

Electric and Magnetic Fields and Radio-Frequency Health Assessment and Safety - 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 EPRI staff expertise 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. Globally, EPRI's EMF program is the longest-running comprehensive research program addressing ongoing and emerging EMF and RF health issues, bringing EPRI an international 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 research, 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 research results, including 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; and
- Comprehensive assessment of the potential effects of EMF exposure on economically important animals (e.g., bees, cattle) and aquatic life from submerged cables.

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;
- Source characterizations of the Itron smart meter deployed by Southern California Edison and San Diego Gas and Electric, and the Silver Spring system deployed by Pacific Gas & Electric;
- 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 residential exposure to magnetic fields and childhood leukemia and brain cancer;
- 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;
- Software and instrumentation characterizing and benchmarking residential and occupational EMF/RF;
- Completion of a three-part video series on EMF covering all aspects of the power frequency health issue in about five hours of viewing;
- RF safety information that guides electric company safety program development and aids compliance with RF safety standards; and
- Responses to public and worker concerns about EMF/RF and information for project regulatory applications, such as environmental impact statements or assessments.

Current Year Activities

High-priority research and effective communication form the foundation for the 2013 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 epidemiology 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 develop a personal monitor to inform workers of possible interference,
- Assess the role of electric shocks encountered on the job in the association between occupational magnetic field exposure and neurodegenerative diseases,
- Characterize electromagnetic spectra in electric vehicles and around charging stations,
- Address emerging concerns about potential EMF effects on behavior and health of honeybees and cattle, and
- Evaluate the potential effects on marine biota from exposure to EMF from underwater transmission cables.

Estimated 2013 Program Funding

\$5.0M

Program Manager

Gabor Mezei, 650-855-8908, gmezei@epri.com

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 e-mailed reports on new research results, scientific meetings, health risk assessments, and regulatory actions. The project also maintains a public EMF website and issues semiannual newsletter to stakeholders.
P60.002	Laboratory Studies Using Cell and Animal Models	The aim of this research is to study potential effects of magnetic field and contact current exposure in an experimental mouse model of childhood environmental leukemogenesis. The model was in 2011, and its genetic characteristics and survival curves were described in a paper to be published in 2012. The project continued into 2012 with further in-depth characterizations of the leukemic lymphocytes and bone marrow. In addition, the system was tested with positive controls (exposures known to be carcinogenic) to establish a reliable methodology for testing EMF or any suspect exposure. Mouse models are essential in research to identify factors involved in disease development. In 2013, a facility will be established for exposing mice to magnetic fields for assessing whether magnetic fields affect the development of leukemia in the mouse model.

Project Number	Project Title	Description
P60.003	Residential and Community Health Studies	This project includes health studies, 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 susceptible population that avoid selection bias and to replicate a much-publicized UK study of childhood leukemia. In addition, the feasibility of an innovative study of EMF and miscarriage is being evaluated through a pilot study. Emerging concerns about potential health and behavioral effects of EMF on animals will also be addressed.
P60.004	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 2013, the feasibility of including modeling capability for underground transmission lines will be assessed. Work in 2013 will also include evaluations of new computing platforms, including the feasibility of developing <ul style="list-style-type: none"> • An iPad tablet computer version in the Apple iOS 4.3 • An Internet-based (cloud computing) version hosted on EPRI servers • A new module for electric field shielding by objects outside rights-of-way (such as trees, buildings, or fences)
P60.005	Residential and Community Exposure Assessment	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)

Key Research Question

The issue of possible health effects from exposure to the extremely low frequency (ELF) EMF and radio-frequency (RF) fields associated with the electric power system and sources such as panel antennas, wireless networks, and automatic metering infrastructure, continues to generate concern. The importance of this issue will grow as electric companies undertake new transmission and distribution projects to deliver electricity from renewable energy sources, and install smart grid technologies and wireless communication devices to maintain reliable power flow and efficiency. Electric power companies must have ready access to credible, up-to-date information to be versed in EMF and RF research issues in order to adequately address public and worker health and safety concerns, respond to decision makers and other stakeholders, and effectively manage the EMF issue.

