Rochester	2025 Peak	132 A	0.36	0.74	2.22	3.22	4.94	12.81	9.09	5.55	3.55	0.98	0.43
		2025 Average	106 A	0.29	0.60	1.78	2.58	3.97	10.29	7.30	4.45	2.85	0.79	0.35
Single-Pole Davit Arm 345/345 kV with 69 kV Underbuild with 1 Active 345 kV Circuit	Preferred Route: US-52 segments Cannon Falls to Zumbrota area	2015 Peak	140/325	0.74	1.65	6.20	10.42	20.73	70.89	8.50	3.77	2.51	1.01	0.52
		2015 Average	112/260	0.59	1.32	4.96	8.33	16.58	56.71	6.80	3.02	2.01	0.81	0.41
		2025 Peak	132/328	0.73	1.62	6.14	10.36	20.71	71.85	8.89	3.92	2.54	0.99	0.50
		2025 Average	106/262	0.58	1.30	4.91	8.28	16.55	57.37	7.09	3.12	2.03	0.79	0.40
Single-Pole Davit Arm 345/345 kV Double-Circuit with one Circuit in Service	N. Rochester to Alma	2015 Peak	403 A	1.12	2.33	6.97	10.11	15.54	40.27	28.58	17.44	11.17	3.09	1.35
		2015 Average	322 A	0.87	1.81	5.41	7.85	12.06	31.24	22.17	13.53	8.67	2.40	1.05
		2025 Peak	415 A	1.12	2.33	6.97	10.11	15.54	40.27	28.58	17.44	11.17	3.09	1.35
		2025 Average	332 A	0.90	1.87	5.57	8.09	12.43	32.21	22.86	13.95	8.94	2.47	1.08

Table 3.6-2:
Calculated Magnetic Fields (mG) for Proposed 345 kV Transmission Line Designs (3.28 Feet Aboveground)

Structure Type	Geographical Segment	System Condition	Current (amps)	-300	-200	-100	-75	-50	0	50	75	100	200	300
Single-Pole Davit Arm 161 kV Single-Circuit	N. Rochester to Northern Hills	2015 Peak	95 A	0.20	0.43	1.50	2.42	4.39	14.29	5.41	2.79	1.65	0.42	0.18
		2015 Average	76 A	0.16	0.34	1.20	1.94	3.51	11.43	4.33	2.23	1.32	0.33	0.14
		2015 Peak	96 A	0.20	0.43	1.52	2.45	4.43	14.44	5.47	2.82	1.66	0.42	0.18
		2015 Average	77 A	0.16	0.34	1.22	1.96	3.56	11.58	4.38	2.26	1.33	0.34	0.15

EXHIBIT D

McKay Magnetic Field Calculations

Calculated Magnetic Field Tables for Proposed 345 kV Transmission Line Designs

STEP 1

THIS TABLE CONTAINS THE COLUMN HEADINGS AND DATA FROM THE TOP ENTRY IN THE TABLE FROM EXHIBIT C

TABLE 3.6-2:

Calculated Magnetic Fields (mG) for Proposed 345 kV Transmission Line Designs (3.28 Feet Aboveground)

STRUCTURE TYPE	GEOGRAPHICAL SEGMENT	SYSTEM CONDITION	CURRENT (AMPS)	-300'	-200'	-100'	-75'	-50'	0'	50'	75'	100'	200'	300'
SINGLE- POLE	PREFERRED ROUTE:	2015 PEAK	140.00	0.38	0.79	2.35	3.41	5.24	13.58	9.64	5.88	3.77	1.04	0.46
DAVIT ARM	HAMPTON TO	2015 AVERAGE	112.00	0.30	0.63	1.88	2.73	4.19	10.87	7.71	4.71	3.01	0.83	0.37
345/345 kV DOUBLE-	CANNON FALLS;													
CIRCUIT WITH ONE CIRCUIT	NON-US-52													
IN SERVICE	SEGMENTS													
	ZUMBROTA AREA TO													
	NORTH ROCHESTER													
	ALTERNATE ROUTE:													
	HAMPTON TO NORTH													
	ROCHESTER													

STEP 2

MVA CALCULATED FROM THE CURRENTS IN TABLE 3.6-2:	
345.00	kV
140.00	Amps PEAK ESTIMATED
1.73	3 Phase
83.56	MVA PEAK CALCULATED
345.00	kV
112.00	Amps AVERAGE ESTIMATED
1.73	3 Phase
66.85	MVA AVERAGE CALCULATED

