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*Electrical Engineering and
Computer Science Practice*

Health Practice

**Catholic Charities Solar Array
Project**

**Magnetic Field Assessment
and Current Status on EMF
and Human Health**

Board of Zoning Adjustment
District of Columbia
CASE NO.19927
EXHIBIT NO.39A

Catholic Charities Solar Array Project

Magnetic Field Assessment and Current Status on EMF and Human Health

Prepared for

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Acronyms and Abbreviations

A	Ampere
ELF	Extremely low frequency
EMF	Electric and magnetic fields
Exponent	Exponent, Inc.
Hz	Hertz
ICES	International Committee on Electromagnetic Safety
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEEE	Institute of Electrical and Electronics Engineers
mG	Milligauss
NA	Not applicable
rms	Root mean square
WHO	World Health Organization

Executive Summary

At the request of Catholic Climate Covenant, on behalf of Catholic Charities of the Archdiocese of Washington, Inc. (Catholic Charities), Exponent, Inc. (Exponent) assessed the levels of magnetic fields associated with the permitting of a solar array of approximately 5,000 solar panels on the property located at 2800 Otis Street NE, Washington, DC that is anticipated to generate a maximum of 1.5 megawatts (MW) of alternating current (AC) power. The magnetic field expected from the project outside the site will come from a short, overhead distribution line that will carry power from the solar panels to an interconnection point across Randolph Street NE to Barnard Hill Park. The solar panels and other equipment on-site would not be expected to affect magnetic field levels outside the boundaries of the Covenant's property. The calculated magnetic field directly beneath the interconnection is 5.0 milligauss (mG) and decreases to 2.8 mG at a distance of 25 feet. These calculated levels are similar to the existing AC magnetic field levels measured in the neighborhood around the proposed Solar Array and are far below the International Commission for Non-Ionizing Radiation Protection (ICNIRP) reference level of 2,000 mG and the International Commission for Electromagnetic Safety (ICES) maximum permissible exposure limit of 9,040 mG for the general population to AC magnetic fields from electrical system sources (ICES, 2002; ICNIRP, 2010).

The conclusion of multiple national and international health and scientific agencies is that the research does not show that electric and magnetic fields (EMF) cause disease, including cancer, in adults or children at the levels we encounter in our everyday environments (WHO, 2007b; NCI, 2016; NIEHS, 1999).

Introduction

At the request of Catholic Climate Covenant, on behalf of Catholic Charities of the Archdiocese of Washington, Inc. (Catholic Charities), Exponent assessed the magnetic fields associated with the proposed solar array. This report summarizes the measured magnetic field levels from existing sources, the methods used to calculate magnetic field levels from the overhead interconnection, and the modeling results. In addition, the report includes a section on the current scientific consensus of electric and magnetic fields (EMF), which summarizes the health-based EMF standards and guidelines as well as the current status of EMF and human health research.

An overview of the project is shown in Figure 1, which illustrates the approximate location of the solar array on the Catholic Charities property.

