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Appendix BB: Onshore Electric and Magnetic Field Assessment

Coastal Virginia Offshore Wind Commercial Project

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ACRONYMS AND ABBREVIATIONS

Dominion Energy	Virginia Electric and Power Company d/b/a Dominion Energy Virginia
EMF	electric and magnetic fields
ft	foot
Hz	Hertz
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICES	International Committee on Electromagnetic Safety
kV	kilovolt
kV/m	kilovolt per meter
m	meter
mG	milligauss
MVA	megavolt Amperes
MW	megawatt
POI	Point of Interconnection
Project	Coastal Virginia Offshore Wind Commercial Project
ROW	right-of-way
SMR	State Military Reservation

EXECUTIVE SUMMARY

Virginia Electric and Power Company, dba Dominion Virginia Power (Dominion Energy), prepared this electric and magnetic field assessment in support of the construction and operation of the Coastal Virginia Offshore Wind Commercial Project (the Project). This Appendix assesses potential impacts from the Onshore Export Cables and Interconnection Cables that transmit the electricity generated in the Lease Area to the Dominion Energy transmission grid at the Point of Interconnection (POI) at the Onshore Substation.

The onshore transmission system will consist of two segments: an underground Onshore Export Cable Route that transmits electricity from the Cable Landing Location to a Common Location just south of Harpers Road in Virginia Beach, Virginia, and an Overhead/Hybrid Interconnection Cable that transmits the electricity from Harpers Road to the Onshore Substation. The Offshore Export Cables will land via Trenchless Installation and transition to the Onshore Export Cables at a Cable Landing Location located at the Proposed Parking Lot west of the Firing Range at the State Military Reservation (SMR). From there the Onshore Export Cable Route proceeds westerly until reaching Oceana Boulevard, where it runs south to a location just north of Harpers Road (Harpers Switching Station). At Harpers Road, the underground Onshore Export Cables will be connected to Overhead Interconnection Cable Route Alternatives 1 through 5 at a switching station located just north of Harpers Road (Harpers Switching Station). Hybrid Interconnection Cable Route Alternative 6 will not utilize the Harpers Switching Station and will continue underground until reaching a Switching Station located just north of Princess Anne Road (Chicory Switching Station), where the cables will transition to overhead. The Overhead Interconnection Cable Routes are comprised of three overhead transmission line circuits that will proceed southwesterly to the Onshore Substation (the POI), where they will be connected to the Dominion Energy transmission grid.

Electric and magnetic fields will be produced by both the underground Onshore Export Cable and Overhead/Hybrid Interconnection Cable, as well as the Switching Station and Onshore Substation. The electric and magnetic fields produced by the Onshore Export and Interconnection Cables were analyzed. Magnetic fields produced within the Switching Station and the Onshore Substation were not analyzed.

The magnetic field levels for all segments at the edge of the rights-of-way for Onshore Export and Interconnection Cables will be less than international safety guidelines for exposure to the public, and thus be protective of human health.. Electric fields will also be produced by the overhead Interconnection Cables. These electric fields will meet international safety guidelines.

BB.1 INTRODUCTION

BB.1.1 Project Description Onshore Transmission System

Virginia Electric and Power Company, dba Dominion Virginia Power (Dominion Energy), prepared this electric and magnetic field (EMF) assessment in support of the construction and operation of the Coastal Virginia Offshore Wind Commercial Project (the Project). The Project will generate between 2,500 and 3,000 megawatts (MW) of electricity. The power will be transmitted from the Lease Area to the Cable Landing Location on nine, 230-kilovolt (kV) Offshore Export Cables each containing three electric phase conductors.

The Offshore Export Cables will be brought to shore at the Cable Landing Location at the Proposed Parking Lot west of the Firing Range at the State Military Reservation (SMR). The Offshore Export Cables will be connected to 27, 230kV underground Onshore Export Cables, or conductors (one conductor for each of the three phases in each of the nine circuits). From there the Onshore Export Cable Route proceeds westerly until reaching Oceana Boulevard, where it runs south to a Common Location just north of Harpers Road (Figure BB.1-1). At Harpers Road, the underground Onshore Export Cables will be connected to Overhead Interconnection Cable Route Alternatives 1 through 5 at a switching station located just north of Harpers Road (Harpers Switching Station). Hybrid Interconnection Cable Route Alternative 6 will not utilize the Harpers Switching Station and will continue underground until reaching a Switching Station located just north of Princess Anne Road (Chicory Switching Station), where the cables will transition to overhead. The Overhead Interconnection Cable Routes are comprised of three overhead transmission line circuits that will proceed southwesterly to the Onshore Substation (the POI), where they will be connected to the Dominion Energy transmission grid. For the purposes of this assessment, a full overhead route was assumed as a conservatively high estimate of EMF. The final Interconnection Cable Route has not been selected. Therefore, the various possible route alternatives of the Interconnection Cable Routes are shown in Figure BB.1-3.

