Exhibit AA
Electric and Magnetic Fields

Umatilla-Morrow County Connect Project

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Application for Site Certificate

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ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

AC	Alternating current
BPA	Bonneville Power Administration
CAFEP	Corona and Field Effects program
dB	Decibels
EFSC	Energy Facility Siting Council
ELF	Extremely low frequency
EMF	Electromagnetic fields
EMR	Electromagnetic radiation
FCC	Federal Communications Commission
GHz	Gigahertz
GPS	Global positioning system
Hz	Hertz
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IECS	International Committee on Electromagnetic Safety
IEEE	Institute of Electrical and Electronics Engineers
kV	Kilovolt
M	Meter
MHz	Megahertz
NESC	National Electric Safety Code
NIEHS	The National Institute of Environmental Health Sciences
NRC	National Research Council
NRPB	National Radiological Protection Board of Great
OAR	Oregon Administrative Rule
POWER	POWER Engineers, Inc.
Project	Umatilla-Morrow County Connect Project
Project Order	First Amended Project Order, In the Matter of the Application for Site Certificate for the Umatilla-Morrow County Connect Project (April 04, 2024)
ROW	Right-of-way
UMCC	Umatilla-Morrow County Connect Project

1.0 INTRODUCTION

Exhibit AA provides an analysis of electric and magnetic fields (EMF) for the Umatilla-Morrow-County Connect Project (Project). This Exhibit shows the Project will be designed, constructed, and operated to ensure public health and safety with EMFs in mind.

2.0 ANALYSIS

2.1 Analysis Area

The Project Order states the analysis area for Exhibit AA is the Project site boundary (First Amended Project Oder (April 4, 2024). For purposes of analyzing the Project's EMFs—specifically the alternating current (AC) magnetic fields, electric fields, and induced currents—the analysis focused on the right-of-way (ROW) for the Proposed Route and Alternative Routes A/B/C/D. The ROW extends outward from the centerline sufficiently far enough to identify and analyze impacts to structures that may be located within 50 feet on each side of the centerline of the final transmission line alignment. As discussed herein, the analysis shows that the Project's AC magnetic fields, electric fields and induced currents will meet the relevant AC electric field standard within the ROW. Moreover, the effects of AC magnetic fields, electric fields and induced currents diminish with distance, meaning the Project will also meet the AC magnetic field and electric field standard beyond the ROW, including throughout the entire Project site boundary, which may exceed the ROW.

2.2 Background

2.2.1 EMF Description

EMFs occur both naturally and because of the generation, transmission, and use of electric power. The earth itself generates steady-state magnetic and electric fields. Electromagnetic fields are present around any conductors or devices that transmit or use electrical energy; as a result, exposure to EMF is common from an array of electrical appliances and equipment, building wiring, and electric distribution and transmission lines. The electrical power system in the United States is an AC system operating at a frequency of 60 hertz (Hz),[1] resulting in "power frequency" or "extremely low frequency (ELF)" EMF.[2] While electric and magnetic fields are often referred to and thought of collectively, each arises through a different mechanism and can have differing effects.

Electric fields around transmission lines are produced by the presence of an electric charge, measured as voltage, on the energized conductor. Electric field strength is directly proportional to the line's voltage; that is, increased voltage produces a stronger electric field.

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[1] Hertz is a measure of cycles per second. In a 60 Hz transmission system, the charge and direction of current flow on each conductor will cycle from positive to negative and back to positive 60 times per second. The direction of force in the electric and magnetic fields will also cycle in direct relation to the charge and direction of flow on the conductor.

[2] The electric transmission system in the U.S. operates at 60 Hz, while in Europe and other parts of the world, the systems operate at 50 Hz; both produce fields that are referred to as power frequency or ELF EMF.

The strength of the electric field is inversely proportional to the distance from the conductors; the electric field strength declines as the distance from the conductor increases. The strength of the electric field is measured in units of kilovolts (kV) per meter (m) or kV/m. Electric fields are readily weakened or blocked by conductive objects such as trees or buildings. The direction of force within the electric field alternates at a frequency of 60 Hz, in direct relation to the charge on each conductor. However, the overall transmission line voltage, and therefore the overall strength and reach of the electric field, remains practically steady and is not affected by the common daily and seasonal fluctuations in usage of electricity by customers.

Magnetic fields around transmission lines are produced by the movement of electrical charge, measured in terms of amperage, through the conductors. Like the electric field, the magnetic field alternates at a frequency of 60 Hz. Magnetic field strength is expressed in units of milligauss (mG).[3] The magnetic field strength is directly proportional to the amperage; that is, increased current flow produces a stronger magnetic field. As with electric fields, the magnetic field is inversely proportional to the distance from the conductors, declining in strength as the distance from the conductor increases. Magnetic fields are not blocked or shielded by most materials. Unlike voltage, the amperage and the resulting magnetic field around a transmission line fluctuate daily and seasonally as the usage of electricity varies and the amount of current flow varies.

Each AC three-phase circuit carries power over one or more conductors per phase. The AC voltage and current in each phase conductor is out of sync with the other two phases by 120 degrees, or one-third of the 360 degree cycle. The fields from these conductors tend to cancel out because of this phase difference. However, when a person stands under a transmission line, one conductor is significantly closer and will contribute a net uncanceled field where a person is standing. This net uncanceled field significantly diminishes the farther away you are from the conductor and with lower voltages.

2.2.2 EMF Standards

No federal regulations or guidelines apply directly to the EMF levels for the Project's proposed lines in Oregon. The National Institute of Environmental Health Sciences (NIEHS) performed an extensive review of field-related issues in the 1990s that resulted in the decision that regulatory actions are unwarranted (NIEHS 1999).

Although there are no federal regulations on power-frequency EMF in the United States, international recommendations and guidelines exist. Table AA-1 lists power-frequency EMF guidelines recommended by the European Union (1999), the International Committee on Electromagnetic Safety (ICES), and the International Commission on Non-Ionizing Radiation Protection (ICNIRP), which is an affiliate of the World Health Organization (ICES 2002; ICNIRP 2010).

[3] Magnetic field strength may also be measured in terms of the Tesla, an International System unit of measurement. 1 Gauss = .0001 Tesla, or 1 Tesla = 10,000 Gauss; 1 Gauss = 1,000 mG.

TABLE AA-1. INTERNATIONAL GUIDELINES FOR ALTERNATING CURRENT POWER-FREQUENCY EMF LEVELS

AGENCY	EXPOSURE	ELECTRIC FIELD (KV/M)	MAGNETIC FIELD (MG)
European Union	General public	4.2	833
ICES[1]	Occupational General public General public within ROW	20 5 10	27,100 9,040 NA
ICNIRP	Occupational General public	8.3 4.2	10,000 2,000

[1] ICES recommendations have been adopted as standards by the Institute of Electrical and Electronics Engineers (IEEE); see Standard C95.6 -2002 (R2007).
Magnetic fields are measured in gauss (G) and milligauss. 1 G = 1,000 mG
NA = Not Applicable (no requirements)

Transmission line projects in Oregon must comply with the electric field standard found in Oregon Administrative Rule (OAR) 345-024-0090, which requires that the applicant design, construct, and operate the proposed transmission line so that AC electric fields do not exceed 9.0 kV/m at 1.0 meter above the ground surface in areas accessible to the public. There is no similar Oregon design standard for magnetic fields.

Six other states have adopted limits for electric field strength either at the edge or within the ROW of the transmission line corridor. Only Florida and New York currently limit magnetic fields levels from transmission lines. The magnetic field levels set in those two states only apply at the edge of the ROW and were developed to prevent magnetic fields from increasing beyond levels currently experienced by the public. Table AA-2 shows the AC electric field and magnetic field standards that have been adopted by states in the United States.