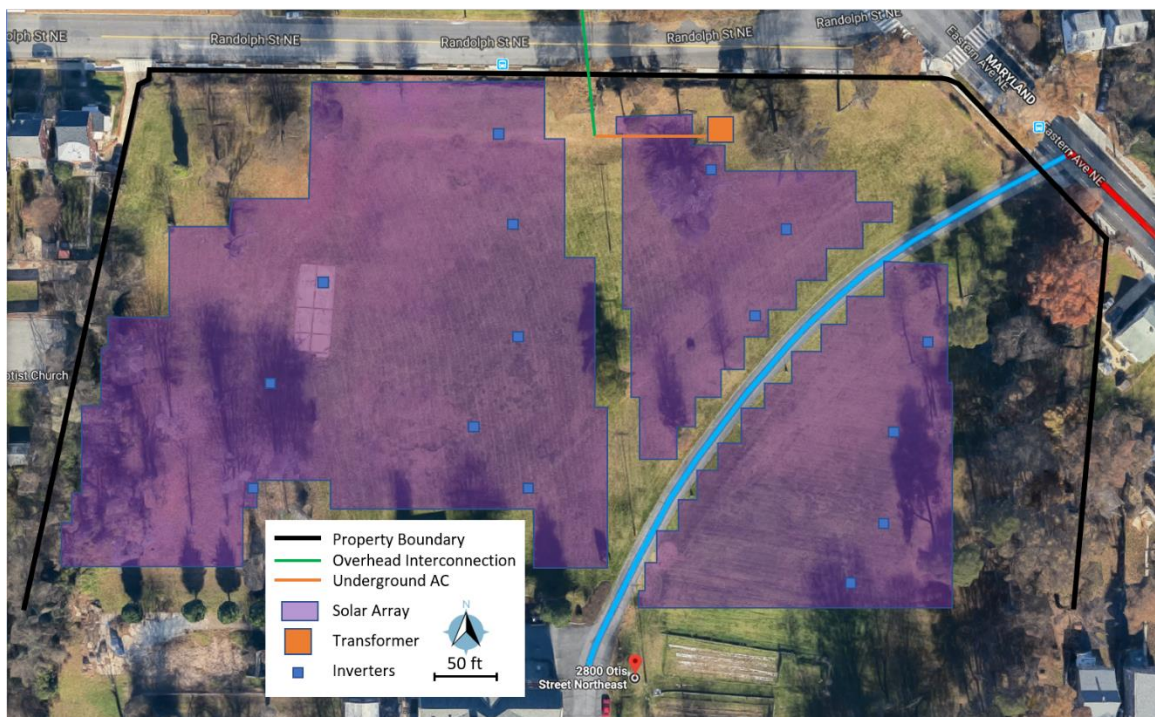


Figure 1. Approximate location of proposed solar array overlaid on an aerial map. Randolph St. NE is shown to the north and Eastern Ave. NE is shown to the northeast.

Magnetic Fields

Any source of electricity, such as transmission lines, distribution lines, household appliances, and equipment in our homes and workplaces, produces magnetic fields. Most electricity in North America is transmitted as AC at a frequency of 60 Hertz (Hz) (i.e., it changes direction and magnitude in a continuous cycle that repeats 60 times per second). The fields from these AC sources are commonly referred to as power-frequency or extremely low frequency (ELF) EMF.

Magnetic fields are created by the electric current that flows in building wiring or overhead distribution line conductors. The strength of magnetic fields in this report are expressed as magnetic flux density in units of milligauss (mG), where 1 Gauss (G) = 1,000 milligauss (mG). Magnetic fields are not blocked by most materials, but the strength of magnetic fields diminishes with increasing distance from the source.

On the project site, the proposed solar array and related equipment will produce weak local magnetic fields. Outside the site boundaries, an overhead interconnection line will be a source of magnetic fields. This interconnection line will deliver power to existing neighborhood distribution lines. In the neighborhood around the proposed solar array, the distribution lines supplying buildings and residences with electrical power are sources of magnetic fields.

Magnetic Field Measurements and Modeling

Measurement Method

Exponent measured existing magnetic field levels on Catholic Charities property as well as on the sidewalk in the neighborhoods surrounding the property on February 5, 2019 between the hours of 11am and 3 pm. All measurements were taken at a height of 1 meter (3.28 feet) above ground in accordance with IEEE Std. C95.3.1-2010 and IEEE Std. 644-2008 (IEEE, 2008; IEEE, 2010). The meter was calibrated by EMDEX LLC by methods like those described in IEEE Std. 644-1994 R2008 (IEEE, 2008). A calibration certificate is included in Appendix A.

Calculation Method

To characterize the magnetic field from the proposed overhead interconnection to the distribution network, Exponent modeled the magnetic field from the line assuming an operating voltage of 13.2 kilovolts and the full rated 1.5 MW output of the solar array. If the sun is shaded by clouds or at night, the power from the solar panels will be less or none. The magnetic fields were calculated using computer algorithms developed by the Bonneville Power Administration (BPA), an agency of the U.S. Department of Energy (BPA, 1991) and are reported at a height of 1 meter (3.28 feet) above ground as the root mean square (rms) value of the field in accordance with IEEE Std. C95.3.1-2010 and IEEE Std. 644-2008 (IEEE, 2008; IEEE, 2010).

The inputs to the program include data regarding voltage, current flow, and conductor configurations.¹ The model simplifies the actual geometry so that each conductor is modeled as infinite in length at a fixed height above a flat earth (also assumed infinite in extent) and is assumed to be parallel to all other conductors. These assumptions simplify the calculations but have been shown to accurately predict magnetic-field levels measured near transmission lines (Chartier and Dickson, 1990; Perrin et al., 1991). In addition, the model used the maximum

¹ The design of the overhead interconnection to the electrical grid is not yet complete and so general Pepco design parameters have been used. The conductors were modeled at a height of 30 feet above ground with a horizontal spacing of 5 feet.

output (1.5 megawatts [MW]) of the solar array ensuring that the calculated values are representative of the highest field levels that may be encountered beneath the interconnection.

