

Electric and Magnetic Fields and Radio-Frequency Health Assessment - Program 60

Program Overview

Program Description

Timely implementation of new transmission and distribution (T&D) projects will take on heightened importance as the power grid is expanded, upgraded, and modernized and as it integrates smart grid technology and remotely located renewable energy resources. New T&D construction (including the development of electric vehicle charging infrastructure) and capacity upgrades, and expansion of smart grid technology's reliance on two-way wireless communication, can create public concerns about possible human health risks from electric and magnetic field (EMF) and radio-frequency (RF) exposures. Such concerns can lead to lengthy delays and possibly cause regulatory decisions that affect project schedules and costs, while revisions to guidelines for public and worker EMF and RF exposures could result in altered exposure limits.

The Electric and Magnetic Fields and Radio-Frequency Health Assessment and Safety program helps electric power companies address questions about EMF and RF exposures and health issues. Program research, combined with the expertise of the Electric Power Research Institute (EPRI) program staff, contributes to the body of scientific knowledge, better enabling objective health risk evaluations and exposure guideline development. The program's commitment to research and public communication on EMF and RF health and safety questions responds to a societal need for information.

Research Value

This program addresses high-priority issues concerning potential health effects related to EMF and RF exposures by contributing to the body of scientific knowledge that enables accurate health risk evaluations and informs exposure guideline development. EPRI's internationally recognized EMF program is the longest-running comprehensive research program addressing ongoing and emerging EMF and RF health issues, bringing EPRI a global reputation as an authoritative source of EMF information. EPRI research provides scientific information to address issues raised by local constituencies with respect to new facility construction or upgrades (transmission lines, substations). Such input has been instrumental in avoiding project delays and reducing project costs associated with expensive measures such as rerouting and undergrounding. Over the past ten years, the highest priority of the EPRI program has been to help resolve the basis for the association between childhood leukemia and residential magnetic fields. More recently, the program has conducted measurement studies of RF emissions from smart meters, providing first-of-its-kind information to the public, regulators, and the scientific community.

Approach

This program provides scientific research results, information, analyses, and expertise that help electric companies, regulators, and society address residential and occupational EMF and RF health and safety issues. This program delivers

- timely, reliable EMF and RF scientific research results, communication materials, relevant background information, and analyses of key external studies;
- publicly accessible, up-to-date information on EMF and RF research, health risk evaluations, and regulatory actions;
- experimental and epidemiologic research investigating high-priority residential and occupational EMF and RF health and safety questions;
- EMFWorkstation software for modeling T&D infrastructure EMF in residential and occupational settings;
- EMF and RF exposure characterization research and exposure assessment software;

- educational materials, including instructional EMF/RF DVDs, tutorials, and RF safety awareness training;
- comprehensive assessment of the potential effects of EMF on aquatic life from submerged cables; and
- investigation of potential EMF interaction with implanted medical devices.

Accomplishments

Through peer-reviewed scientific publications, presentations at scientific meetings and seminars, and participation in scientific and technical advisory panels, the program staff have an international reputation for independent scientific research. Recent accomplishments include

- publication of a new public information brochure on EMF health research;
- peer-reviewed scientific publications on characterization of RF emissions from wireless smart meters;
- development of a new and innovative mouse model of childhood leukemia;
- development and evaluation of innovative study designs to address the issue of selection bias in epidemiologic studies of magnetic fields and childhood leukemia;
- new combined analysis of epidemiologic studies on occupational exposure to magnetic fields and neurodegenerative diseases;
- international evaluation of survival of children with leukemia with respect to EMF exposure;
- updated comprehensive evaluation of the epidemiology of occupational magnetic field exposures and adult leukemia and brain cancer;
- characterization of magnetic fields in electric vehicles and charging infrastructure;
- software and instrumentation characterizing and benchmarking residential and occupational EMF and RF exposures;
- completion of a three-part video series on EMF covering all aspects of the power frequency health issue in about five hours of viewing; and
- RF safety information that guides electric company safety program development and aids compliance with RF safety standards.

Current Year Activities

High-priority research and effective communication form the foundation for the 2014 program. Specific efforts will

- use California birth and cancer registry data and innovative GIS techniques to resolve the basis for a reported association of magnetic fields with childhood leukemia associated with transmission lines,
- implement an innovative epidemiologic study design to address the role of selection bias in the magnetic field–childhood leukemia association,
- assess the role of mobility in the observed association between residential magnetic field exposure and adverse pregnancy outcomes,
- develop a new study to replicate a recently reported association between maternal exposure to magnetic fields during pregnancy and asthma in the offspring,
- implement testing of the mouse leukemia model to determine whether exposure to magnetic fields or contact currents accelerates disease development,
- investigate potential EMF/RF interference with implanted medical devices (e.g., pacemakers and defibrillators) and develop a personal monitor to inform workers of possible interference,
- assess the role of parental occupational exposure to magnetic fields in childhood cancer development,
- characterize electromagnetic spectra in electric vehicles and around charging stations, and
- evaluate the potential effects of EMF exposure on marine biota from underwater transmission cables.