Approach

The EMF and RF Information Project provides timely, reliable EMF and RF research information through hard-copy and electronic media. Participants receive communication materials, relevant background information, and EPRI Comments on key peer-reviewed studies and technical reports. This project includes a public EMF web page and a semiannual public newsletter that summarizes both EPRI EMF/RF research news and key

worldwide news events. In conjunction with Resource Strategies' ELF Gateway and RF Gateway, the project provides e-mailed reports on recently published research results, health risk assessments, scientific meetings, and regulatory actions. Both ELF Gateway and RF Gateway websites have a searchable database of EMF information that is available to participants.

Impact

- Improves EMF/RF issue management by providing comprehensive, objective, reliable, and timely information and analyses on possible health effects from exposure to EMF
- Provides issue managers with information to address public and worker concerns about health risks and to take appropriate steps to ensure health and safety and avoid unnecessary costs

How to Apply Results

EMF and RF issue managers will use the materials and information from this project to remain knowledgeable about EMF and RF health and safety research, health risk evaluations, and regulatory actions. Managers can also use this information to communicate current knowledge about possible health effects and the results of recent health risk evaluations to concerned workers and the public.

2013 Products

Product Title & Description	Planned Completion Date	Product Type
ELF & RF Gateways: Resource Strategies' ELF Gateway and RF Gateway e-mail news service provides summaries of new research results, international scientific meetings, health risk assessments, and regulatory actions.	12/31/13	Technical Resource

P60.002 Laboratory Studies Using Cell and Animal Models (SP1736)

Key Research Question

In vitro and in vivo laboratory models provide important data for evaluating possible health risks from environmental exposures. In EMF health science, results from laboratory models provide a strong complement to epidemiologic findings. For childhood leukemia, virtually all of the laboratory evidence fails to support epidemiologic evidence of an association with magnetic field exposure. However, no adequate in vivo model of acute lymphoblastic leukemia (ALL), the most common form of childhood leukemia, currently exists. In its 2007 Environmental Health Criteria on EMF, the World Health Organization (WHO) assigned a high research priority to developing a rodent model. Such a model is needed to test the potential effects of environmental exposures, including magnetic fields and contact currents, on childhood leukemia development and progression. Further investigation of neurodegenerative diseases was also identified as high-priority research. As in cancer research, animal models play a crucial role in risk evaluation of neurodegenerative diseases.

Approach

This project has supported the development of an in vivo mouse model of childhood leukemia adaptable to studying potential leukemogenic effects of magnetic fields and other suspected exposures, such as contact currents. Full-scale experiments planned through 2013 will use laboratory models developed in 2009–2012. An additional project aim is to identify the best animal model for use in laboratory investigations assessing a potential effect of EMF exposure in the development of neurodegenerative diseases, such as Alzheimer's disease.

Impact

- This research provides essential information for health risk assessments by clarifying the plausibility and dose-response characteristics of effects from electric and magnetic fields and contact currents through careful examination of relevant exposures, cell systems, and whole animals.

- By providing accurate experimental evidence for health risk assessments, this research contributes to sound public health policy and helps members address public concerns about health risks.
- This research, combined with epidemiologic and exposure assessment studies, will provide accurate scientific information that helps address public concerns about power facility siting, construction, and operation.

How to Apply Results

Publication of research results in the peer-reviewed literature provides accurate information that EMF issue managers can use to address concerns about health risks. Publication of research results also demonstrates the electric power industry's commitment to resolving uncertainties about EMF and health through active support of the highest quality research. Project involvement will keep members informed on project progress and on the most recent scientific developments in laboratory science. EPRI is in an ideal position to facilitate broader use and awareness of results by briefing key stakeholders, including policymakers and policy researchers; developing materials for the trade press and the media; presenting at meetings and seminars; and continuing service on various advisory panels.

