

**BEFORE THE PUBLIC UTILITIES COMMISSION  
OF THE STATE OF SOUTH DAKOTA**

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In the Matter of the Transmission Permit for the  
Big Stone South to Ellendale Project

EL13-028

**DIRECT TESTIMONY OF JON LEMAN**

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1 BACKGROUND OF WITNESS

2 **Q. Please state your name, employer, and business address.**

3 A. My name is Jon Leman. I work for POWER Engineers, Inc. (“POWER”). My  
4 business address is 1300 16<sup>th</sup> Ave, Suite 200, Clarkston, WA 99403.

5 **Q. What is your current position with POWER?**

6 A. Senior Project Engineer and Area Lead - electrical system studies.

7 **Q. What are your duties and responsibilities in that position?**

8 A. Electrical design and analysis of AC and DC power delivery systems, including  
9 transmission lines. As part of that work, I coordinate and prepare engineering studies regarding  
10 conductor (line) insulation, corona effects, electrical and magnetic field, effects, conductor and  
11 shield wire selection, transient studies, power system planning, protective relaying, and arc flash.  
12 I also supervise other electrical engineers in POWER’s Clarkston, WA office.

13 **Q. How long have you worked for POWER?**

14 A. Since June of 2005.

15 **Q. How long in your current position?**

16 A. Approximately two and one-half years.

17 **Q. Can you describe your work experience before your current position.**

18 A. Prior to my current position I worked as a junior engineer, mid level engineer, and  
19 project engineer in POWER’s SCADA and Analytical Services (electrical studies) business unit.  
20 Prior to POWER I worked for the United States Navy as an electrical engineering instructor.

21 **Q. What is your education?**

1 A. I received a Bachelor of Science in electrical engineering from the University of  
2 Idaho in 2001. In 2010, I received a Master of Science degree in electrical engineering from the  
3 University of Idaho.

4 **Q. Are you a licensed engineer?**

5 A. Yes, I am a licensed electrical engineer in the State of Idaho.

6 **Q. Do you have any prior experience working on electrical transmission lines?**

7 A. Yes, most of my career at POWER has involved electrical analysis of transmission  
8 lines and I have been involved in many projects prior to this one. Much of my experience is with  
9 345 kV transmission lines though I have also worked with many other projects ranging from 35  
10 kV sub-transmission through 500 kV transmission projects.

11 **Q. What is exhibit 15?**

12 A. This is my a copy of my curriculum vitae.

13 **Q. Is it true and accurate?**

14 A. Yes.

15 **Q. What is the purpose of your testimony?**

16 A. I am going to testify about the electrical engineering issues arising out of the  
17 construction and operation of the transmission line.

18 **ROLE IN THE PROJECT**

19 **Q. What is your role in the Big Stone South to Ellendale Project (“Project”)?**

20 A. I have performed electrical design activities and have assisted in addressing some of  
21 the purported electrical engineering concerns arising out of the construction of the Project,  
22 including concerns about electrical fields, magnetic fields, and stray voltage associated with the  
23 project.

1 **Q. Have you reviewed any studies or research as part of your work on the Project?**

2 A. Yes. In performing my work, I reviewed the following:

3 1. *National Electrical Safety Code (NEESC)*, Institute of Electrical and Electronics  
4 Engineers (IEEE), 2012

5  
6 2. *IEEE Std. C95.6, Standard for Safety Levels with Respect to Human Exposure to*  
7 *Electromagnetic Fields, 0-3kHz*, Institute of Electrical and Electronics Engineers (IEEE),  
8 2002

9  
10 3. *ICNIRP Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and*  
11 *Electromagnetic Fields (up to 300 GHz)*, International Commission on Non-Ionizing  
12 Radiation Protection, 1998

13  
14 4. *Field and Wave Electromagnetics, 2<sup>nd</sup> ed.*, D. K. Cheng, 1992

15  
16 5. *EPRI Transmission Line Reference Book, 200 kV and Above 3<sup>rd</sup> ed.*, 2005

17  
18 6. *Corona Performance of High Voltage Transmission Lines*, P. S. Maruvada, 2000

19  
20 7. *Electric and Magnetic Fields Associated with the Use of Electric Power –*  
21 *Questions and Answers*, National Institute of Environmental Health Services (NIEHS),  
22 2002

23 **Q. Are these studies or research the type of information an electrical engineer**  
24 **would commonly rely on in performing electrical engineering services?**

25 A. Yes, they are.

26 **Q. Has POWER performed any engineering studies relating to your work on the**  
27 **Project?**

28 A. Yes, POWER performed a conductor optimization study. In the conductor  
29 optimization study, POWER analyzed the options for selecting conductors (lines) for the Project.  
30 In analyzing the conductor options, POWER modeled the electric and magnetic fields (EMF) and  
31 corona effects associated with the Project. POWER also performed studies to confirm whether

1 the Project's design will comply with National Electric Safety Code (NESC), which requires that  
2 any induced currents due to electric fields do not exceed a specified level.