Results and Discussion

The magnetic field from the overhead interconnection calculated from the model is shown in Figure 2 and indicates that at the maximum output of the solar array, the calculated magnetic field directly beneath the interconnection to the electrical grid is 5.0 milligauss (mG), and decreases to 2.8 mG at a distance of 25 feet. Most of the area beneath this interconnection will be within Eastern Avenue NE. At night, when no sun is shining on the solar panels, there will be no electricity generated or a magnetic field from the interconnection; when the sun on the panels is weaker due to clouds or obstruction by trees and buildings, the magnetic field will be less than calculated.

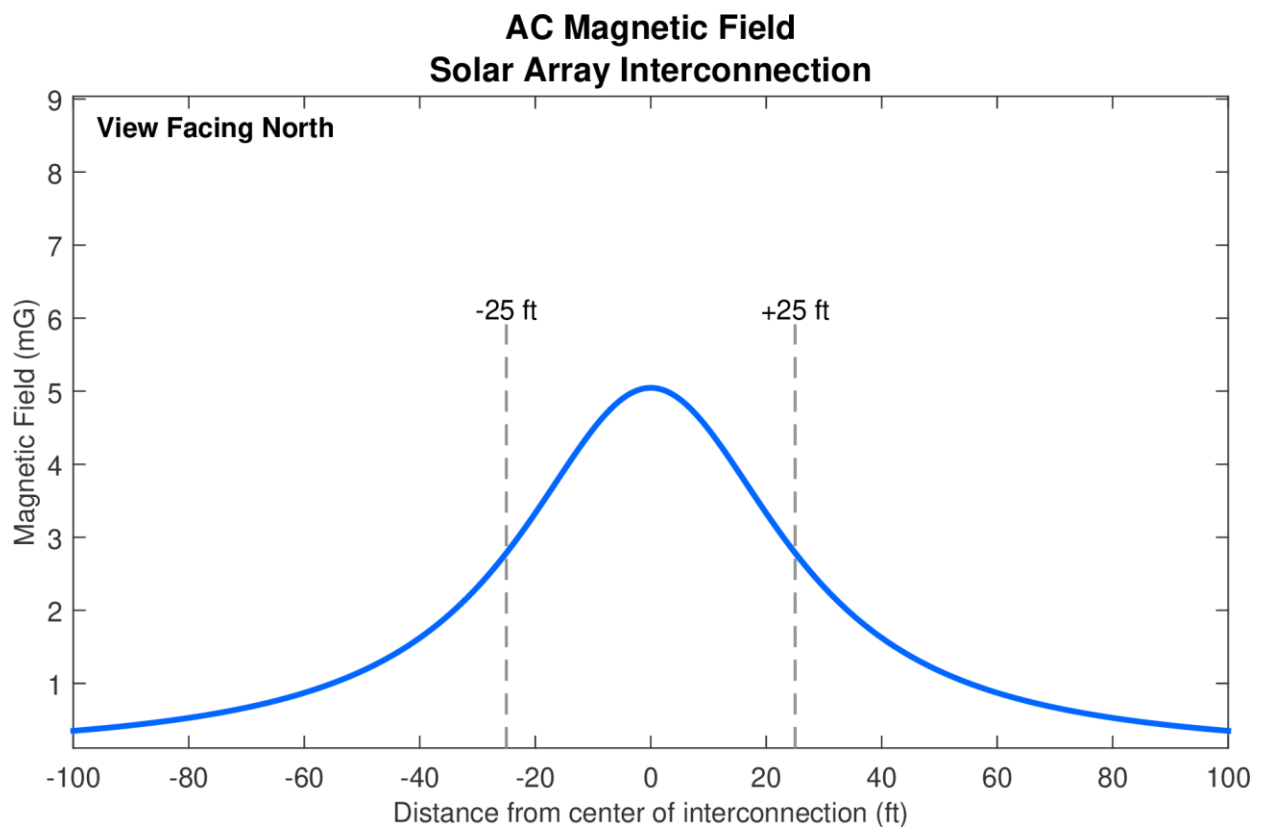


Figure 2. Calculated magnetic-field level for the conceptualized AC interconnection