Estimated 2014 Program Funding

\$5.0M

Program Manager

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Summary of Projects

PS60A EMF and RF Health Assessment: Community and Residential Studies (055840)

Project Set Description

Through peer-reviewed scientific publications, presentations at scientific meetings and seminars, and participation in scientific and technical advisory panels, the program staff has an international reputation for rigorous, independent, credible scientific research on potential health effects of EMF and EMF exposure assessment. EMF/RF issue managers at member companies report that supporting EPRI EMF research is in itself an appropriate response to public concerns.

In addition to health effects and exposure assessment research, this Project Set includes EMFWorkstation software for modeling both electric and magnetic fields in residential and occupational settings. Also included is the EMF and RF Information Project, which provides clearly presented research results and information to help participants address public concerns about EMF and health.

Project Number	Project Title	Description
P60.001	EMF and RF Information Project	The EMF and RF Information Project provides timely, reliable EMF and RF research information, including communication materials, relevant background information, and EPRI Comments on key peer-reviewed studies and technical reports. In conjunction with Resource Strategies' ELF Gateway and RF Gateway, this project provides emailed reports on new research results, scientific meetings, health risk assessments, and regulatory actions. The project also maintains a public EMF website and issues a quarterly newsletter to stakeholders.
P60.002	Health Studies Related to EMF From T&D Infrastructure	This project includes health studies (both epidemiologic studies and laboratory investigations), analyses of existing data, and evaluations of current knowledge to elucidate the epidemiologic association between magnetic fields and childhood leukemia. Research is in progress to conduct an international case-control study and potentially a cohort study in a highly exposed population that avoid selection bias, and to replicate a much-publicized UK study of childhood leukemia. A novel, recently developed mouse model for childhood leukemia will be used to assess whether magnetic fields affect the development of leukemia in the mouse model. The feasibility of an innovative study of EMF and miscarriage is being evaluated through a pilot study. A replication of the Swiss EMF-neurodegenerative study is planned in Denmark. Emerging concerns about potential effects of EMF on aquatic life from submerged cables will be addressed.
P60.003	EMFWorkstation	EMFWorkstation software is a powerful, flexible set of tools for modeling both electric and magnetic fields in residential, commercial, or occupational environments and for evaluating field management options. EMFWorkstation will be maintained for compatibility with current PC operating systems, and any needed enhancements will be addressed. New features will be added only as requested by EPRI members. In 2014, the inclusion of modeling capability for underground transmission lines will be assessed.

Project Number	Project Title	Description
P60.004	EMF and RF Exposure Assessment Related to Emerging Technologies	This new research anticipates growing public concerns about potential exposures associated with smart grid and renewable technologies, electric vehicles, and their charging infrastructure. Exposures, heretofore uncharacterized, will include those from devices such as solar photovoltaics with highly distorted waveforms due to dc-to-ac conversion, RF exposures from a range of wireless devices, and exposures within electric vehicles.

P60.001 EMF and RF Information Project (070650)

Description

The issue of possible health effects from exposure to the extremely low frequency (ELF) EMF and RF fields associated with the electric power system and sources such as panel antennas, wireless networks, and automatic metering infrastructure continues to generate concern among the public and workers. The importance of this issue may grow as electric companies undertake new T&D projects to deliver electricity from new energy sources, and as they install smart grid technologies and wireless communication devices to maintain reliable power flow and efficiency. Electric power companies must be well informed on recent and ongoing international EMF and RF research and regulatory activities by having ready access to credible, up-to-date information and expert EPRI staff to adequately address public and worker health and safety concerns, respond to decision makers and other stakeholders, and effectively manage the EMF issue.

P60.002 Health Studies Related to EMF From T&D Infrastructure (SP1736)

Description

National and international risk assessments by agencies such as the International Agency for Research on Cancer and the National Institute of Environmental Health Sciences concluded, on the basis of an epidemiologic association between magnetic fields and childhood leukemia, that magnetic fields are possibly carcinogenic to humans. In 2007, the World Health Organization (WHO) released an assessment that supported this conclusion while noting that uncertainties remain. Uncertainties surround other health endpoints as well, including miscarriage and neurodegenerative diseases such as Alzheimer's disease and amyotrophic lateral sclerosis. Well-informed EMF health research, including both epidemiologic studies and laboratory investigations, continues to remain important as other groups, including the BioInitiative Working Group, have called for stringent exposure standards. Along with well-conducted, focused research to resolve scientific uncertainties, effective communication remains essential for EPRI and its members to effectively address developments in EMF health research. With respect to community health impacts, construction of transmission lines in rural areas and transmission lines that link offshore renewable generation facilities (such as wind and wave) to the mainland grid also has raised concerns about potential effects of EMF on animal health and behavior (for example, cattle, deer, bees, and marine life).

