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

In the Matter of the Route Permit Application by Great River Energy and Xcel Energy for a 345 kV Transmission Line from Brookings County, South Dakota to Hampton, Minnesota	OAH DOCKET NO. 7-2500-20283-2 PUC DOCKET NO. ET-2/TL-08-1474

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. To date, I have 16 years experience in these areas as a licensed Master Electrician, followed by 14 years as a licensed Professional Engineer.

3. I am a landowner about 3 miles north of the proposed Le Sueur-Henderson crossing and about 7 miles south of the proposed Belle Plaine crossing and therefore am not potentially directly affected by either route proposed for the CapX2020 Brookings transmission line.

4. I have participated in 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 couple of years.

5. The first purpose of this statement is to point out the fact that the CapX2020 Magnetic Field tables and charts that I've seen at public hearings and been able to find in CapX2020 documents all fail to address the <u>full potential Magnetic Field</u> along the transmission lines. Each table and chart that I've seen displays Magnetic Field data calculated from <u>estimated</u> Peak and <u>estimated</u> Average System Conditions (Current (Amps)) rather than from transmission line <u>design capacities</u>. An example of such a table is presented in the attached "Exhibit A - Table 3-4. Calculated Magnetic Fields - Application", which is from the CapX2020 Engineering Design, Construction and Right-of-Way Acquisition document, December 2008, pages 3-20 through 3-22.

6. The second purpose of this statement is to point out the fact that a problem with a table such as this is that it underestimates the Magnetic Field that would be created if the transmission line was utilized to its full potential capacity. The attached "Exhibit B - CALCULATED MAGNETIC FIELD TABLES" 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. By following through STEPS 1, 2, 3, and 4 in Exhibit B, you can see that the Calculated PEAK MAGNETIC FIELDS increase by 414% and the Calculated AVERAGE MAGNETIC FIELDS increase by 540% when design capacities are used for the calculations rather than using estimated load currents. (Please Note: Exhibit B 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.)

7. The third purpose of this statement is to stress that right-of-way corridor widths along the proposed transmission line need to be based on Calculated Magnetic Fields derived from <u>design capacities</u>, NOT on Calculated Magnetic Fields derived from estimated transmission line currents.

8. It is my opinion that a right-of-way based on low transmission line current estimates does not sufficiently protect people living near the transmission lines from potential negative health effects resulting from the line's Magnetic Field.

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

Further your affiant sayeth naught.

Dated: October 16, 2010

Bruce McKay

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

Signed and sworn to before me this 15th day of October, 2010.

Notary Public

ELIZABETH A MOEN
Notary Public
Minnesota
My Commission Expires Jan. 31, 2012

EXHIBIT A

Table 3-4. Calculated Magnetic Fields – Application

Table 3-4. Calculated Magnetic Fields (milligauss) for Proposed Single/Double/Triple Circuit Transmission Line Designs (3.28 feet above ground)