BB.1.2 Underground Onshore Export Cable

At the Cable Landing Location, the Offshore Export Cables will be spliced to a series of underground Onshore Export Cables to transmit the power from the Lease Area to the Dominion Energy transmission system. The underground Onshore Export Cable Route to Harpers Road is shown Figure BB.1-1.

Generally, the underground Onshore Export Cable will consist of two duct banks laid parallel in a single 52-foot (ft; 16-meter [m]) wide right-of-way (ROW). One duct bank will contain four circuits and the other will contain five. The Onshore Export Cable Route Corridor was modeled with a total width of 400 ft (122 m) to evaluate the level of magnetic fields at some distance outside the ROW. The duct banks will be arranged as shown in Figure BB.1-2.

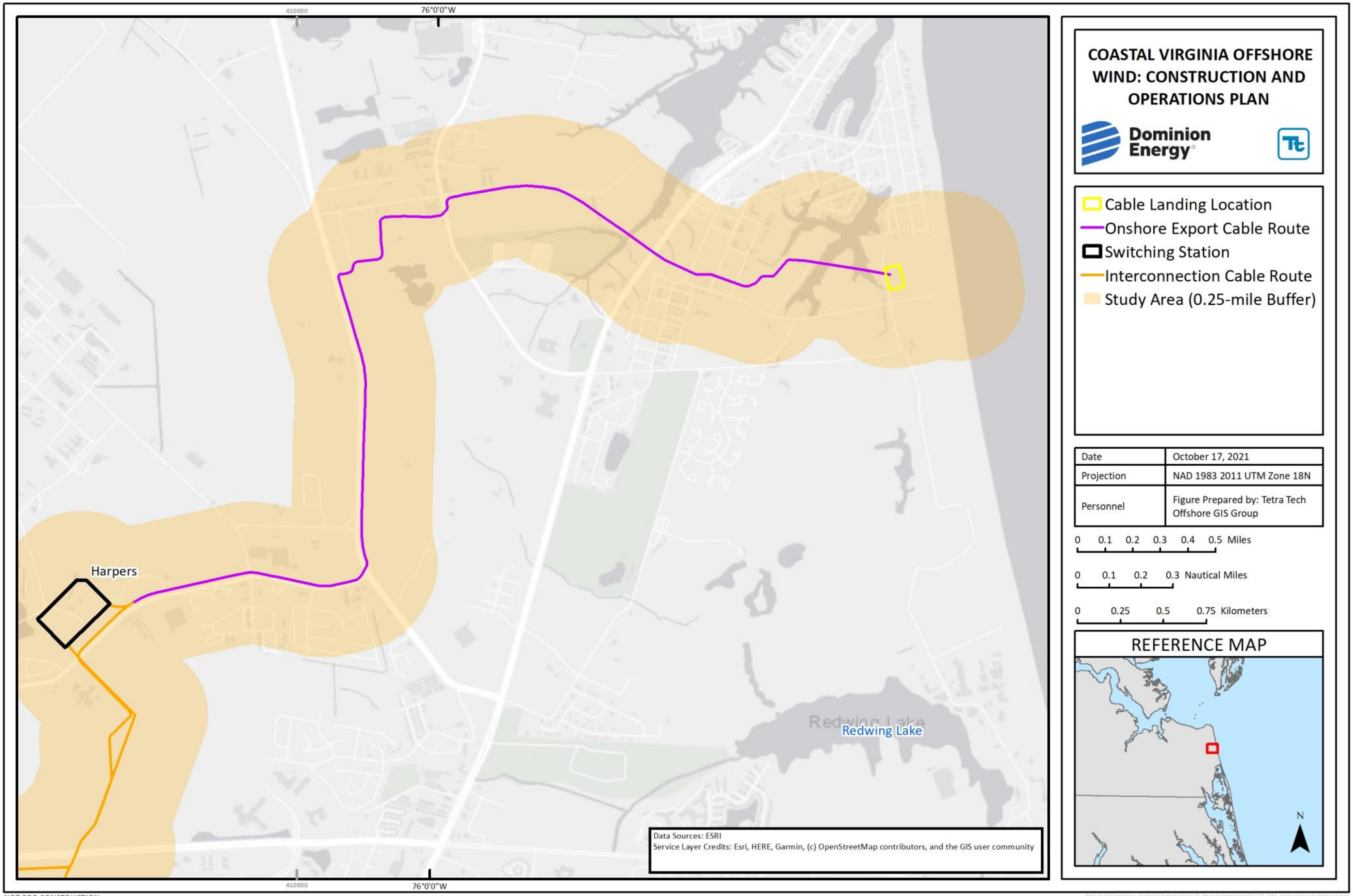
The generating capacity of the Project will be between 2,500 and 3,000 MW. The preferred 2,640-MW peak power flow was divided equally between the 27 underground cables so that 293 MW will flow in each of the nine circuits. This results in a phase current of 852 amperes per phase conductor in each of the underground 230-kV circuits. The modeling was performed for this peak power flow condition.