TABLE AA-2. OTHER STATE ALTERNATING CURRENT POWER-FREQUENCY EMF STANDARDS

STATE	LOCATION	ELECTRIC FIELD (KV/M)	MAGNETIC FIELD (MG)
Florida • 230 to 500 kV lines	Within ROW Edge of ROW	10 2	N/A 200 (1)
• 230 kV or less	Within ROW Edge of ROW	8 2	N/A 150
Minnesota	Within ROW	8	N/A
Montana	Within ROW–road crossing Edge of ROW	7 1 (2)	N/A N/A
New Jersey	Within ROW Edge of ROW	N/A 3	N/A N/A
New York	Within ROW–open Within ROW–public road Within ROW–private road Edge of ROW	11.8 7 11 1.6	N/A N/A N/A 200
North Dakota	Within ROW Edge of ROW	9 N/A	N/A N/A

STATE	LOCATION	ELECTRIC FIELD (KV/M)	MAGNETIC FIELD (MG)
Oregon	Within ROW Edge of ROW	9 NA	N/A N/A

[1] Magnetic field strength is limited to 250 mG for new double-circuit 500 kV lines constructed on a previously existing ROW.

[2] Can be waived by landowner.

N/A = Not Applicable (no requirements)

In the fall of 2009, the Energy Facility Siting Council (EFSC or Council) commissioned a review of existing information to prepare for the review of several transmission lines under discussion at that time. That review was conducted by Dr. Kara Warner and presented to the Council on November 20, 2009, during a regular Council meeting. The prevailing conclusions were that there is a need to continue to monitor the science on EMF; that low-cost, prudent avoidance measures of public EMF exposure are appropriate; and that health-based limits are not appropriate given the scientific data available (EFSC 2009).

2.3 Distance Between Transmission Line Center Lines and ROW Edge

> OAR 345-021-0010(1)(aa)(A)(i): The distance in feet from the proposed center line of each proposed transmission line to the edge of the right-of-way.

The transmission line will be located approximately in the middle of the ROW. Unless otherwise specified, the ROW width will be 60 feet, but in a few areas for very short distances may extend to 150 feet.

2.4 Potential Impacts

> OAR 345-021-0010(1)(aa)(A): (ii) The type of each occupied structure, including but not limited to residences, commercial establishments, industrial facilities, schools, daycare centers and hospitals, within 200 feet on each side of the proposed center line of each proposed transmission line. (iii) The approximate distance in feet from the proposed center line to each structure identified in (A). (iv) At representative locations along each proposed transmission line, a graph of the predicted electric and magnetic fields levels from the proposed center line to 200 feet on each side of the proposed center line. (vi) The assumptions and methods used in the electric and magnetic field analysis, including the current in amperes on each proposed transmission line.
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> OAR 345-024-0090: which requires that the applicant design, construct, and operate the proposed transmission line so that AC electric fields do not exceed 9.0 kV/m at 1.0 meter above the ground surface in areas accessible to the public.

2.4.1 Methods for Identifying Occupied Structures Within 200 Feet

Geographic information system and aerial photographs were used to identify and classify potential structures near the transmission line that could be affected by the Project. A study via computer was conducted to determine occupied dwellings. Based on review of aerial photography from Google Earth Pro (5/30/2023), occupied structures within 200 feet of the transmission line or Alternative Routes A/B/C/D were identified. Occupied structures included in this analysis are defined by OAR 345-021-0010 as including but not limited to residences, commercial establishments, industrial facilities, schools, daycare centers, hospitals, and rest areas. Receptors that were not included as occupied structures consisted of silos, tanks, gravel pits, mines, quarries, and water features.

2.5 Predicted Electric and Magnetic Field Levels

2.5.1 EMF Modeling Methods

The electric field, magnetic field, and audible noise that may be produced by the proposed transmission line was predicted using the Corona and Field Effects Program (CAFEP), a Windows-based model developed by the Bonneville Power Administration (BPA). The CAFEP program uses the algorithms developed by BPA (BPA n.d.). The inputs to the CAFEP model are line voltage, load flow (current), and the physical dimensions of the line (number of phases, conductor diameter, spacing, height, and sub conductor configuration).

2.5.2 Modeling Assumptions

The EMF values were calculated at a reference height of 1.0 meter above ground. For modeling purposes, the voltage of the 230 kV circuits was 241.5 kV, 5% above the nominal 230 kV value.

One transmission line design was modeled corresponding to the designs that are expected to be used in Oregon. Exhibit B provides illustrations of the Proposed Route and Alternative Routes A/B/C/D structures. The line geometry below was modeled for the Proposed Route and its Alternative Routes A/B/C/D:

- 230 kV transmission line on a double-circuit, tangent monopole structure.

For the proposed 230 kV line:

- Each phase of the 230 kV three-phase circuit will be composed of two conductors. The proposed conductors for the 230 kV line are 1272 kcmil 54/19 ACSS-HS285 "Pheasant."
- A minimum ground clearance of 41.65 feet was used.
- A maximum voltage of 241.5 kV and a line current of 5,194 A for winter emergency was used.

The Project's conductor distance above ground is based on the lowest midspan height at maximum loading conditions, or the lowest point of the catenary. For most of the transmission line alignment, the conductors will be higher than this minimum allowable clearance and resulting EMF levels on the ground will be lower than indicated. Two other structure types are listed in the design as a possibility for the Proposed. Only the monopole structure was modeled due to the nature of the Proposed, line voltage and spacing, the other structures proposed would have similar results to the monopole.

The level of EMF was predicted with the CAFEP program. The strength and range of EMF near transmission lines is a function of the line design, the voltage, and amperage (also referred to as current or load). The shape or distribution of EMF around transmission lines are a function of the conductor geometry as well as the size of the conductor and its configuration, including if the conductors for each phase are single wires or composed of multiple sub conductors or bundles. The electric field strength is proportional to the voltage while the magnetic field strength is proportional to current (amperage). Unlike voltage which is typically stable, the amperage and the resulting magnetic field around a transmission line fluctuate with the amperage or load that the line is carrying. As electrical loads vary, the magnetic field will also vary, and this assessment was based on the design load of 5,194 A for winter emergency.

Weather and humidity do not influence EMF levels. Weather does affect the level of corona activity which influences the resulting audible noise and level of radio-frequency interference. Corona activity is greater during wet weather and at high altitude. Corona and noise modeling is discussed in Appendix A. The contours of the earth or ground elevation may influence the minimum ground clearance, and EMF decreases with increasing distance. The assessment in this Exhibit was based on a minimum ground clearance of 41.65 feet. EMF levels may be influenced by other sources of EMF, such as at the crossing of other transmission lines; however, the nature of those interactions is to be determined through a site-specific study conducted during detailed engineering and design.

2.5.3 Interaction with Existing Transmission Lines

In areas where the transmission lines parallel each other within a common corridor, fields at the edges of the ROW nearest the adjacent line may increase or decrease depending on load and phasing. The separation between the proposed 230 kV line and parallel lines will be greater than 200 feet where the lines do not cross and outside of the substation interconnection area. As seen in Figure AA-1, existing parallel lines near the proposed 230 kV corridors will not result in exceedances of the 9 kV/m electric field standard. Table AA-3 shows the existing parallel line for the Common Corridor.

TABLE AA-3. CONSTRUCTION EQUIPMENT NOISE LEVELS VERSUS DISTANCE

COUNTY	PARALLELED TRANSMISSION LINE	PARALLEL LOCATION	PARALLEL DISTANCE	SEPARATION DISTANCE	EFFECT ON ELECTRIC AND MAGNETIC FIELD
Morrow	UEC BPAB281 – 115 kV. Coyote Springs to Freeway.	South of Highway 730 Ordnance Switchyard	0.64 miles	483 feet	Little effect on highest fields within ROW May increase or decrease fields at edges of ROW nearest adjacent line <20% depending on load and phasing;