2013 Products

Product Title & Description	Planned Completion Date	Product Type
Effects of Positive Controls on the Development of Leukemia in a Translocation-Knockout Mouse Model of Childhood Leukemia: The newly developed genetically engineered mouse model will be tested with known carcinogens to investigate whether the model can demonstrate carcinogenic effects.	12/31/13	Peer Literature
Magnetic Field Exposure System Suitable for Exposing Genetically Engineered Leukemic Mice to Magnetic Fields: This project will identify and develop a suitable magnetic field exposure system for evaluation of carcinogenicity of magnetic fields in the newly developed genetically engineered mouse model of childhood leukemia.	12/31/13	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Results of Leukemic Mouse Magnetic Field Bioassay: This 2014 peer-reviewed literature paper will present the results of the translocation-knockout leukemic mouse model tested for potential effects of EMF on the development of leukemia.	09/30/14	Peer Literature

P60.003 Residential and Community Health Studies (SP0239)

Key Research Question

On the basis of the epidemiologic association between magnetic fields and childhood leukemia, risk assessments by agencies such as the International Agency for Research on Cancer and the National Institute of Environmental Health Sciences concluded that magnetic fields are a possible human carcinogen. In 2007, the 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 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).

Approach

This project addresses, as its main focus, the EMF–childhood leukemia issue, with a threefold approach: supporting high-quality, hypothesis-based health studies; analyzing and integrating available data; and synthesizing and evaluating the state of knowledge. The key elements of this project in 2013 are to

- Continue the TransExpo study to examine the role of selection bias in the epidemiologic association between magnetic fields and childhood leukemia in a highly exposed population. TransExpo is an international epidemiologic study of children living in multilevel apartment buildings with built-in transformer rooms;
- Replicate the 2005 Draper study, which reported a positive association of distance to power lines with childhood leukemia;
- Evaluate the feasibility of establishing a cohort of children with Down syndrome (a group at extremely high risk of developing childhood leukemia) to assess potential EMF effects;
- Investigate the relationship between magnetic field exposure and miscarriage; and
- Assess the scientific literature to evaluate possible health and behavioral effects of EMF exposure on animals.

Impact

- Improves risk assessment and public understanding by providing timely data and analyses to help resolve key uncertainties related to residential EMF exposure and childhood leukemia
- Clarifies results of previous studies reporting an association between magnetic field exposure and miscarriage
- Addresses public concern about residential proximity to electrical installations
- Fills research gaps in understanding impacts related to environmental EMF exposure generated by renewable energy sources
- Mitigates unintended health consequences of advanced technology integration
- Addresses emerging concerns about potential health and behavioral effects of EMF on animals

How to Apply Results

Results published in the peer-reviewed literature provide accurate information that EMF issue managers can communicate to address concerns about health risks. Publication of research results also demonstrates the electric power industry's commitment to resolving uncertainties about EMF and health through active support of the highest quality research. Project involvement will keep members informed in advance of formal release of the results in the peer-reviewed literature. In addition, EPRI researchers will facilitate broader use and awareness of results by briefing key stakeholders, including policymakers and policy researchers; developing materials for the trade press, public and the media; presenting at meetings and seminars; organizing topical workshops and webcasts; and continuing participation on various advisory panels and professional committees.