The magnetic fields that are formed near a power line are directly proportional to the amount of power and electric current flowing in the line. If lower power and thus lower current is flowing in the power line, then the magnetic fields would be reduced proportionately. The modeling of magnetic fields was done using the maximum preferred power flow of 2,640 MW. The electric fields produced by the Onshore Export Cables or Interconnection Cables, however, will be constant as the line is energized at 230 kV and the voltage on the line does not change.

This power flow values and the geometry of the nine duct banks were then entered into the EMF digital computer model to compute the resulting magnetic fields. Since the circuits in the underground Onshore Export Cable are located below ground, these circuits will only result in magnetic fields detectable at the surface. Any electric fields from the underground circuits will be absorbed by the cable shielding and soil before they reach the surface.

The model used for calculating the electric and magnetic fields for this analysis is the FIELDS 2.0 model developed by Southern California Edison Company (SCE 1993). In other EMF modeling analyses, the CORONA 3 computer model developed by Bonneville Power Administration (BPA; 1991) was sometimes used. However, CORONA 3 does not model magnetic fields from underground conductors. Therefore, the Southern California Edison Company FIELDS 2.0 model was used for all modeling in this analysis. The field calculations were made at an elevation of 3.3 ft (1 m) above the ground surface.

The results of the magnetic field modeling for the underground segment are shown in Figure BB.1-4. The magnetic fields at the edges of the underground Onshore Export Cable Route Corridor are 119 milligauss (mG) on the left edge of the corridor and 44.5 mG on the right edge. The highest magnetic fields within the corridor are 4,126 mG at 6 ft (1.8 m) left of centerline. Outside of the corridor at 200 ft (61 m) from the centerline, the magnetic fields drop to approximately 1. 1 to 1. mG on both sides, reflective of ambient background levels.



NOT FOR CONSTRUCTION

Figure BB.1-1. Underground Onshore Export Cable Route

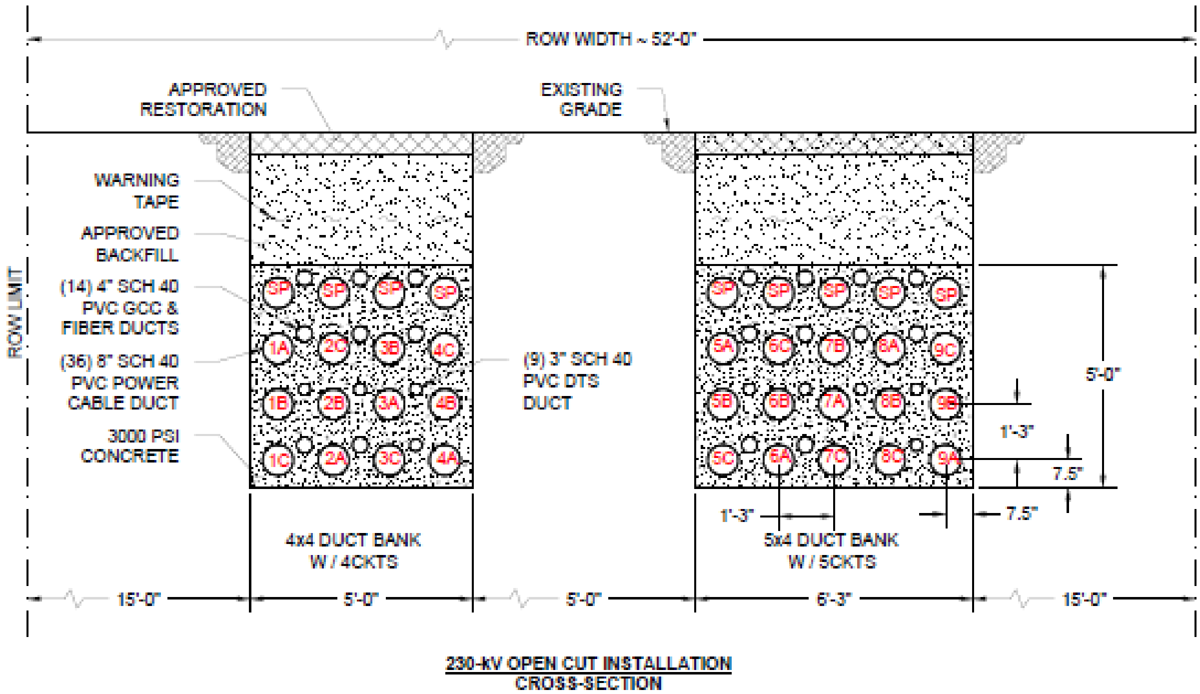


Figure BB.1-2. Underground Duct Banks in Underground Onshore Export Cable

BB.1.3 Overhead/Hybrid Interconnection Cable

From the Harpers Switching Station, Overhead Interconnection Cable Route Alternatives 1 through 5 will proceed toward the southwest to the Onshore Substation where they will connect to the Dominion Energy electric transmission system. Hybrid Interconnection Cable Route Alternative 6 will not utilize the Harpers Switching Station and will continue underground until reaching the Chicory Switching Station, where the cable will transition to overhead and proceed toward the southwest to the Onshore Substation (the POI) where they will connect to the Dominion Energy electric transmission system. The potential routes for the Overhead/Hybrid Interconnection Cable Route are shown in Figure BB.1-3.