3 **Q. What was your role regarding these two studies?**

4 A. I supervised the creation of the two studies by POWER. I have reviewed both  
5 studies.

6 **Q. Are these studies the type of information an electrical engineer would commonly  
7 rely on in performing electrical engineering services?**

8 A. Yes, they are.

9 ISSUES WITH ELECTRICAL AND MAGNETIC FIELDS (EMF)

10 **Q. Do high voltage transmission lines like the 345kV transmission line as part of the  
11 Project create an electrical field?**

12 A. Yes, high voltage transmission lines, like power lines of all voltages, create both  
13 electric fields and magnetic fields, which are collectively referred to as EMF.

14 **Q. What did the conductor optimization study indicate regarding the effects of the  
15 EMF?**

16 A. The design of the Project results in EMF levels that are lower than the levels  
17 recommended by the Institute of Electrical and Electronic Engineers (IEEE), who issue standards  
18 and guidelines for the industry. The EMF levels are also below the recommendation of  
19 International Commission on Non-Ionizing Radiation Protection (ICNIRP), who have done  
20 studies on the effects of EMF and published guidelines for exposure limits. Also, the Project's  
21 design meets the safety requirements imposed by the NESC.

22 **Q. Are there any potential issues arising from the electrical fields created by the  
23 transmission line for the project?**

1           A. Yes, like all high voltage transmission lines, there are some potential effects due to  
2 the electric field interactions between the high voltage transmission line of the Project and  
3 metallic objects near the transmission line. Depending on the design of the transmission line, the  
4 electrical field can cause stray voltage in metallic objects. Also, electric fields from high voltage  
5 transmission lines ionize the air around the conductor resulting in corona. Corona can cause  
6 audible noise (AN), radio interference (RI), and television interference (TVI). The conversion of  
7 television transmission to digital eliminated most problems with TVI.

8           **Q. What has POWER done to address those issues?**

9           A. POWER has designed the line to meet National Electrical Safety Code (NESC)  
10 clearance requirements. These clearance requirements prevent electric fields from being strong  
11 enough at ground level to cause a harmful shock if a person touches a large metallic object. An  
12 example of such an object would be the chassis of a semi tractor-trailer or farm equipment  
13 parked within the influence of the transmission line electric field. The larger the metal surface  
14 area of the object and the closer to the transmission line, the greater the risk of the electrical field  
15 creating a shock. By designing to NESC requirements, the risk associated with electric fields is  
16 mitigated. Additionally, the conductor size, conductor bundles, phase spacing, and other line  
17 geometry are designed to minimize corona audible noise and radio interference effects.  
18 Ultimately, the conductor optimization study indicates that the EMF and corona effects of the  
19 transmission line meet NESC requirements, industry guidelines, and design specifications.

20           **Q. Are there any safety issues to people from the electrical field created by the**  
21 **Project?**

22           A. No, both the conductor optimization study and the NESC clearance study establish  
23 that the electric field created by the transmission line does not pose a safety hazard.

1           **Q. Are there any safety concerns for livestock or wildlife?**

2           A. No. Livestock and terrestrial wildlife will not experience electrical fields any higher  
3 than humans, and the compliance of the transmission line with the NESC design clearances  
4 means no electric field safety hazard to animals on the ground.

5           **Q. When constructed and energized, will the transmission line create a magnetic  
6 field?**

7           A. Yes, it will create a magnetic field when current flows in the conductors.

8           **Q. Do these magnetic fields create any issues?**

9           A. Yes, magnetic fields from current on high voltage transmission lines can induce  
10 voltages in parallel facilities (*e.g.*, fences, railroads, pipelines). In poorly designed systems, this  
11 can lead to corrosion, shock, or service interruption on the parallel facility. The Project's design  
12 and routing avoid these problems.