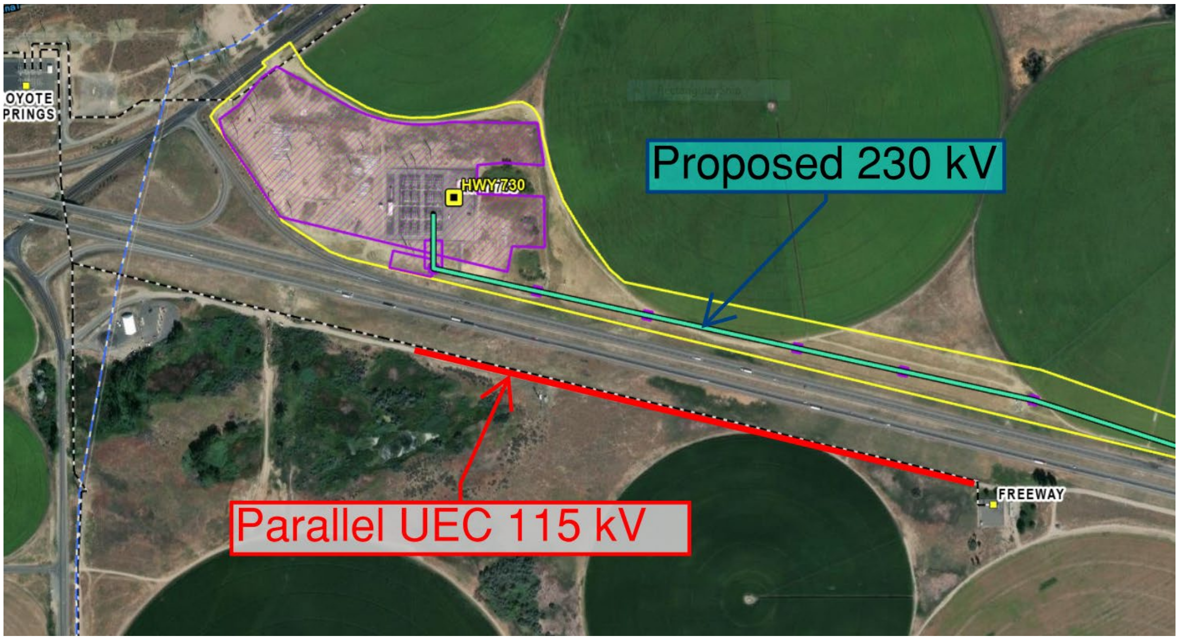


FIGURE AA-1 EXISTING ADJACENT LINES FOR THE PROPOSED ROUTE

2.6 Graphs of Predicted Electric and Magnetic Field Levels

Using the transmission line design parameters described above, the CAFEP model predicts electric and magnetic field strength at one meter above ground level, extending to either side of the centerline. As noted earlier, the predicted EMF levels are for the midspan point, or the lowest point in the catenary; field strengths would be lower than these predicted values where the conductors are higher. The predicted EMF levels out to distances of 150 feet on either side of each proposed transmission line structure type are shown as follows:

- Figures AA-2 and AA-3 show electric and magnetic field profiles for double-circuit 230 kV braced post monopole tangent structure with vertical conductor configuration.

To demonstrate compliance with Oregon's electric field limit of 9.0 kV/m and demonstrate consistency with other states' standards and international guidelines, Table AA-4 and Table AA-5 provide the maximum electrical and magnetic field strength within the ROW and EMF levels at the edge of the ROW. Based on the design and modeling parameters described above, the Project will meet Oregon's electric field standard, and EMF levels within and at the edge of the ROW will be lower than standards and guidelines from other states and international organizations (EU 1999) (NIEHS 1999).

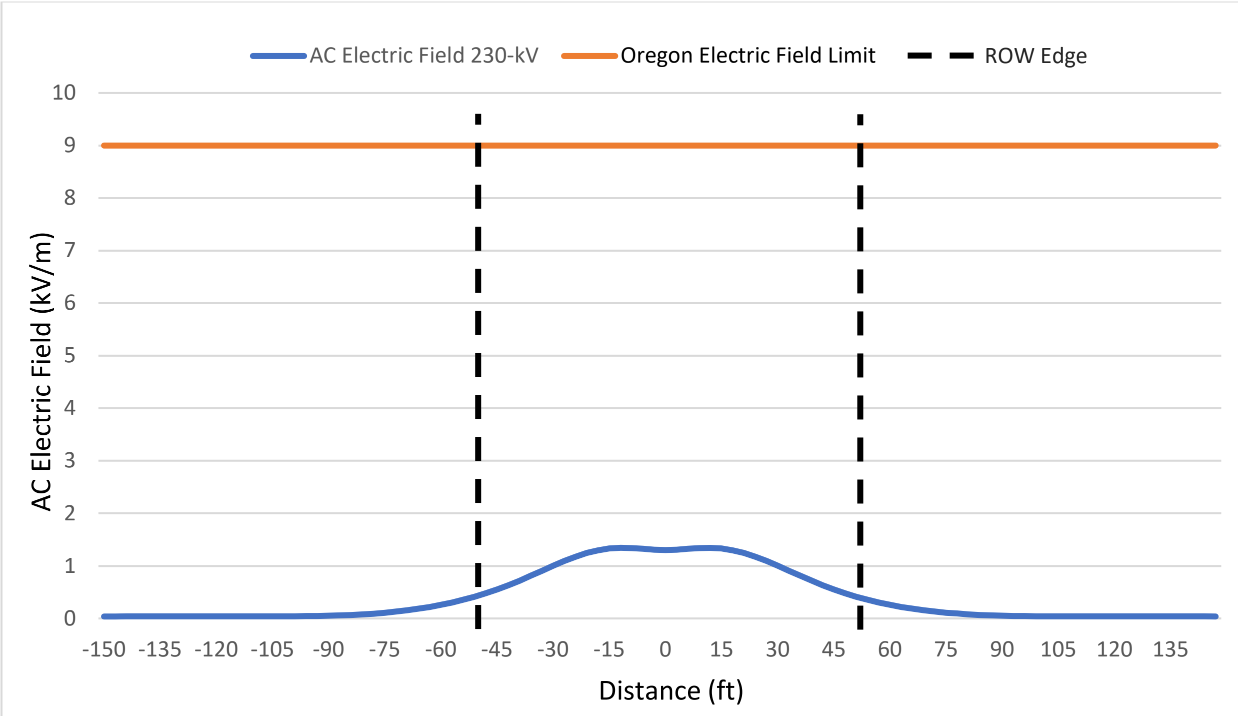


FIGURE AA-2 ELECTRIC FIELD PROFILE FOR DOUBLE-CIRCUIT 230 KV TANGENT MONOPOLE STRUCTURE

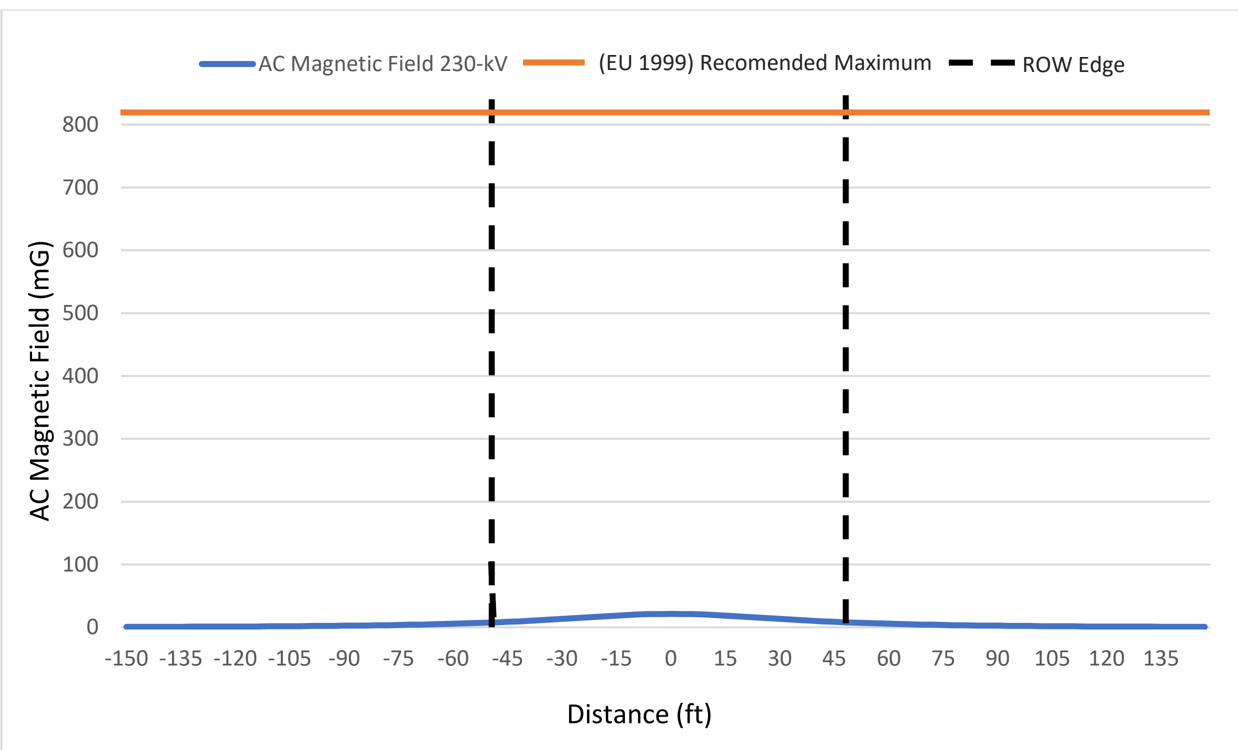


FIGURE AA-3 MAGNETIC FIELD PROFILE FOR DOUBLE-CIRCUIT 230 KV TANGENT MONOPOLE STRUCTURE

TABLE AA-4. ELECTRIC FIELD STRENGTH FOR EACH CONSIDERED STRUCTURAL CONFIGURATION

STRUCTURE TYPE	ROW WIDTH (FEET)	SOUTH/WEST ROW EDGE (KV/M)	MAXIMUM WITHIN ROW (KV/M)	NORTH/EAST ROW EDGE (KV/M)
Tangent Monopole	60	0.4	1.34	0.47