The Overhead Interconnection Cable will consist of three circuits suspended on three single-pole transmission structures. The three structures will be placed in a single ROW that has a total width of 140 ft (43 m; Interconnection Cable Route Corridor). The single-pole structures will be arranged as shown in Figure BB.1-5. Each of the structures will support one circuit.

Each of the three 230-kV overhead circuits will have bundled phase conductors with two conductors separated by a distance of 18 inches (0.46 m) in a horizontal configuration. Each of the three circuits will carry 1,500 megavolt amperes (MVA). The 1,500-MVA power flow per circuit separated into the two conductors per bundle results in 1,883 amperes of current per conductor. These conductors were modeled similarly to the underground Onshore Export Cable Route using the FIELDS 2.0 digital computer program.

Figure BB.1-6 and Figure BB.1-7 show the electric and magnetic field profiles for the Overhead Interconnection Cable, respectively.

The electric fields for the Overhead Interconnection Cable will be about 1.1 kilovolt per meter (kV/m) on one side of the Interconnection Cable Route Corridor and 0.3 kV/m on the other side of the corridor. The highest electric field within the 140-ft (43-m) Interconnection Cable Route Corridor will be about 4.6 kV/m. The electric fields drop to less than 0.1 kV/m at 200 ft (61 m) from the centerline of the corridor.

The magnetic fields for Overhead Interconnection Cable Route Corridor will be 174 mG on one side of the corridor and 83 mG on the other. The highest magnetic fields will be 358 mG within the corridor. The magnetic fields drop to 16 mG and 10 mG at 200 ft (61 m) from the corridor centerline.