P60.003 EMF Workstation (SP1246)

Description

The EPRI EMF Workstation is a versatile software tool for characterizing magnetic fields from power lines and substations in residential, commercial, and occupational environments.

P60.004 EMF and RF Exposure Assessment Related to Emerging Technologies (070651)

Description

This project addresses the need to characterize electromagnetic environments across the spectrum from 0 Hz (DC) to over 5 gigahertz (GHz, 1 billion Hz) or greater, covering fields associated with transmission (ac and dc) and distribution (T&D). These electromagnetic environments, among others, include RF exposures from an advanced metering infrastructure (AMI), electric vehicles and their charging infrastructure, and renewable energy resources. Accurate exposure characterization is essential for addressing public and worker concerns about the potential new exposure environments and potential health effects.

Offshore wind turbines, and tidal and wave energy generators will need to be linked to the mainland system through undersea cables. There is also an ongoing development of transmission capacity under bodies of waters (sea, lakes, and rivers). EMF from these submerged underwater cables will also be evaluated.

PS60B EMF and RF Health Assessment: Occupational Studies (055841)

Project Set Description

The Occupational Studies Project Set produces scientific research and information on important occupational health and safety issues related to EMF exposure and RF safety. The Occupational Studies Project Set develops technical projects informing the basis for EMF and RF exposure guidelines. Current guidelines protect against neurostimulatory (EMF) or thermal (RF) effects arising through known biophysical mechanisms; however, guideline limits have not yet incorporated all the recent advances in dosimetry, dose-effect relationships, and exposure modeling, many of these originating from EPRI research. Coupled with its contribution to guideline science, EPRI will continue to monitor guideline revisions and other developments. EPRI occupational health studies focus on neurodegenerative diseases, particularly amyotrophic lateral sclerosis (ALS) and Alzheimer's disease, among electrical and other workers. EMF and RF occupational health and safety research refinement of the RF exposure modeling software is suitable for modeling occupational exposure from RF sources at electric utility workplaces. As the use of implanted medical devices is rapidly expanding among both the general population and active workers, potential interference issues related to extremely low frequency (ELF) and RF/EMF exposure remains a concern. The Occupational Studies Project Set will review medical literature on ELF and RF/EMF interference and will identify research gaps in the area for potential future research.

Project Number	Project Title	Description
P60.005	EMF and RF Occupational Health	<p>This project provides a comprehensive assessment of potential links between EMF exposure and health effects among electrical and other workers. In accordance with WHO research priorities, work in 2014 will continue to focus on neurodegenerative diseases. This project also monitors updates to EMF and contact current occupational exposure guidelines and investigations of related scientific and technical issues. In addition, the project addresses potential interference with implanted medical devices.</p> <p>Research in this project builds on the foundation established through 2013 in RF exposure characterization (source description, measurement techniques, and exposure modeling), dosimetry, and safety program design. Additional work will include refinement of the RF exposure modeling software.</p>

P60.005 EMF and RF Occupational Health (070652)

Description

Epidemiologic studies have investigated health effects possibly associated with work in electrical occupations and with occupational exposure to EMF, contact current, and spark discharge. In its 2007 EMF health risk assessment, the World Health Organization (WHO) assigned a high priority to research on ALS among those working in electrical occupations. WHO also assigned a high priority to research on magnetic field exposure in relation to Alzheimer's disease. Well-conducted research done as part of this project set advances science by reducing uncertainties, filling information gaps, and providing sound bases for development of work practices that protect health and safety. The EPRI EMF and RF program will begin to explore innovative approaches such as the possible role of occupational exposures in genetic and epigenetic processes.

Accurate exposure assessment is critical for minimizing worker exposures near RF and wireless facilities and emerging energy technologies. RF exposure assessment can be facilitated by reliable software for modeling RF fields, dependable RF measurements, and improved dosimetry to estimate the internal body dose corresponding to external fields. The feasibility of expanding platforms for the modeler software will be explored.

New work environments will be created as electric companies plan new transmission and distribution projects and deal with increasing electricity demand by delivering electricity from alternative energy resources. Possible health effects from ELF EMF exposure associated with the electric power system continue to generate concern. The increased use of implanted medical devices coincides with an aging workforce, driving questions about potential effects from EMF environments. Electric companies can anticipate the need for quantitative exposure assessment related to these issues.