Electric field strength calculated at standard height of one meter above ground surface.
kV = kilovolt; kV/m = kilovolt per meter; ROW = right-of-way.

TABLE AA-5. MAGNETIC FIELD STRENGTH FOR EACH CONSIDERED STRUCTURAL CONFIGURATION

STRUCTURE TYPE	ROW WIDTH (FEET)	SOUTH/WEST ROW EDGE (MG)	MAXIMUM WITHIN ROW(MG)	NORTH/EAST ROW EDGE (MG)
Tangent Monopole	60	7.5	21.4	7.4

Magnetic field strength calculated at standard height of one meter above ground surface.

OAR 345-021-0010(1)(aa)(A)(v): Any measures the applicant proposes to reduce electric or magnetic field levels.

2.7 Measures to Reduce Electric and Magnetic Field Levels

The modeling results (Attachment AA-1) are based on certain minimum ground clearances. To ensure compliance with the AC electric field provisions of the Specific Standards for Transmission Lines, POWER Engineers, Inc. Based on the modeling and analysis results, mitigation measures to reduce the effects of electric and magnetic fields are not required due to the voltage on the line (230 kV produces lower electric fields than the standard), structure geometry, and phasing of the line which are designed and optimized to reduce the impacts of electric and magnetic fields below industry standards and guidelines.

2.8 Monitoring

OAR 345-021-0010(1)(aa)(A)(vii): The applicant's proposed monitoring program, if any, for actual electric and magnetic field levels.

Post-construction monitoring is not necessary because modeling shows electric fields levels will be below Oregon’s 9.0 kV/m standard. Moreover, EMF levels (both electric and magnetic fields) have been conservatively calculated assuming worst-case conditions of line overvoltage and minimum ground clearance, and therefore, EMF levels likely will be lower than those presented here.

2.9 Radio Interference

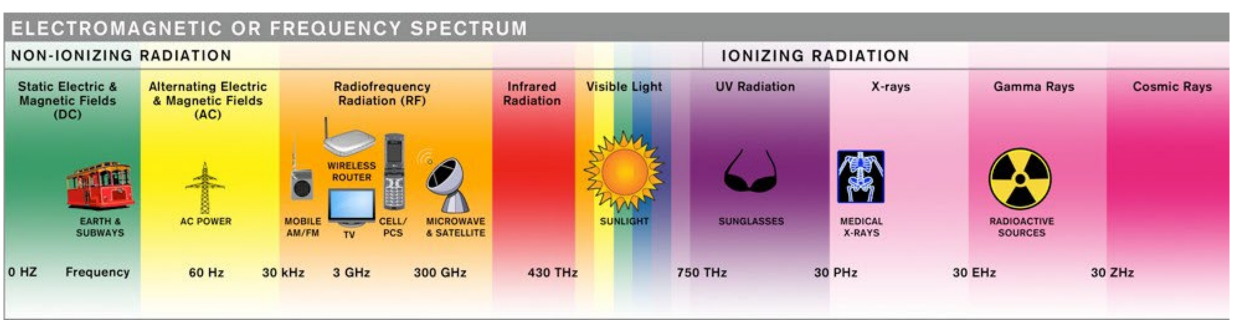
> OAR 345-021-0010(1)(aa)(B): An evaluation of alternate methods and costs of reducing radio interference likely to be caused by the transmission line in the primary reception area near interstate, U.S., and state highways.

2.9.1 Background

Electromagnetic Interference

Electromagnetic interference from power transmission systems in the United States is governed by the Federal Communications Commission (FCC) Rules and Regulations (FCC 1988). A power transmission line is categorized by the FCC as an "incidental radiation device." It is defined as "a device that radiates radio frequency energy during the course of its operation although the device is not intentionally designed to generate radio frequency energy." Such a device "shall be operated so that the radio frequency energy that is emitted does not cause harmful interference. If harmful interference is caused, the operator of the device shall promptly take steps to eliminate the harmful interference." In this case, "harmful interference" is defined as "any emission, radiation or induction which endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radio communication service operating in accordance with this chapter" (FCC 1988). Oregon does not have regulatory standards for either radio or TV interference.

Modern communications systems all rely on electromagnetic radiation (EMR) to transmit information. AM and FM radio, TV, shortwave radio, cellular telephones, radar, Global Positioning System (GPS) devices and satellite communications, cordless telephones, Bluetooth, and wireless computer networks such as Wi-Fi or wireless local area network all utilize a region of the electromagnetic spectrum known as "radio frequency" EMR, which extends from the very low-frequency end at about 30 kilohertz (kHz) up into the high-frequency microwave range at about 300 gigahertz (GHz). Each type of technology uses a specific segment of the electromagnetic frequency spectrum; older technology such as AM radio is at the low-frequency end, while newer technologies such as GPS and Wi-Fi utilize high-frequency signals. Figure AA-4 provides a visual representation of typical communications frequencies.



Source: EMF & Radio Frequency Solutions. Available at: http://www.emfrf.com/index.php/emf-rf/emf-overview/electromagnetic- spectrum-or-frequency-spectrum.html.

FIGURE AA-4 COMMUNICATIONS FREQUENCY SPECTRUM

The level of interference can be partially determined by how similar or different the signal frequency is compared to the noise frequency. In general, there is very little interaction between signals of differing frequency; radio signals, TV signals, cellular phone signals, and GPS signals can all coexist in the same space and time without interfering with each other. For interference to occur, frequencies must be similar.

Sources of Electromagnetic Interference

EMR and resulting interference can be an indirect product of electric transmission lines. EMR arises not from the lines themselves, but from the interaction of the strong electric field at the surface of the conductors and other energized components with the surrounding air. Two types of interactions may occur that create electromagnetic interference: corona discharge and gap discharge.

Corona Discharge

High-voltage power transmission lines generate a strong electric field at the surface of the conductor, which can be strong enough to split the surrounding air molecules, resulting in the emission of electromagnetic energy in the form of ultraviolet and near-ultraviolet light and broad-band radio frequency EMR (corona discharge also produces audible sound, which is addressed in Appendix A; audible sound is not discussed further in this Exhibit). The former can sometimes be seen by humans under the right conditions or with specialized equipment, while the latter can sometimes be heard as electronic “noise,” or interference with radio signal reception.

Broadband corona EMR discharge typically occurs in the frequency spectrum from below 100 kHz to approximately 1,000 megahertz (MHz), which overlaps with the frequencies used for AM and FM radio and some TV signals. With sufficient corona activity, low-frequency radio and TV interference can be noticeable within a few hundred feet of the transmission line. These effects are most pronounced directly underneath the line conductors and decrease with distance from the transmission line.

Corona on a transmission line conductor depends on several factors such as operating voltage, conductor diameter, overall line geometry, weather conditions, and altitude. Conductor size, line voltage and line geometry are taken into consideration when designing a transmission line so that the electric fields at the conductor surface are minimized. However, for a high-voltage line, any incidental irregularities on the conductor surface (for example, water droplets, dust, debris, and nicks or scratches in the conductor) act as points where the electric field may be intensified sufficiently to produce corona. Thus, the level of corona activity is elevated during foul weather when raindrops on the conductor surface act as points producing corona.