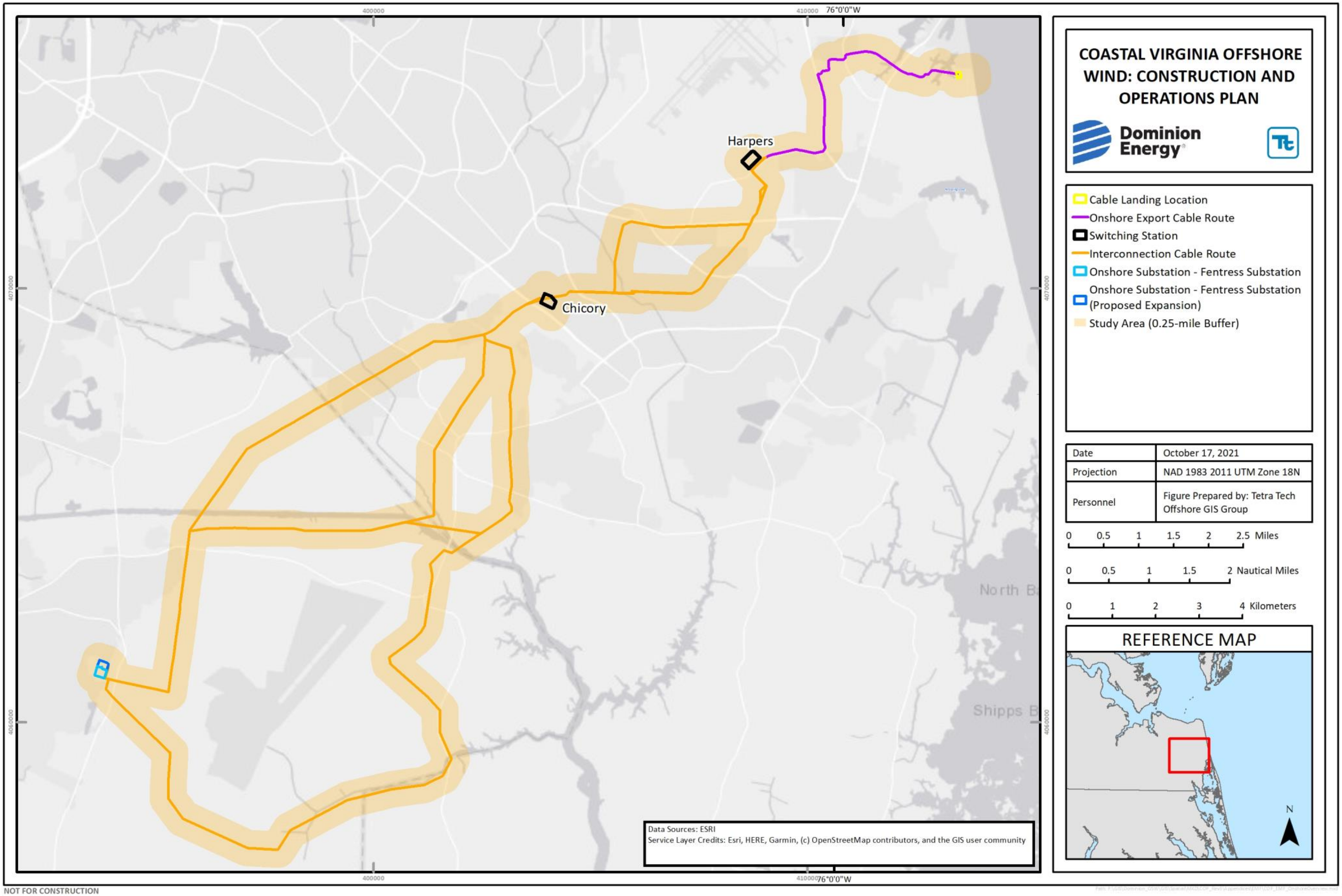


Figure BB.1-3. Overhead/Hybrid Route Alternatives for the Interconnection Cable System