Supplemental Projects

EMAlert (105255)

Background, Objectives, and New Learning

The use of personally worn or implanted medical devices for treating numerous health conditions is expanding rapidly. Cardiac pacemakers (1960) and implantable cardioverter defibrillators (ICD) (1980) were the first devices implanted in human patients and remain the most widely used medical implants. A recent review cites about 3 million pacemaker and 1 million ICD implants between 1993 and 2008, with nearly a 5% increase in the number of implants each year. Other devices now in use include: cochlear ear implants to assist hearing; insulin pumps to manage diabetes, whose prevalence is on the rise; implanted neurostimulators to alleviate chronic pain; and mechanical limb prostheses. Although such devices are designed to withstand interference from external electromagnetic fields, the probability that interference could occur, though small, cannot be assumed to be zero.

Employees (and contractors) in the electric utility industry in various job categories engage in tasks that include exposure to relatively high levels of power frequency electric and magnetic fields and their associated harmonics and transients. These are known to include line workers, substation operators, electricians, and cable splicers. Thus a possibility remains that a worker with an implanted device may be at risk of interference under certain exposure conditions.

Project Approach and Summary

To address the need for such a device, EPRI initiated the development of the EMAlert (formerly the Personal EMF Exposure Monitor) in 2011. The Alpha2 version of the device, completed in 2012, weighs 2.6 oz. and measures about 2-¼" across, 3" high (including the switches), and less than 1" thick (including the clip). The device, designed for this version to be carried in the shirt pocket, detects the electric and magnetic field and compares the magnitude of each to respective pre-set thresholds.

The Alpha2 units were field tested in Jan-Feb 2013. At the end of this period, the EPRI developers conferred with the Alpha2 test users, and gathered important feedback concerning performance factors and features that would require re-design. In general, the device performed well enough to assure proof-of-concept. The meter, with its small weight and size, did not present a hindrance to a worker's performing his/her required tasks, and appeared acceptable from that perspective for routine use.

The project activities will include redesign of the device to the beta version, field testing, and then any further modifications prior to seeking a commercializer.

Benefits

A personally-worn monitor indicating that the ambient electric or magnetic field was approaching a level that could conceivably interfere with an implanted device's performance would be a valuable component of a comprehensive workplace safety program. Such a monitor could be programmed to specific field thresholds and provide audible, visual, and/or vibratory signals to alert the wearer that a programmed threshold had been exceeded.

Epidemiologic Study of Maternal Exposure to Power Frequency Magnetic Fields and Asthma in Offspring (072608)

Background, Objectives, and New Learning

The lack of transmission capacity is perhaps the largest barrier facing renewable energy projects and the overall safe and reliable operation of the power delivery system. Timely implementation of new transmission projects will take on heightened importance as the power grid is expanded, upgraded, and modernized. Construction of new or upgraded transmission lines can create public concern about possible human health risks from exposure to electric and magnetic fields (EMF). This can lead to lengthy delays and possibly cause regulatory decisions affecting project schedules and costs for industry and society alike.

A number of potential health outcomes have been studied over the years in relation to power frequency magnetic field exposure. For most health outcomes, there is no consistently shown link with magnetic field exposure. In 2007, for example, the accumulating body of scientific evidence prompted the World Health Organization to conclude that cardiovascular diseases and breast cancer are probably not related to magnetic field exposure. An epidemiologic association between residential magnetic field exposure and childhood leukemia remains the most consistently reported finding.

In August 2011, a new epidemiologic study reported a statistically significant association between maternal exposure to power frequency magnetic fields during pregnancy and risk of asthma in the offspring before age 13. The 2011 study, the first to look at this issue, has some merit but also has limitations, and its findings warrant further research to confirm or refute the reported association.

The objective of this research project is to conduct a new study to provide an independent evaluation and assess the relationship between maternal exposure to magnetic fields and the risk of asthma in offspring.

Project Approach and Summary

The project will take advantage of a large existing set of data. A comprehensive database on a cohort of about 100,000 women, recruited during their pregnancies between 1996 and 2002, and their children from these pregnancies will be used for further research. The data set contains detailed health information, hospital records and information on drug prescriptions. Records on residential address and nearby transmission facilities will be used for estimation of residential exposure to magnetic fields at the time of pregnancy. This study will include a sufficiently large number of asthma cases (estimated in the several thousands) and will result in a statistically robust finding. The availability of this data set also provides a valuable input to the proposed study without incurring additional costs to collect new data.

Benefits

This work will build upon EPRI's expertise in EMF health assessment research and contribute to a greater body of scientific knowledge of EMF health effects. This work will provide new learning for a specific emerging health issue, with timely state-of-the-science information, providing better overall understanding of potential health effects related to magnetic field exposure. This better understanding by the scientific community and by the public at large may facilitate timely construction of future transmission and distribution facilities and may aid in avoiding costly delays due to health concerns.