Gap Discharge

A gap discharge occurs when current arcs across a gap between two conductive objects. Gap discharges can produce radio noise in the lower frequencies (AM radio frequencies) and well into the microwave range (analog TV frequencies). These discharges can be produced by loose connections, a problem that more commonly occurs on low-voltage distribution lines but rarely occurs on high-voltage transmission lines (Trinh 2012). Unlike corona discharge, which may occur anywhere along a high-voltage transmission line conductor, gap discharge occurs at mechanical connectors and components that are used to hold the conductors in place. Gap discharge is controlled through proper construction and maintenance practices to ensure all mechanical connectors and components are properly assembled. Because gap discharge is an intermittent, temporary, and readily resolved problem, and results only in localized electrical interference issues, the potential for interference with TV signals or higher-frequency communications is not considered a significant problem.

Radio Interference Effects

The corona induced broadband EMR from transmission lines can produce interference to AM signals, such as a commercial AM radio audio signal (i.e., radio noise) or the video portion of an older analog broadcast TV station (i.e., TV noise). Technologies that use frequency modulation, such as FM radio stations and the audio portion of older analog broadcast TV signals, are generally not affected by noise from a transmission line. As digital signal processing has been integrated into these communication systems, the potential interference impact of corona-generated radio noise has decreased.

The level of interference caused by radio noise from a transmission line to the reception of a radio signal depends on the location of the radio transmitter, the radio receiver, and the transmission line. A transmission line that is directly between a radio transmitter and a listener's receiver may be more likely to interfere with that listener's reception, whereas a transmission line behind or beside the listener in relation to the transmitter will not necessarily cause interference, depending on the radio receiver's antennae. The radio noise generated by a transmission line is very low in power and decreases rapidly as distance from the line increases. It is experienced only when near the transmission line.

In general, complaints related to corona-generated interference are infrequent. Moreover, the advent of cable and satellite TV service, and the federally mandated conversion to digital TV broadcast in June 2009 have greatly reduced the occurrence of corona-generated interference. Low-frequency corona-induced EMR does not interact with the higher-frequency satellite signals or with wired communication systems, while digital TV receivers are equipped with systems to filter out interference. Many radio stations also broadcast in digital, reducing the likelihood of corona induced EMR interference. Electric power companies can operate very effectively under the present FCC rule because harmful interference can generally be eliminated or effectively mitigated.

Radio noise is measured in units of decibels (dB) based on its field strength referenced to a signal level of 1 microvolt per meter (Institute of Electrical and Electronics Engineers [IEEE] 1986). Corona-induced radio noise during fair weather is calculated to be approximately 40 dB (dB-1 microvolt per meter [1 µV/m]) at the edge of the ROW. This is considered an acceptable level (IEEE 1971). When the transmission line is in proximity to roadways (for example, interstate, U.S., and state highways), such as when it passes over these roadways, radio interference may be experienced for short distances while in proximity to the line. Interference may be more noticeable near the line particularly during foul weather, when corona activity is elevated.

Interference with Other Electronic Communications

Wireless computer network systems, cell phones, GPS units, and satellite receivers operate at high frequencies in the tens to hundreds of MHz or even GHz. These systems also often use FM or digital coding of the signals, so they are relatively immune to electromagnetic interference from transmission line corona. GPS units are used in a wide range of activities, including several important agricultural activities such as monitoring pivot irrigation, tracking wheeled and tracked equipment movements during farming operation, and checking the orientation of aerial spraying aircraft. GPS units operate in the frequency range of 1.2 to 1.6 GHz. Satellite receivers operate at frequencies of 3.4 GHz to 7.0 GHz and have shown no effect from transmission lines unless the receiver was trying to view the satellite through the transmission tower or conductor bundle of the transmission line (Chartier et al. 1986). Repositioning the receiver by a few feet was sufficient to eliminate the obstruction and reduced signal. Mobile phones operate in the radiofrequency range of about 800 MHz to 1,900 MHz or higher. As a result of the high frequencies used by these devices, modulation and processing techniques, and the typically lower-frequency corona-induced EMR, effects from interference are unlikely.

The voltages and currents associated with the transmission line have the potential to induce voltage and current in nearby conductors (e.g., ungrounded metal fences and ungrounded metal irrigation systems). This effect is more likely where ungrounded fences or irrigation systems are parallel and long (one mile or more). These induced voltages could result in a “nuisance” shock to anyone who touches such a fence or irrigation system. These shocks are known as nuisance or “startle” shocks as they will not physically harm someone but may be noticed by some people and provoke a startle reaction. An example of an ungrounded metal irrigation system would be a center pivot system on rubber tires. By contrast, the Vermeer-type metal irrigation system is grounded through its metal wheels and therefore presents less of a shock hazard.

A GPS unit in farming equipment should work properly within the vicinity of a transmission line. GPS devices continually pull signals from a number of satellites, not just one and may also utilize a fixed base station. A signal may be blocked temporarily if the transmission structure is between the receiver and a weak signal, but it will return as the farm equipment moves past the structure. It is also common for GPS receivers to drop and pick up signals even in the absence of transmission lines and structures. If the base station signal is weak or blocked, additional or alternate locations may improve the signal and performance.

Signal interference occurs when other signals at the same frequency as the satellite signal are present. Multipath occurs when objects such as buildings, structures, or tractor parts reflect a GPS satellite signal, causing the satellite signal to arrive at the receiver later than it would have if it followed a straight line from the satellite. A study commissioned by EPRI found that signal interference is “unlikely” based on the design of GPS receivers and their ability to separate the GPS signal from background noise (Silva and Olsen 2002). Another study compared the accuracy of real-time kinematic GPS receivers at different locations to transmission lines and towers (Gibbings et al. 2001). This study concluded that multipath from transmission towers could result in GPS-initialization errors (e.g., the system reports the wrong starting location) 1.1% to 2.3% of the time. This study also reported that GPS software was able to identify and correct these initialization errors within the normal startup time. This study reported initialization errors caused by electromagnetic interference from energized overhead transmission lines when the GPS receiver was located outside the vehicle, but concluded that “most, if not all of this effect can be eliminated by shielding the receiver and cables.” Placing the receiver inside the vehicle significantly reduced initialization errors.

POWER does not specifically track interference with GPS tractor navigation systems; however, these systems are widely used in other locations in POWER’s service area and several existing transmission lines up to 500 kV cross the area. Over the last 10 years, POWER has not been contacted about interference with tractor GPS navigation systems. Users of these systems have expressed concerns about the possibility of interference, but no specific examples have been reported.

2.9.2 Evaluation of Alternate Methods and Costs to Reduce Interference

Design options for reducing the radio noise from the transmission line include use of larger diameter conductors, or use of more conductors within the conductor bundles. Increasing the distance between phases of the lines (conductor bundles) may also result in a decrease in the radio noise. These line design options have been employed to minimize the generation of radio noise to acceptable levels.

3.0 CONCLUSION

Exhibit AA demonstrates the Project will comply with relative standards related to EMFs. Also, this Exhibit, together with the data provided in Exhibit DD, demonstrates that the Project’s AC electric fields and induced currents will comply with the Specific Standards for Transmission Lines under OAR 345-024-0090.

4.0 COMPLIANCE CROSS REFERENCES

Table AA-4 identifies the location within the application for site certificate of the information responsive to the application submittal requirements OAR 345-021-0010(1)(aa), the Specific Standards for Transmission Lines at OAR 345-024-0090, and the relevant Amended Project Order provisions.

