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Product Abstract

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Electric and Magnetic Field Exposure Levels (0 to 3 GHz) in Occupational Environments near Photovoltaic Energy Generation Facilities

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Abstract

Electric and magnetic field levels associated with photovoltaic energy generation facilities were measured and characterized in this study. This evaluation included the measurement of static (direct current [DC]) magnetic fields, power-frequency alternating current (AC) electric and magnetic fields (up to 3,000 Hz), and radio-frequency (RF) electric and magnetic fields (up to 3,000 MHz) at two electric utility solar generation facilities.

The major sources of DC magnetic fields within a solar generation facility are the inverter and the DC fuse box. Next to an inverter, DC magnetic fields can approach 3 Gauss (0.0003 T) in close proximity (1 in. [25.4 m]) to the equipment and exhibits constant fluctuations in field intensity. Next to a DC fuse box (1 in.), DC magnetic fields can approach 2 Gauss (0.0002 T). Field levels, however, attenuated quickly with distance. For other equipment (solar panels, DC cables, and combiner boxes), measured DC magnetic fields rarely exceeded a 500 mG (0.00005 T) variation from the earth's static magnetic field, even within 1 in. of the equipment. None of these values exceeds recommended guidelines established by various organizations such as the International Council on Non-Ionizing Radiation Protection (ICNIRP), American Conference of Governmental Industrial Hygienists (ACGIH), and IEEE.

None of the equipment within the photovoltaic generation facilities surveyed exhibited significant power-frequency AC electric field levels. Equipment is typically housed within conduits or enclosures that shield the AC electric field. The major sources of AC magnetic fields are not the photovoltaic equipment (solar panels, connecting cables, combiner boxes, and fuse boxes), but rather the AC power cables (over 400 mG [0.00004 T] at 1 in. away), inverters (around 1,100 mG [0.00011 T] at 1 in. away), transformers (1,767 mG [0.0001767 T] at 1 in. away), and switchgear (432 mG [0.0000432 T] at 1 in. away). In very close proximity (within 1 in.) to inverters and transformers at some locations, measured magnetic field levels can exceed the ACGIH guideline (of 1 Gauss [0.0001 T]) for workers with implanted medical devices. However, most locations were measured to have levels below this threshold and other organization guidelines (such as IEEE and ICNIRP).

The principal sources of RF fields associated with the solar generation facility equipment were the inverters, with a fundamental frequency component at the 5-kHz switching rate for the 500-kW rated inverters. The greatest magnetic flux density was found at a single point on the surface of an inverter operating at near full output (40 µT). The greatest 5-kHz electric field strength was measured at the surface of the inverter (1.4 V/m). Magnetic flux density decreased with distance from the inverter. RF measurements were performed across the frequency range of 1 kHz to 100 kHz and electric fields from 100 kHz to 3 GHz.

Higher frequency RF measurements showed the production of broadband RF noise up to approximately 30 MHz with field strengths as great at 0.2 V/m with little detectable energy above 30 MHz. The elevated RF energy also decreased rapidly with increasing distance from the inverter. The broadband RF fields could present the possibility of RF interference with nearby communications systems.

RF electric and magnetic fields associated with inverter full-output operation did not produce uniform exposure that exceeds recommended guidance on exposure established by both IEEE and the more restrictive guidelines from ICNIRP. Although the greatest measured value at a single point on the surface of an inverter was found to exceed the ICNIRP recommended guidance for lower frequency magnetic fields, this value cannot be interpreted as uniform over the body dimensions in accordance with the description of the limit provided by ICNIRP.

Program

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Report

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