13           **Q. What has POWER done to address those issues?**

14           A. POWER designed the line according to NESC clearances which help reduce the  
15 effect of induced voltages due to magnetic fields. Also, the transmission line does not parallel  
16 any railroads or pipeline facilities. For locations with equipment such as fencing, mitigation  
17 options are well known in industry and will be dealt with on a case by case basis via grounding,  
18 filters, etc.

19           **Q. Does the Project pose any safety issues to people based as a result of the  
20 magnetic fields?**

21           A. No, because there are no parallel railroad and pipeline facilities, and because the  
22 Project will employ industry standard mitigation methods for fencing and other equipment.





1           **Q. What do those studies indicate?**

2           A. They indicate that the transmission line's clearance design is sufficient to limit  
3 induced currents caused by stray voltage to levels that comply with NESC requirements.

4           **Q. What affect does stray voltage have in locating a transmission line in  
5 comparison to a railroad track?**

6           A. If a transmission line runs parallel to a railroad track, there is a risk of stray voltage.  
7 As a result, if a project has the potential to be near a railroad track, studies are done to identify  
8 stray voltage and electromagnetic issues. If issues are identified the line is either routed farther  
9 from the track or mitigation is implemented to eliminate or reduce the effects. This is not an  
10 issue with the Project, however, because no known railroads are near the preferred route for the  
11 Project.

12           **Q. Do you have an opinion regarding whether the construction or operation of the  
13 transmission line will result in stray voltage that will affect farming operations,  
14 vehicle usage, or location of metal buildings?**

15           A. Yes, I have an opinion.

16           **Q. What is your opinion?**

17           A. The Project will not cause stray voltage that will affect farming operations, vehicle  
18 usage, or location of metal buildings. Although large metallic objects (such as large vehicles or  
19 metal buildings) can experience electrostatic induced voltages due to electric fields from power  
20 lines, the clearance of the Project is designed to meet NESC requirements for large farm  
21 combines and semi tractor-trailers. Vehicles up to these sizes should not have any issues with  
22 stray voltage. Metallic buildings that are very close to the transmission line may require  
23 grounding to eliminate electric field effects. There are no metallic buildings in the right-of-way.

1 If there are any metallic buildings outside the right-of-way that are close enough and large  
2 enough to create stray voltage issues, the Project will work with the landowner to address the  
3 issue during the construction process by using industry standard mitigation techniques.

#### 4 GLOBALY POSITIONING SYSTEM (GPS) ISSUES

5 **Q. Do you foresee any issues with the transmission line negatively affecting GPS for**  
6 **farming?**

7 A. As indicated in interrogatory answer no. 12 of Gerald Pesall's First Set of Discovery  
8 Requests to Applicants, which is Exhibit 4 attached to Henry Ford's direct testimony, isolated  
9 cases of interference are possible but unlikely. Electric field corona from high voltage power  
10 lines can produce radio frequency emissions, but these radio frequency emissions are generally at  
11 a lower frequency than the frequencies used for satellite GPS systems. Individual transmission  
12 structures near GPS based farm equipment may block or reflect GPS signals like a building  
13 would, but the presence of multiple GPS satellites usually prevents this from being a significant  
14 issue.

15 **Q. What is the effect of transmission line on ground based GPS?**

16 A. Isolated cases of corona based interference from transmission lines are possible, but  
17 unlikely. Interference effects tend to be very location specific and also depend on the location  
18 and type of antennas, weather conditions, presence of other radio frequency noise sources, etc.  
19 Ground based GPS can also be impacted by transmission structures, but the effects are similar to  
20 trees, buildings or other obstructions that can block line-of-site communications between GPS  
21 base stations and roving equipment. As with any other line-of-site obstruction this issue can be  
22 overcome by relocating the base station or using repeater stations.

1           **Q. Based on your experience, education, training, research, and work on the**  
2 **project, do you have an opinion regarding whether the construction, operating, or**  
3 **maintaining of the South Dakota facility, from an electrical engineering perspective, will**  
4 **cause any significant problems (*i.e.*, electrical fields, magnetic fields, stray voltage) for**  
5 **landowners, their families, and other inhabitants where the line is anticipated to be**  
6 **constructed?**

7           A. Yes, I have an opinion.

8           **Q. What is that opinion?**

9           A. From an electrical engineering perspective, the construction and operation of the  
10 transmission line will not create significant problems.

11           **Q. Does this complete your direct testimony?**

12           A. Yes.

13