TABLE AA-6. COMPLIANCE REGULATIONS AND RELEVANT CROSS-REFERENCES

REQUIREMENT	LOCATION
OAR 345-021-0010(1)(aa)	
Exhibit AA. If the proposed energy facility is a transmission line or has, as a related or supporting facility, a transmission line of any size:	
(A) Information about the expected electric and magnetic fields, including:	
(i) The distance in feet from the proposed center line of each proposed transmission line to the edge of the right-of-way;	Exhibit AA, Section 2.3
(ii) The type of each occupied structure, including but not limited to residences, commercial establishments, industrial facilities, schools, daycare centers and hospitals, within 200 feet on each side of the proposed center line of each proposed transmission line;	Exhibit AA, Section 2.4
(iii) The approximate distance in feet from the proposed center line to each structure identified in (A);	Exhibit AA, Section 2.4
(iv) At representative locations along each proposed transmission line, a graph of the predicted electric and magnetic fields levels from the proposed center line to 200 feet on each side of the proposed center line;	Exhibit AA, Section 2.6, Exhibit Y Figure AA-1 through Figure AA-8
(v) Any measures the applicant proposes to reduce electric or magnetic field levels;	Exhibit AA, Section 2.7
(vi) The assumptions and methods used in the electric and magnetic field analysis, including the current in amperes on each proposed transmission line; and	Exhibit AA, Section 2.5
(vii) The applicant's proposed monitoring program, if any, for actual electric and magnetic field levels; and	Exhibit AA, Section 2.8
(B) An evaluation of alternate methods and costs of reducing radio interference likely to be caused by the transmission line in the primary reception area near interstate, U.S. and state highways;	Exhibit AA, Section 2.9
OAR 345-024-0090	
To issue a site certificate for a facility that includes any transmission line under Council jurisdiction, the Council must find that the applicant:	
(1) Can design, construct and operate the proposed transmission line so that alternating current electric fields do not exceed 9 kV per meter at one meter above the ground surface in areas accessible to the public;	Exhibit AA, Section 2.5; Section 2.3
(2) Can design, construct and operate the proposed transmission line so that induced currents resulting from the transmission line and related or supporting facilities will be as low as reasonably achievable.	Exhibit AA, Section 2.5; Section 2.4
Amended Project Order, Section III(aa)	
The provisions of Exhibit AA apply.	Throughout Exhibit AA

5.0 REFERENCES

Algers, B., and K. Hennichs. 1985. The Effect of Exposure to 400 kV Transmission Lines on the Fertility of Cows: A Retrospective Cohort Study. Preventive Veterinary Medicine 3:351–361.

Algers, B., and J. Hultgren. 1987. Effects of Long-Term Exposure to a 400 kV, 50-Hz Transmission Line on Estrous and Fertility in Cows. Preventive Veterinary Medicine 5:21–36.

Angell, R.F., M.R. Schott, R.J. Raleigh, and T.D. Bracken. 1990. Effects of a High-Voltage Direct-Current Transmission Line on Beef Cattle Production. Bioelectromagnetics 11(4):273–282.

Barold, S.S., M.D. Falkoff, L.S. Ong, and R.A. Heinle. 1991. Interference in cardiac pacemakers: exogenous sources. In: Cardiac Pacing and Electrophysiology, 3rd Ed. El-Sherif, N; Samet, P (eds). Philadelphia, PA: WB Saunders Co, pp. 608-633.

Bonneville Power Administration (BPA). Undated. “Corona and Field Effects” Computer Program – Public Domain Software. Bonneville Power Administration, Vancouver, WA.

Burchard, J.F., D.H. Nguyen, and E. Block. 1998. Effects of Electric and Magnetic Fields on Nocturnal Melatonin Concentrations in Dairy Cows. Journal of Dairy Science 81(3):722-727.

Burchard, J.F. D.H. Nguyen, H.G. Monardes, and D. Petitclerc. 2004. Lack of Effect of 10 kV/m 60 Hz Electric Field Exposure on Pregnant Dairy Heifer Hormones. Bioelectromagnetics 25(4):308-312.

Canadian Centre for Occupational Health and Safety (CCOHS). 1988. Possible Health Hazards for Cardiac Pacemaker Wearer From Exposure to Electromagnetic Fields. CCOHS Number: P88-5E; DSS catalogue number: CC273-2/88-5E; Hamilton, Ontario.

Chartier, V., R. Sheridan, J. DiPlacido, and M. Loftness. 1986. Electromagnetic Interference Measurements at 900 MHz on 230 kV and 500 kV Transmission Lines. IEEE Transactions on Power Systems, PWRD-1: 140-149.

Council of the European Union (EU). 1999. Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields. Official Journal of the European Communities. 1999/199/59. Available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1999:199:0059:0070:EN:PDF

Oregon Energy Facility Siting Council (EFSC). 2009. EMF Report: A Review of the Current Scientific Literature on Health Effects of Electric and Magnetic Fields. Oregon Department of Energy, Salem, OR.

Electric Power Research Institute (EPRI). 2005. AC Transmission Line Reference Book: 200 kV and Above. Third ed. EPRI, Palo Alto, CA. 1011974.

_____. 1997. EMFWorkstation: ENVIRO. Version 3.52. Palo Alto, CA.

Exponent. 2015. Prepared for the BPA: Research on Extremely Low Frequency Electric and Magnetic Fields and Health. Menlo Park, CA.

Federal Communications Commission (FCC). 1988. Federal Communications Commission Rules and Regulations. 10-1-88 ed. Vol. II part 15, 47 CFR, Ch. 1.

Gibbings, P., B. Manuel, R. Penington, and K. McDougall. 2001. Assessing the Accuracy and Integrity of RTK GPS Beneath High-voltage Power Lines. In: 42nd Australian Surveyors Congress 2001: A Spatial Odyessy, 25-28 Sep 2001, Brisbane, Australia.

Goodwin Jr., J.G. 1975. Big Game Movement Near a 500 kV Transmission Line in Northern Idaho. Bonneville Power Administration, Engineering and Construction Division, Portland, OR. June 27.

Greenberg, B., V.P. Bindokas, M.J. Frazier, and J.R. Gauger. 1981. Response of honey bees, apis mellifera L., to high-voltage transmission lines. Environmental Entomology 10:600–610.

Griffin, J.C. 1986. Cardiac pacemakers: effects of power frequency electric and magnetic fields. Presented at the International Utility Symposium, Health Effects of Electric and Magnetic Fields: Research, Communications, Regulation. September 16-19; Toronto, Canada.

Health Council of the Netherlands (HCN). 2004. ELF Electromagnetic Fields Committee. Electromagnetic fields: Annual Update 2003. The Hague: Health Council of the Netherlands. Publication No. 2004/1.

_____.2001. ELF Electromagnetic Fields Committee. Electromagnetic fields: Annual Update 2001. No. 2001/14.

International Agency for Research on Cancer (IARC). 2002. IARC Monographs on the evaluation of carcinogenic risks to humans. Volume 80: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields. IARC Press. Lyon, France.

International Committee on Electromagnetic Safety (ICES). 2002. IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields 0 to 3 kHz C95. 6-2002. Piscataway, NJ: IEEE.

International Commission on Non-Ionizing Radiation Protection (ICNIRP). 2010. Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). Health Physics, 2010.

Institute of Electrical and Electronics Engineers (IEEE). 1986. IEEE Standard Procedures for Measurement of Radio Noise from Overhead Power Lines and Substations. ANSI/IEEE Std. 430-1986, New York, NY. (see also) IEEE Committee Report. March/April 1971. Radio Noise Design Guide for High Voltage Transmission Lines. IEEE Transactions on Power Apparatus and Systems, PAS-90 (No. 2, March/April):833-842.

_____. 1971. Radio Noise Design Guide for High Voltage Transmission Lines. IEEE Radio Noise Subcommittee Report-Working Group No. 3. Paper 70TP631-PWR.

Lee, J.M., K.S. Pierce, C.A. Spiering, R.D. Stearns, and G. Van Ginhoven. 1996. Electrical and biological effects of transmission lines: a review. Bonneville Power Administration, Portland, Oregon. December.

Lee, J.M., Stormshak, F., Thompson, J., Hess, D.L., and Foster, D.L. 1995. Melatonin and Puberty in Female Lambs Exposed to EMF: A Replicate Study. Bioelectromagnetics 16(2):119–123.

Lee, J.M., F. Stormshak, J. Thompson, P. Thinesen, L. Painter, B. Olenchek, D. Hess, and R. Forbes. 1993. Melatonin Secretion and Puberty in Female Lambs Exposed to Environmental Electric and Magnetic Fields. Biology of Reproduction 49(4):857–864.

Medtronic. 2006. Technical Memo Regarding Electromagnetic Compatibility (EMC) and Electromagnetic Interference (EMI). p. 2.

National Academy of Sciences. 1999. Research on POWER-FREQUENCY FIELDS, Completed Under the Energy Policy Act of 1992, Committee to Review the Research Activities Completed Under the Energy Policy Act of 1992, Commission on Life Sciences, National Research Council, National Academy Press, Washington, D.C.