Measured magnetic-field levels around the perimeter of the Catholic Charities property were generally low (average of approximately 0.1 milligauss [mG]), with a maximum of approximately 0.7 mG measured beneath the existing overhead distribution line on the property. Magnetic-field levels measured on the sidewalk in the neighborhoods surrounding the Catholic Charities were generally higher. The average magnetic field level measured in the immediate neighborhood (along Randolph St., NE, 26^e St. NE, Otis St. NE, 30th Pl. NE, Perry St. NE and Eastern Ave. NE) was approximately 0.9 mG with a maximum measured level of 7.5 mG

The calculated magnetic field from the overhead AC interconnection to the electrical grid (crossing Randolph St. NE) is similar to the existing AC magnetic field levels measured in the neighborhood around the Catholic Charities property (and other neighborhoods – Savitz et al., 1989). The maximum calculated magnetic field level directly beneath the interconnection (5.0 mG) is similar to the maximum levels measured in the immediate neighborhood (7.5 mG), and magnetic field levels at a distance of 50 feet from the interconnection (1.2 mG) are similar to average levels measured in the neighborhood (0.9 mG).

These calculated levels are far below the recommended limits for exposure of the general public to magnetic fields, which are discussed in the next section. The calculated field levels are also comparable to those from other facilities in the District. In a letter to the DC Board of Zoning Adjustment regarding EMF exposures from a proposed neighborhood substation, the chief science advisor for the Department of Energy and Environment noted that the EMF levels [from community power sources] *“are comparable (perhaps even generally lower) to the levels to which we are exposed on a daily basis from typical household appliances, or the normally occurring background levels. Indeed, the typical field measurement levels tend to be far lower than the public exposure levels set by internationally-recognized expert organizations... As such, we believe that public health and safety are not likely to be compromised”* (Asante-Duah, 2018).

Current Scientific Consensus on EMF and Health

The previous section summarized the existing and proposed magnetic field levels associated with the solar array project. To better place the field levels into context, the following section summarizes EMF health-based standards and guidelines and the current consensus of health agencies about EMF health research.

Standards and Guidelines

There are no national recommendations, guidelines, or standards in the United States to regulate magnetic fields or to reduce public exposures. Several states (e.g., New York, Florida) have statutes or guidelines that apply to magnetic fields produced by new transmission lines, but these guidelines are not health based.

Recommended health-based EMF exposure limits have been developed by scientific and health agencies, including the International Committee on Electromagnetic Safety (ICES) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Both agencies have published magnetic field exposure limits for the general public that are based upon reviews and evaluations of relevant health research. In the letter to the DC BZA, Dr. Asante-Duah noted that the ICNIRP exposure limits were developed “*following meticulous reviews of numerous peer-reviewed scientific works*” (Asante-Duah, 2018). The published magnetic-field limits from ICES and ICNIRP are 9,040 mG and 2,000 mG, respectively (ICES, 2002; ICNIRP, 2010). In an outline of its guidance to the public, the World Health Organization – a scientific organization within the United Nations system mandated with providing leadership on global health matters, shaping health research agendas, and setting norms and standards – recommended that policy makers should adopt international exposure limit guidelines, such as those from ICNIRP or ICES, for exposure to EMF and that compliance with these standards is protective of public health (WHO, 2007a).

Summary of Research on EMF and Health

Over the past 40 years, researchers have examined whether EMF from man-made sources can cause short- or long-term health effects in humans. These laboratory and epidemiology research studies have been subsequently reviewed by numerous national and international scientific agencies and organizations such as the WHO, the U.S. National Cancer Institute (NCI), and the U.S. National Institute of Environmental Health Sciences (NIEHS), among others. When conducting reviews, these agencies consider *all* the evidence in a systematic and thorough manner to draw conclusions about EMF exposure in the general public. The conclusions of these scientific organizations are generally consistent with one another and state that the cumulative body of research to date does not support the idea that EMF causes any long-term adverse health effects in adults or children at the levels generally found in residential and occupational environments, including in proximity to electric transmission and distribution facilities or equipment (WHO, 2007b; NIEHS, 1999). The current guidance from the WHO on its website states that “[b]ased on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields” (WHO, 2019).

While health agencies have noted that some epidemiology studies reported a weak statistical association between childhood leukemia and rare exposures to high average magnetic field levels, the association is uncertain and is not confirmed by laboratory research or a mechanism that would explain effects at magnetic field levels found in our communities. Thus, the association has not been considered a causal relationship and the WHO did not conclude that EMF causes childhood leukemia. The most recent review of the literature was released in 2015 by a health agency in the European Union, which concluded that the epidemiological data on childhood leukemia and EMF exposure continued to “*prevent a causal interpretation*” (SCENIHR, 2015).