STEP 4- SINGLE CIRCUIT

THIS TABLE CONTAINS DATA SCALED FROM THE TABLE IN STEP 1 USING CURRENTS CALCULATED IN STEP 3- SINGLE CIRCUIT

TABLE 3.6-2 SCALED for SINGLE CIRCUIT DESIGN CAPACITY:

Calculated Magnetic Fields (mG) for Proposed 345 kV Transmission Line Designs (3.28 Feet Aboveground)

STRUCTURE TYPE	GEOGRAPHICAL SEGMENT	SYSTEM CONDITION	CURRENT (AMPS)	-300'	-200'	-100'	-75'	-50'	0'	50'	75'	100'	200'	300'
SINGLE- POLE	PREFERRED ROUTE:	2015 PEAK	1852.22	5.03	10.45	31.09	45.11	69.33	179.67	127.54	77.79	49.88	13.76	6.09
DAVIT ARM	HAMPTON TO	2015 AVERAGE	1481.78	3.97	8.34	24.87	36.12	55.43	143.81	102.00	62.31	39.82	10.98	4.90
345/345 kV DOUBLE-	CANNON FALLS;													
CIRCUIT WITH ONE CIRCUIT	NON-US-52													
IN SERVICE	SEGMENTS													
	ZUMBROTA AREA TO													
	NORTH ROCHESTER													
	ALTERNATE ROUTE:													
	HAMPTON TO NORTH													
	ROCHESTER													

STEP 3- SINGLE CIRCUIT

CURRENT CALCULATED FROM SINGLE CIRCUIT MVA DESIGN CAPACITY:	
1105.50	*MVA PEAK DESIGN
345.00	kV
1.73	3 Phase
1852.22	Amps PEAK CALCULATED
884.40	**MVA AVERAGE DESIGN
345.00	kV
1.73	3 Phase
1481.78	Amps AVERAGE CALCULATED

STEP 4- DOUBLE CIRCUIT

THIS TABLE CONTAINS DATA SCALED FROM THE TABLE IN STEP 1 USING CURRENTS CALCULATED IN STEP 3- DOUBLE CIRCUIT

TABLE 3.6-2 SCALED for DOUBLE CIRCUIT DESIGN CAPACITY:

Calculated Magnetic Fields (mG) for Proposed 345 kV Transmission Line Designs (3.28 Feet Aboveground)

STRUCTURE TYPE	GEOGRAPHICAL SEGMENT	SYSTEM CONDITION	CURRENT (AMPS)	-300'	-200'	-100'	-75'	-50'	0'	50'	75'	100'	200'	300'
SINGLE- POLE	PREFERRED ROUTE:	2015 PEAK	3704.45	10.05	20.90	62.18	90.23	138.65	359.33	255.08	155.59	99.76	27.52	12.17
DAVIT ARM	HAMPTON TO	2015 AVERAGE	2963.89	7.94	16.67	49.75	72.24	110.88	287.66	204.03	124.64	79.65	21.96	9.79
345/345 kV DOUBLE-	CANNON FALLS;													
CIRCUIT WITH ONE CIRCUIT	NON-US-52													
IN SERVICE	SEGMENTS													
	ZUMBROTA AREA TO													
	NORTH ROCHESTER													
	ALTERNATE ROUTE:													
	HAMPTON TO NORTH													
	ROCHESTER													

STEP 3- DOUBLE CIRCUIT

CURRENT CALCULATED FROM DOUBLE CIRCUIT MVA DESIGN CAPACITY:	
2211.00	*MVA PEAK DESIGN
345.00	kV
1.73	3 Phase
3704.45	Amps PEAK CALCULATED
1769.00	**MVA AVERAGE DESIGN
345.00	kV
1.73	3 Phase
2963.89	Amps AVERAGE CALCULATED

NOTES:
1. MVA = (kV * Amps * 1.73) /1000
2. Amps = (MVA * 1000) / (kV * 1.73)
3. For a given physical and electrical configuration, milligauss at one location is proportional to current (Amps) (for example, double the current and the milligauss level also doubles).
4. For a given physical and electrical configuration and constant current, the milligauss level changes as the inverse square of the distance from away from the source (for example, move 2 times as far away and the milligauss level decreases to 1/4 of what it was).

*. MVA PEAK DESIGN CAPACITY IS FROM A COMBINATION OF THE DATA PRESENTED IN EXHIBITS A, B, AND C.

**. MVA AVERAGE DESIGN CAPACITY WAS CHOSEN TO BE ABOUT 80% OF PEAK DESIGN CAPACITY