National Electric Safety Code (NESC). 2023. National Electrical Safety Code. 2023 ed. Institute of Electrical and Electronics Engineers, Inc., New York, NY.

National Institute of Environmental Health Sciences (NIEHS). 1999. Health effects from exposure to power line frequency electric and magnetic fields. NIH; National Institute of Health; NIH No. 99-4493; Research Triangle Park, NC.

_____. 1998. Assessment of health effects from exposure to power-line frequency electric and magnetic fields: Working Group Report. NIH Publication No. 98-3981. Research Triangle Park, NC: National Institute of Environmental Health Sciences of the U.S. National Institutes of Health.

National Research Council (NRC). 1997. An evaluation of the U.S. Navy's Extremely Low Frequency Communications System Ecological Monitoring Program. National Academy Press, Washington, D.C.

National Radiological Protection Board of Great Britain (NRPB). 2004. Review of the Scientific Evidence for Limiting Exposure to Electromagnetic Fields (0-300 GHz) National Radiological Protection Board, Volume 15, No 3.

_____. 2001. Response statement of the NRPB: ELF electromagnetic fields and the risk of cancer. National Radiological Protection Board, Chilton, Dicot, Oxon, Volume 12, No.1, ISNB 0-859951-456-0.

Picton, H.D., J.E. Canfield, and G.P. Nelson. 1985. The impact of a 500 kV transmission line upon the North Boulder Winter Elk Range. U.S. Forest Service Contract 53-0398-30E-3.

Silva, M., and R. Olsen. 2002. Use of Global Positioning System (GPS) Receivers Under Power-Line Conductors. IEEE Transactions on Power Delivery 17: 938–944.

Stormshak, F., T.D. Bracken, M. Carey, V. Chartier, L. Dickson, R. Forbes, A. Hall, P. Havens, D. Hess, S. Krippaehne, J. Lee, B. Ogden, B. Olenchek, L. Painter, K. Rowe, R. Stearns, P. Thinesen, and J. Thompson. 1992. Joint HVAC Transmission EMF Environmental Study: Final Report on Experiment 1. Bonneville Power Administration, Contract # DE-B179-90BPO4293, Portland, Oregon. May.

Thompson, J.M., F. Stormshak, J.M. Lee, D. Hess, and L. Painter. 1995. Cortisol secretion and growth in ewe lambs chronically exposed to electric and magnetic fields of a 60-Hertz 500 kilovolt AC transmission line. Journal of Animal Science 73(11):3274–3280.

Trinh, G.N. 2012. Chapter 16, Corona and Noise. In: Electric Power Generation, Transmission, and Distribution. 3rd Edition edited by Leonard L. Grigsby. CRC Press, Taylor & Francis Group LLC, Boca Raton, FL. ISBN: 9781439856284.

ATTACHMENT AA-1 CAFEP EMF MODEL RESULTS

Ûßß
Û C O R O N A A N D F I E L D Û
Û E F F E C T S P R O G R A M Û
Û Source: Bonneville Power Administration Û
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DATE: 02-MAY-24 TIME: 15:02:04
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\+ 1 0 6 8 241.5 4.40 1.00 500.00

(ENGLISH UNITS OPTION)

LINE GRADIENTS COMPUTED BY PROGRAM

PHYSICAL SYSTEM CONSISTS OF 8 CONDUCTORS, OF WHICH 6 ARE ENERGIZED PHASES

COMB		5	6	32.8	0	1	75	3.28	4	3.28
S1L1A	A	-8	73.95	2	1.381	18	139.43	0	5.2	0
S1L1B	A	-8	57.8	2	1.381	18	139.43	240	5.2	0
S1L1C	A	-8	41.65	2	1.381	18	139.43	120	5.2	0
S1L2A	A	8	73.95	2	1.381	18	139.43	120	5.2	0
S1L2B	A	8	57.8	2	1.381	18	139.43	240	5.2	0
S1L2C	A	8	41.65	2	1.381	18	139.43	0	5.2	0

S1S1	A	-3	89.25	1	0.435	0	0	0	0	0
S1S2	A	3	89.25	1	0.726	0	0	0	0	0
100	-150	3								
0	0	0								

COMBINED OUTPUT OF AUDIBLE NOISE, RADIO NOISE, TVI', OZONE CONCENTRATION, GROUND GRADIENT AND MAGNETIC FIELD

Case 1: Electric and Magnetic Field

179233 - Umatilla-Morrow County Connect Project

241.5 KV

	Distance from center of tower	Maximum Height	SUBCON Gradient	NO. OF DIAM	SUBCON	SUBCON Spacing	Voltage L-N	Phase Angle	Current	Corona Losses
	(FEET)	(FEET)	(KV/CM)	(MM)		(IN)	(KV)	(DEGREES)	(kAmps)	(KW/MI)
S1L1A	-8	73.95	11.21	1.38	2	18	139.43	0	5.19	2.838
S1L1B	-8	57.8	10.46	1.38	2	18	139.43	240	5.19	1.802
S1L1C	-8	41.65	11.18	1.38	2	18	139.43	120	5.19	2.792
S1L2A	8	73.95	11.22	1.38	2	18	139.43	120	5.19	2.847
S1L2B	8	57.8	10.46	1.38	2	18	139.43	240	5.19	1.802
S1L2C	8	41.65	11.18	1.38	2	18	139.43	0	5.19	2.791
S1S1	-3	89.25	3.26	0.44	1	0	0	0	0	0
S1S2	3	89.25	2.13	0.73	1	0	0	0	0	0

0AN MICROPHONE HT.= 5.0 FT, RI ANT. HT.= 6.0 FT, TV ANT. HT.= 32.8 M,ALTITUDE= 500.0 FT

RI FREQ= 1.000 MHZ, TV FREQ= 75.000 MHZ, 'WIND VEL.(OZ) = 4.400 MPH, GROUND CONDUCTIVITY = 4.0 MMHOS/M

E-FIELD TRANSDUCER HT.= 3.3FT, B-FIELD TRANSDUCER HT.= 3.3FT

LATERAL DISTANCE FROM REFERENCE	Audible Noise		Radio interference		TVI	OZONE	Electric Field	Magnetic Field
	(RAIN)	(FAIR)	(RAIN)	(FAIR)				
	L50	L50	L50	L50	Total	IN/HR		
(FEET)	DBA	DBA	DBUV/M	DBUV/M	DBUV/M	PPB	KV/M	GAUSS
-150	28.7	3.7	33.7	16.7	-3.7	0	0.037	0.00741
-147	28.7	3.7	33.9	16.9	-3.5	0	0.037	0.00782
-144	28.8	3.8	34.2	17.2	-3.3	0	0.038	0.00825
-141	28.9	3.9	34.4	17.4	-3.1	0	0.039	0.00872
-138	29	4	34.7	17.7	-2.9	0	0.039	0.00922
-135	29.1	4.1	34.9	17.9	-2.7	0	0.04	0.00975
-132	29.2	4.2	35.1	18.1	-2.5	0	0.04	0.01033
-129	29.3	4.3	35.4	18.4	-2.3	0	0.04	0.01095
-126	29.4	4.4	35.7	18.7	-2.1	0	0.041	0.01162
-123	29.5	4.5	35.9	18.9	-1.9	0	0.041	0.01234
-120	29.6	4.6	36.2	19.2	-1.6	0	0.041	0.01312
-117	29.7	4.7	36.5	19.5	-1.4	0	0.041	0.01397
-114	29.8	4.8	36.7	19.7	-1.1	0	0.041	0.01489
-111	29.9	4.9	37	20	-0.9	0	0.041	0.01588
-108	30	5	37.3	20.3	-0.6	0	0.041	0.01696
-105	30.2	5.2	37.6	20.6	-0.4	0	0.041	0.01813
-102	30.3	5.3	37.9	20.9	-0.1	0	0.041	0.0194
-99	30.4	5.4	38.2	21.2	0.2	0	0.042	0.02079
-96	30.5	5.5	38.5	21.5	0.5	0	0.044	0.0223
-93	30.6	5.6	38.8	21.8	0.8	0	0.047	0.02396
-90	30.7	5.7	39.1	22.1	1.1	0	0.051	0.02576
-87	30.9	5.9	39.5	22.5	1.4	0	0.058	0.02774
-84	31	6	39.8	22.8	1.7	0	0.067	0.02991
-81	31.1	6.1	40.1	23.1	2.1	0	0.078	0.03229