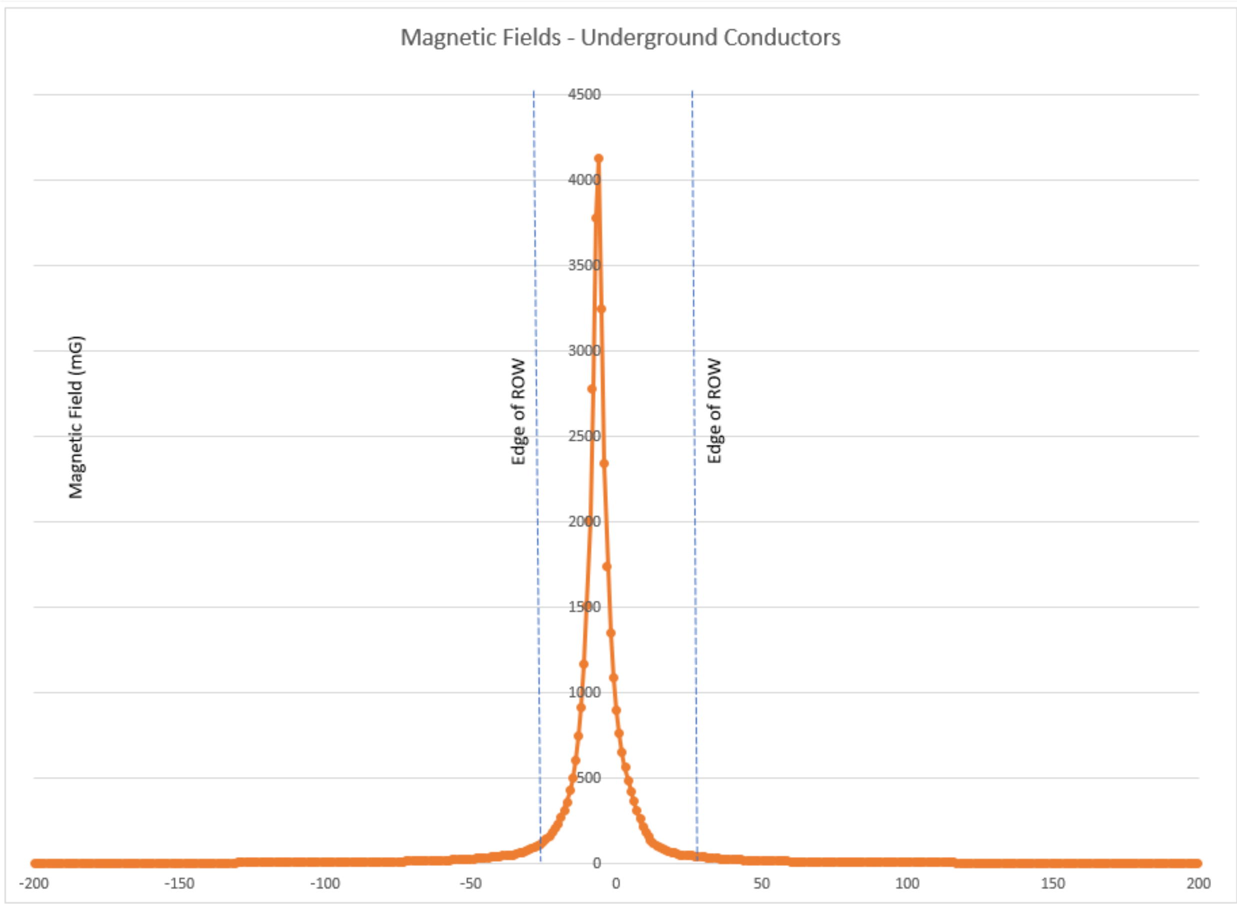


Figure BB.1-4. Magnetic Fields from Underground Interconnection Cable

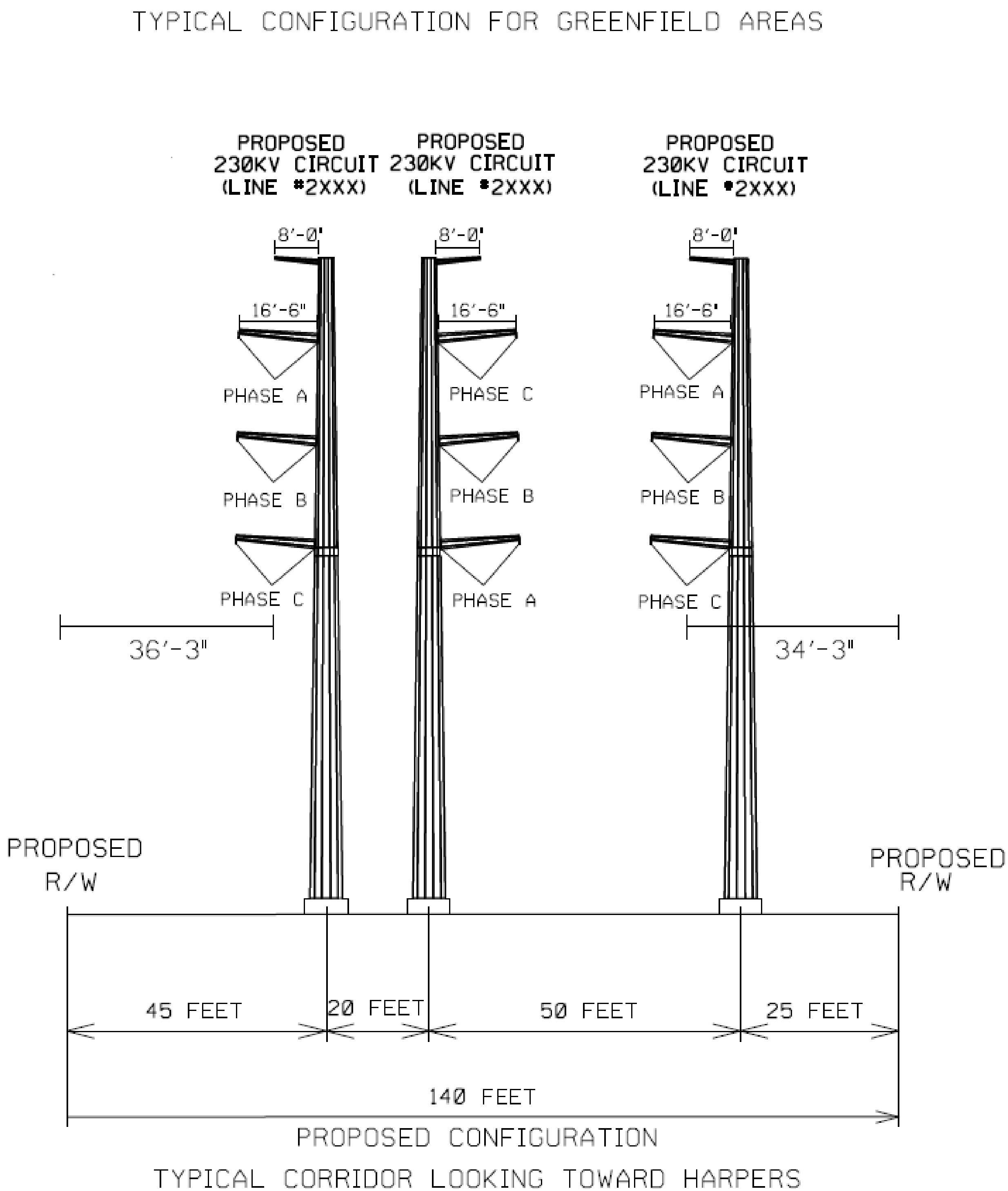


Figure BB.1-5. Transmission Structures for Overhead Interconnection Cable

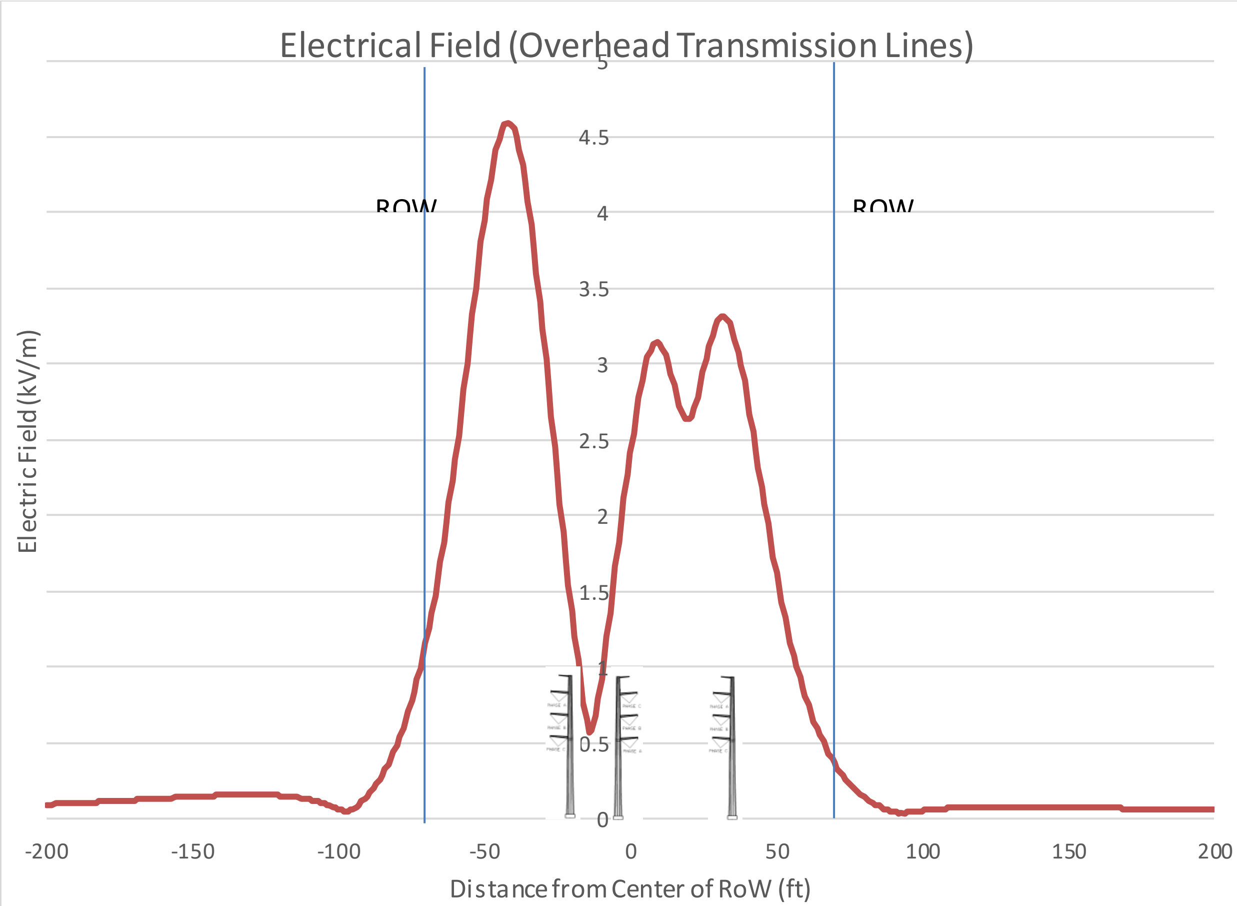


Figure BB.1-6. Electric Field Profile for Overhead Interconnection Cable

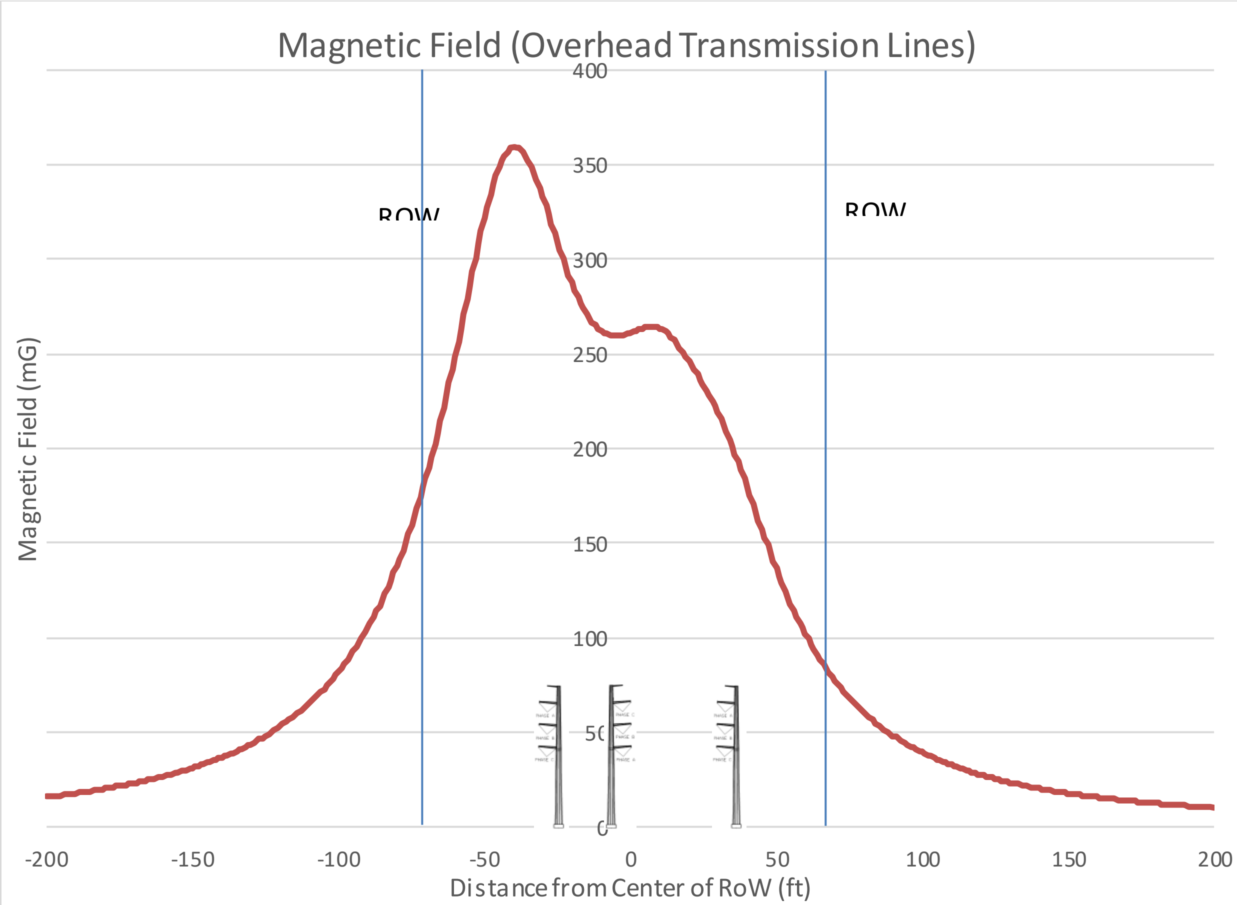


Figure BB.1-7. Magnetic Field Profile for Overhead Interconnection Cable

BB.1.4 Electric and Magnetic Field Exposure Guidelines and Standards

There are no federal or Commonwealth of Virginia standards that limit exposure by members of the public to electric or magnetic fields produced by electric transmission power lines. However, two international organizations have adopted safe exposure guidelines that provide a base of comparison for evaluating potential human health effects from exposure to electric and magnetic fields. These guidelines are based on extensive review and evaluations of relevant research of health and safety issues.

The first guideline is the International Committee on Electromagnetic Safety (ICES; 2002), which is a committee under the oversight of the Institute of Electrical and Electronics Engineers. The second is the International Commission on Non-Ionizing Radiation Protection (ICNIRP; 2010), an independent organization that provides scientific advice and guidance on electromagnetic fields.