Notice

At the request of Catholic Climate Covenant, on behalf of Catholic Charities of the Archdiocese of Washington, Inc. (Catholic Charities), Exponent, Inc. (Exponent) assessed the levels of magnetic fields associated with the permitting of a solar array of approximately 5,000 solar panels on the property located at 2800 Otis Street NE, Washington, DC.

This report summarizes work performed to date and presents the findings resulting from that work. In the analysis, we have relied on geometry, material data, usage conditions, specifications, and various other types of information provided by Catholic Charities, Solar Energy Services, Inc. & Pepco. Catholic Charities has confirmed to Exponent that the data provided to Exponent are not subject to Critical Energy Infrastructure Information restrictions. We cannot verify the correctness of these input data and rely on the client for the data's accuracy. Although Exponent has exercised usual and customary care in the conduct of this analysis, the responsibility for the design and operation of the Project remains fully with the client.

The findings presented herein are made to a reasonable degree of engineering and scientific certainty. Exponent reserves the right to supplement this report and to expand or modify opinions based on review of additional material as it becomes available, through any additional work, or review of additional work performed by others.

The scope of services performed during this investigation may not adequately address the needs of other users of this report beyond the permitting of the Project for which it was prepared, and any re-use of this report or its findings, conclusions, or recommendations presented herein are at the sole risk of the user. The opinions and comments formulated during this assessment are based on observations and information available at the time of the investigation. No guarantee or warranty as to future life or performance of any reviewed condition is expressed or implied.

References

Asante-Duah, Kohi. Letter from Kohi Asante-Duah, Department of Energy and Environment, to Washington DC Board of Zoning Adjustment. November 7, 2018.

Bonneville Power Administration (BPA). Corona and Field Effects Computer Program. Bonneville Power Administration, 1991.

Chartier VL and Dickson LD. Results of Magnetic Field Measurements Conducted on Ross-Lexington 230-kV Line. Report No. ELE-90-98. Bonneville Power Administration, 1990.

Institute of Electrical and Electronics Engineers (IEEE). IEEE Recommended Practice for Measurements and Computations of Electric, Magnetic, and Electromagnetic fields with respect to Human Exposure to Such Fields, 0 Hz to 100 kHz. New York: IEEE. IEEE Std. C95.3.1-2010.

Institute of Electrical and Electronics Engineers (IEEE). Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines (ANSI/IEEE Std. 644-1994, R2008). New York: IEEE, 2008.

International Commission on Non-ionizing Radiation Protection (ICNIRP). ICNIRP Statement-Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). Health Phys 99: 818-836, 2010.

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

National Institute of Environmental Health Sciences (NIEHS). Health Effects from Exposure to Power Line Frequency Electric and Magnetic Fields. NIH Publication No. 99-4493. Research Triangle Park, NC: NIEHS, 1999.

Perrin, N, Aggarwal, RP, Bracken, TD, Rankin, Survey of Magnetic Fields near BPA 230-kV and 500-kV Transmission Lines, 1991.

Savitz DA, Pearce NE, Poole C. Methodological issues in the field of epidemiology of electromagnetic fields and cancer. Epidemiol Rev 11: 59-68, 1989.

Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). Opinion on Potential Health Effects of Exposure to Electromagnetic Fields (EMF). Brussels, Belgium: European Commission, DG Health and Food Safety, 2015.

World Health Organization (WHO). Electromagnetic fields and public health. 2007a. <http://www.who.int/peh-emf/publications/facts/fs322/en/> (accessed 2/13/2019).

World Health Organization (WHO). Environmental Health Criteria 238: Extremely Low Frequency (ELF) Fields. Geneva, Switzerland: World Health Organization, 2007b.

World Health Organization (WHO). What are electromagnetic fields? Summary of health effects. 2019. <http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html> (accessed 2/13/2019).

Attachment A

Certificate of Calibration

The calibration of this instrument was controlled by documented procedures as outlined on the attached Certificate of Testing Operations and Accuracy Report using equipment traceable to N.I.S.T., ISO 17025, and ANIZ540-1 COMPLIANT.

Instrument Model: EMDEX II

Frequency: 60 Hertz

Serial Number: 1134

Date of Calibration: 10/24/2018

Re-Calibration suggested at one year from above date.

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