LATERAL DISTANCE FROM REFERENCE	Audible Noise		Radio interference		TVI	OZONE	Electric Field	Magnetic Field
	(RAIN)	(FAIR)	(RAIN)	(FAIR)				
	L50	L50	L50	L50	Total	IN/HR		
(FEET)	DBA	DBA	DBUV/M	DBUV/M	DBUV/M	PPB	KV/M	GAUSS
-78	31.3	6.3	40.4	23.4	2.4	0	0.092	0.0349
-75	31.4	6.4	40.8	23.8	2.8	0	0.11	0.03777
-72	31.5	6.5	41.1	24.1	3.2	0	0.13	0.04092
-69	31.7	6.7	41.4	24.4	3.6	0	0.155	0.04439
-66	31.8	6.8	41.8	24.8	4	0	0.184	0.04821
-63	32	7	42.1	25.1	4.5	0	0.218	0.05241
-60	32.1	7.1	42.4	25.4	4.9	0	0.258	0.05704
-57	32.3	7.3	42.8	25.8	5.4	0	0.303	0.06213
-54	32.4	7.4	43.4	26.4	6	0	0.355	0.06773
-51	32.6	7.6	44.1	27.1	6.5	0	0.414	0.07387
-48	32.7	7.7	44.8	27.8	7.1	0	0.48	0.0806
-45	32.9	7.9	45.5	28.5	7.8	0	0.553	0.08795
-42	33	8	46.2	29.2	8.5	0	0.633	0.09595
-39	33.2	8.2	46.9	29.9	9.2	0	0.72	0.1046
-36	33.3	8.3	47.6	30.6	10	0	0.812	0.11389
-33	33.5	8.5	48.2	31.2	10.9	0	0.907	0.12378
-30	33.6	8.6	48.9	31.9	11.9	0	1.002	0.13419
-27	33.7	8.7	49.5	32.5	13	0	1.093	0.145
-24	33.9	8.9	50	33	14.1	0	1.175	0.15601
-21	34	9	50.5	33.5	15.5	0	1.245	0.16698
-18	34.1	9.1	51	34	16.9	0	1.297	0.17761
-15	34.2	9.2	51.3	34.3	18.3	0	1.33	0.18755
-12	34.3	9.3	51.5	34.5	19.6	0	1.342	0.1964
-9	34.4	9.4	51.6	34.6	20.4	0	1.338	0.20378

LATERAL DISTANCE FROM REFERENCE	Audible Noise		Radio interference		TVI	OZONE	Electric Field	Magnetic Field
	(RAIN)	(FAIR)	(RAIN)	(FAIR)				
	L50	L50	L50	L50	Total	IN/HR		
(FEET)	DBA	DBA	DBUV/M	DBUV/M	DBUV/M	PPB	KV/M	GAUSS
-6	34.4	9.4	51.6	34.6	20.2	0	1.325	0.20935
-3	34.4	9.4	51.4	34.4	19.2	0	1.311	0.21281
0	34.4	9.4	51.2	34.2	17.9	0	1.305	0.21398
3	34.4	9.4	51.4	34.4	19.2	0	1.311	0.21281
6	34.4	9.4	51.6	34.6	20.2	0	1.325	0.20935
9	34.4	9.4	51.6	34.6	20.4	0	1.338	0.20378
12	34.3	9.3	51.5	34.5	19.6	0.000008	1.343	0.1964
15	34.2	9.2	51.3	34.3	18.3	0.00005	1.33	0.18755
18	34.1	9.1	51	34	16.9	0.000184	1.298	0.17761
21	34	9	50.5	33.5	15.5	0.000467	1.246	0.16698
24	33.9	8.9	50	33	14.1	0.000932	1.176	0.15601
27	33.7	8.7	49.5	32.5	13	0.001582	1.093	0.145
30	33.6	8.6	48.9	31.9	11.9	0.00241	1.002	0.13419
33	33.5	8.5	48.2	31.2	10.9	0.003427	0.907	0.12378
36	33.3	8.3	47.6	30.6	10	0.004658	0.813	0.11389
39	33.2	8.2	46.9	29.9	9.2	0.006111	0.721	0.1046
42	33	8	46.2	29.2	8.5	0.00777	0.634	0.09595
45	32.9	7.9	45.5	28.5	7.8	0.009596	0.554	0.08795
48	32.7	7.7	44.8	27.8	7.1	0.011539	0.48	0.0806
51	32.6	7.6	44.1	27.1	6.5	0.013551	0.415	0.07387
54	32.4	7.4	43.4	26.4	6	0.01559	0.356	0.06773
57	32.3	7.3	42.8	25.8	5.4	0.017622	0.304	0.06213
60	32.1	7.1	42.4	25.4	4.9	0.01962	0.259	0.05704
63	32	7	42.1	25.1	4.5	0.021567	0.219	0.05241

LATERAL DISTANCE FROM REFERENCE	Audible Noise		Radio interference		TVI	OZONE	Electric Field	Magnetic Field
	(RAIN)	(FAIR)	(RAIN)	(FAIR)				
	L50	L50	L50	L50	Total	IN/HR		
(FEET)	DBA	DBA	DBUV/M	DBUV/M	DBUV/M	PPB	KV/M	GAUSS
66	31.8	6.8	41.8	24.8	4	0.02345	0.185	0.04821
69	31.7	6.7	41.5	24.5	3.6	0.025259	0.156	0.04439
72	31.5	6.5	41.1	24.1	3.2	0.026989	0.131	0.04092
75	31.4	6.4	40.8	23.8	2.8	0.028636	0.11	0.03777
78	31.3	6.3	40.5	23.5	2.4	0.030198	0.093	0.0349
81	31.1	6.1	40.1	23.1	2.1	0.031675	0.079	0.03229
84	31	6	39.8	22.8	1.7	0.033066	0.067	0.02991
87	30.9	5.9	39.5	22.5	1.4	0.034372	0.058	0.02774
90	30.7	5.7	39.2	22.2	1.1	0.035594	0.052	0.02576
93	30.6	5.6	38.8	21.8	0.8	0.036735	0.047	0.02396
96	30.5	5.5	38.5	21.5	0.5	0.037795	0.044	0.0223
99	30.4	5.4	38.2	21.2	0.2	0.038778	0.042	0.02079
102	30.3	5.3	37.9	20.9	-0.1	0.039686	0.041	0.0194
105	30.2	5.2	37.6	20.6	-0.4	0.040522	0.04	0.01813
108	30	5	37.3	20.3	-0.6	0.041289	0.04	0.01696
111	29.9	4.9	37	20	-0.9	0.04199	0.04	0.01588
114	29.8	4.8	36.8	19.8	-1.2	0.042628	0.04	0.01489
117	29.7	4.7	36.5	19.5	-1.4	0.043207	0.04	0.01397
120	29.6	4.6	36.2	19.2	-1.6	0.04373	0.04	0.01312
123	29.5	4.5	35.9	18.9	-1.9	0.044199	0.04	0.01234
126	29.4	4.4	35.7	18.7	-2.1	0.044617	0.04	0.01162
129	29.3	4.3	35.4	18.4	-2.3	0.044989	0.04	0.01095
132	29.2	4.2	35.2	18.2	-2.5	0.045316	0.039	0.01033
135	29.1	4.1	34.9	17.9	-2.7	0.045601	0.039	0.00975

LATERAL DISTANCE FROM REFERENCE	Audible Noise		Radio interference		TVI	OZONE	Electric Field	Magnetic Field
	(RAIN)	(FAIR)	(RAIN)	(FAIR)				
	L50	L50	L50	L50	Total	IN/HR		
(FEET)	DBA	DBA	DBUV/M	DBUV/M	DBUV/M	PPB	KV/M	GAUSS
138	29	4	34.7	17.7	-2.9	0.045848	0.039	0.00922
141	28.9	3.9	34.4	17.4	-3.1	0.046058	0.038	0.00872
144	28.8	3.8	34.2	17.2	-3.3	0.046233	0.038	0.00825
147	28.7	3.7	34	17	-3.5	0.046378	0.037	0.00782