Both organizations have recommended limits designed to protect the health and safety of persons in both occupational settings and for the general public. The ICES exposure reference level for the general public to 60 Hertz (Hz) magnetic fields is 9,040 mG. ICNIRP determined a reference level limit for whole-body exposure of the general public to 60 Hz magnetic fields at 2,000 mG (ICNIRP 2010). The ICES exposure standard for public exposure to electric fields is 5 kV/m. The ICNIRP exposure standard for electric fields is 4.2 kV/m.

In addition, as a reference for comparison, other states have adopted standards for public exposure for electric and magnetic fields from new electric transmission power lines (NIEHS 2002). The State of New York has adopted a magnetic field standard of 200 mG and an electric field standard of 1.5 kV/m at the edge of the ROW. Similarly, the State of Florida has adopted a magnetic field standard of 150 mG and an electric field of 2 kV/m at the edge of the ROW for 230-kV transmission lines such as these.

BB.1.5 Comparison to Exposure Guidelines and Standards

The magnetic fields produced by the underground Onshore Export Cable and Overhead Interconnection Cables are less than the adopted international safety guidelines and other states' standards and will therefore be in compliance. Also, the electric field levels produced by the Overhead Interconnection Cables will comply with these international safety guidelines and other states' standards. The magnetic fields produced by the Overhead Interconnection Cables will comply with the ICES and ICNIRP international safety standards.

BB.1.6 Conclusions

The calculated electric and magnetic field levels generated by the underground Onshore Export Cables and Overhead Interconnection Cables are well below the international safety guidelines published by the ICNIRP and ICES designed to protect the health and safety of the public. The calculated magnetic field level at the edge of the Interconnection Cable Route Corridor is approximately 179 mG, which is less than one-eleventh of the ICNIRP reference level of 2,000 mG and less than one fiftieth of the ICES exposure reference level of 9,040 mG for the general public. The electric field level at the edge of the Overhead Interconnection Cable Route Corridor of 0.1 kV/m is less than all international safety guidelines.

BB.2 REFERENCES

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