				Distance to Proposed Centerline										
Structure Type	Section	System Condition	Current (Amps)	-300'	-200'	-100'	-75'	-50'	0'	50'	75'	100'	200'	300'
Single Pole Davit Arm 345 kV/345 kV Double Circuit with both Circuits In Service	Brookings to Lyon County	Peak	826.7	0.60	1.81	10.40	19.02	37.45	94.04	37.90	19.33	10.61	1.86	0.61
		Average	496.02	0.36	1.08	6.24	11.41	22.47	56.42	22.74	11.60	6.36	1.11	0.36
Single Pole Davit Arm 345 kV/345 kV Double Circuit with one Circuit In Service	Brookings to Lyon County.	Peak	826.7	2.23	4.65	13.88	20.14	30.96	80.21	56.92	34.74	22.25	6.16	2.70
		Average	496.02	1.34	2.79	8.33	12.09	18.58	48.13	34.15	20.85	13.35	3.69	1.62
Single Pole Davit Arm 345 kV/345 kV Double Circuit with both Circuits In Service	Lyon County to Hazel Creek	Peak	644.3	0.47	1.41	8.10	14.83	29.19	73.29	29.54	15.07	8.27	1.45	0.47
		Average	386.58	0.28	0.85	4.86	8.90	17.51	43.97	17.72	9.04	4.96	0.87	0.28
Single Pole Davit Arm 345 kV/345 kV Double Circuit with one Circuit In Service	Lyon County to Hazel Creek	Peak	644.3	1.74	3.62	10.82	15.70	24.13	62.52	44.36	27.08	17.34	4.80	2.10
		Average	386.58	1.04	2.17	6.49	9.42	14.48	37.51	26.62	16.25	10.41	2.88	1.26
Single Pole Davit Arm 345 kV/345 kV Double Circuit with both Circuits In Service	Hazel Creek to Minnesota Valley	Peak	247.4	0.18	0.54	3.11	5.69	11.21	28.14	11.34	5.79	3.17	0.56	0.18
		Average	148.44	0.11	0.32	1.87	3.42	6.72	16.88	6.81	3.47	1.90	0.33	0.11
Single Pole	Hazel	Peak	247.4	0.67	1.39	4.15	6.03	9.27	24.01	17.03	10.40	6.66	1.84	0.81

				Distance to Proposed Centerline										
Structure Type	Section	System Condition	Current (Amps)	-300'	-200'	-100'	-75'	-50'	0'	50'	75'	100'	200'	300'
Davit Arm 345 kV/345 kV Double Circuit with one Circuit In Service	Creek to Minnesota Valley	Average	148.44	0.40	0.83	2.49	3.62	5.56	14.40	10.22	6.24	4.00	1.11	0.48
Single Pole Davit Arm 345 kV/345 kV Double Circuit with both Circuits In Service	Helena to Lake Marion	Peak	1005.9	0.73	2.2	12.65	23.15	45.57	114.42	46.12	23.53	12.91	2.26	0.74
		Average	603.54	0.44	1.32	7.56	13.89	27.34	68.65	27.67	14.12	7.74	1.36	0.44
Single Pole Davit Arm 345 kV/345 kV Double Circuit with one Circuit In Service	Helena to Lake Marion	Peak	1005.9	2.71	5.66	16.89	24.51	37.68	97.60	69.26	42.28	27.07	7.49	3.28
		Average	603.54	1.63	3.39	10.13	14.71	22.61	58.56	41.56	25.37	16.24	4.49	1.97
Single Pole Davit Arm 345 kV/345 kV Double Circuit with both Circuits In Service	Lake Marion to Hampton	Peak	354.8	0.26	0.78	4.46	8.16	16.07	40.36	16.27	8.30	4.55	0.80	0.26
		Average	212.88	0.15	0.47	2.68	4.90	9.64	24.21	9.76	4.98	2.73	0.48	0.16
Single Pole Davit Arm 345 kV/345 kV Double Circuit with one Circuit In Service	Lake Marion to Hampton	Peak	354.8	0.96	2.00	5.96	8.65	13.29	34.43	24.43	14.91	9.55	2.64	1.16
		Average	212.88	0.57	1.20	3.57	5.19	7.97	20.66	14.66	8.95	5.73	1.59	0.69
H-Frame 345 kV/345 kV/69kV Triple Circuit	Cedar Mountain to Helena	Peak	776/776/138	0.9	2.5	13.5	24.9	48.7	68.1	14.6	6.7	3.5	0.5	0.2
		Average	466/466/83	0.5	1.5	8.1	15.0	29.2	40.9	8.8	4.0	2.1	0.3	0.1

Distance to Proposed Centerline														
Structure Type	**Section**	**System Condition**	**Current (Amps)**	**-300'**	**-200'**	**-100'**	**-75'**	**-50'**	**0'**	**50'**	**75'**	**100'**	**200'**	**300'**
H-Frame 345 kV/345 kV/115kV Triple Circuit	Lyon County to Cedar Mountain	Peak	841/841/266	1.3	3.2	15.9	28.3	52.9	67.4	15.3	8.0	4.6	1.1	0.6
		Average	505/505/160	0.75	2.0	9.5	17.0	31.8	40.5	9.2	4.8	2.7	0.6	0.3
Single Pole, 115 kV Single Circuit	Redwood Falls – Franklin to Cedar Mountain	Peak	266	0.3	0.6	2.3	3.9	7.7	33.9	7.4	3.8	2.3	0.6	0.3
		Average	150	0.2	0.4	1.4	2.3	4.6	20.4	4.4	2.3	1.4	0.4	0.2
Single Pole, 345 kV / 345 kV Double Circuit with one Circuit strung at 230 kV	Minnesota Valley to Hazel Creek	Peak	247	0.8	1.8	6.5	10.1	16.6	23.8	9.2	6.0	4.2	1.4	0.7
		Average	148	0.5	1.1	3.9	6.1	10.0	14.3	5.5	3.6	2.5	0.8	0.4

EXHIBIT B

Calculated Magnetic Field Tables

STEP 1

THIS TABLE CONTAINS THE COLUMN HEADINGS AND DATA FROM THE TOP ENTRY IN THE TABLE FROM EXHIBIT A1

TABLE 3-4. Calculated Magnetic Fields (milligauss) for Proposed Single/Double/Triple Circuit Transmission Line Designs (3.28 feet above ground)

STRUCTURE TYPE	SECTION	SYSTEM CONDITION	CURRENT (AMPS)	DISTANCE TO PROPOSED CENTERLINES -300'	-200'	-100'	-75'	-50'	0'	50'	75'	100'	200'	300'
SINGLE POLE DAVIT ARM 345 kV / 345 kV DOUBLE CIRCUIT W/ BOTH CICUITS IN SERVICE	BROOKINGS TO LYON COUNTY	PEAK	826.70	0.60	1.81	10.40	19.02	37.45	94.04	37.90	19.33	10.61	1.86	0.61
		AVERAGE	496.02	0.36	1.08	6.24	11.41	22.47	56.42	22.74	11.60	6.36	1.11	0.36

STEP 2

MVA CALCULATED FROM THE CURRENTS IN TABLE 3-4:

345.00	kV
826.70	Amps PEAK ESTIMATED
1.73	3 Phase
493.42	MVA PEAK CALCULATED
345.00	kV
496.02	Amps AVERAGE ESTIMATED
1.73	3 Phase
296.05	MVA AVERAGE CALCULATED

STEP 4

THIS TABLE CONTAINS DATA SCALED FROM THE TABLE ABOVE USING CURRENTS CALCULATED IN STEP 3

TABLE 3-4 SCALED. Calculated Magnetic Fields (milligauss) for Proposed Single/Double/Triple Circuit Transmission Line Designs (3.28 feet above ground)

STRUCTURE TYPE	SECTION	SYSTEM CONDITION	CURRENT (AMPS)	DISTANCE TO PROPOSED CENTERLINES -300'	-200'	-100'	-75'	-50'	0'	50'	75'	100'	200'	300'
SINGLE POLE DAVIT ARM 345 kV / 345 kV DOUBLE CIRCUIT W/ BOTH CICUITS IN SERVICE	BROOKINGS TO LYON COUNTY	PEAK	3434.70	2.49	7.52	43.21	79.02	155.59	390.71	157.46	80.31	44.08	7.73	2.53
		AVERAGE	2680.74	1.95	5.84	33.72	61.67	121.44	304.92	122.90	62.69	34.37	6.00	1.95

STEP 3

CURRENT CALCULATED FROM MVA DESIGN CAPACITY:

2050.00	*MVA PEAK DESIGN
345.00	kV
1.73	3 Phase
3434.70	Amps PEAK CALCULATED
1600.00	**MVA AVERAGE DESIGN
345.00	kV
1.73	3 Phase
2680.74	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 Docket No. E002/CN-06-1115, TRANSMISSION CAPACITY

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