2013 Products

Product Title & Description	Planned Completion Date	Product Type
<p>Evaluation of EMF Impacts of Underwater Power Cables on Aquatic Life: Offshore wind turbine projects are being proposed to harness wind energy over the oceans and convert it to electricity. Some of this potential energy may be near major energy load centers where energy costs are high and land-based wind development opportunities are limited. Undersea electric cables are used to connect multiple turbines in the wind facility and transport the electricity to a transformer, where the electricity is converted to a high voltage for transmission via undersea cables to a substation. There the electricity is connected to the onshore electricity grid. There may be concern about potential interference with navigation for endangered and threatened aquatic species. Electromagnetic fields created by the electric cables running from the turbines and underwater noises and vibrations could affect their orientation and navigational ability. This technical report, as a follow-on to a 2012 technical update, will identify research gaps related to the potential effects on marine life of EMF from underwater high-voltage cables and will outline potential future research projects in this area.</p>	12/31/13	Technical Report
<p>Use of Transmission Line Easements for the Benefit of Native Bees: Final Report: Concern for the maintenance of wild bee populations has increased in recent years, with evidence from Europe and the United States suggesting a general decline in abundance and diversity. The decline in honeybee populations due to colony collapse disorder, pesticides, and parasites has led to efforts to create native bee–friendly habitat as a way to take the pressure off managed honeybee colonies as pollinators. It has been suggested that electric and magnetic fields have adverse effects on bees, including bee behavior and flight performance. This project will determine the impact of electric and magnetic fields on flight performance and behavior of native bees and evaluate the benefits of managed habitat in transmission line easements to local native bee diversity.</p>	12/31/13	Technical Report
<p>Childhood Leukemia among Children with Down Syndrome: Children with Down syndrome (DS) have significantly higher risk of childhood leukemia than children without DS. The paper will evaluate existing epidemiologic, clinical, and laboratory literature in an attempt to determine whether leukemia among children with DS could be used as an appropriate model for the general population in a potential future cohort study of EMF and childhood leukemia.</p>	12/31/13	Peer Literature
<p>Socioeconomic Status (SES) and Childhood Cancer: As part of the ongoing California study of childhood cancer and residential proximity of power lines, the association between SES and childhood cancer will be examined. SES is frequently considered a potential confounder in childhood cancer epidemiologic studies.</p>	12/31/13	Peer Literature
<p>Update on TransExpo Study Progress: The technical update will review study progress for the international epidemiologic study of childhood leukemia among children who lived in multilevel residential buildings with built-in transformers. The study aims to minimize or potentially eliminate control selection bias and will focus on highly exposed populations of children. The technical update will describe results from the international meeting of study investigators and any revisions the investigators' group deems necessary based on results of the national feasibility assessment studies.</p>	12/31/13	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Residence near Power Lines and Childhood Cancer: This study will replicate the 2005 Draper study, which reported that residing within 600 meters of overhead transmission lines increased leukemia risk among children in the United Kingdom. The replication study will use improved exposure assessment methods and will include calculated magnetic fields and, for houses near power lines, measured fields.	12/31/14	Peer Literature
Country-Specific Results of TransExpo Feasibility Studies: Feasibility studies are currently being carried out in a number of countries such as Italy, The Netherlands, and China. The manuscript will report on the results of these ongoing feasibility studies. TransExpo is an international epidemiologic study of childhood leukemia among children who lived in multilevel residential buildings with built-in transformers. The study aims to minimize or potentially eliminate control selection bias and will focus on highly exposed populations of children.	12/31/14	Peer Literature
TransExpo Study Results : The manuscript will report on the results of the international epidemiologic study of childhood leukemia among children who lived in multilevel residential buildings with built-in transformers. The study will minimize or potentially eliminate control selection bias and will focus on highly exposed populations of children.	12/31/16	Peer Literature

P60.004 EMFWorkstation (SP1246)

Key Research Question

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

Approach

Over the past decade, the EMFWorkstation has been one of EPRI's most popular software products. The software provides a cost-effective method for characterizing magnetic field levels and for evaluating different magnetic field management options. In 2013, the software will be updated for compatibility with contemporary PC operating systems, and new features will be included as requested by members. The feasibility of including modeling capability for underground transmission lines will also be assessed.

Impact

- This product provides a versatile tool for characterizing and evaluating magnetic fields in residential, commercial, and occupational environments.
- EPRI's EMFWorkstation is the only integrated EMF management software available offering accurate results for complex environments in a user-friendly product.

How to Apply Results

Participants (including industrial hygienists and design engineers) can use EMFWorkstation software to model magnetic field environments in residential, commercial, and occupational settings and to evaluate magnetic field management options. Participants can use the output of the models to explain field levels to regulators and other interested parties.

2013 Products

Product Title & Description	Planned Completion Date	Product Type
EMFWorkstation 2013: EMFWorkstation 2013 will incorporate fixes, maintain compatibility with current PC operating systems, and add capabilities as members request them.	12/31/13	Software

P60.005 Residential and Community Exposure Assessment (070651)

Key Research Question

This project addresses an array of emerging industry research needs, including possible RF exposures from an advanced metering infrastructure (AMI), electric vehicles, and integration of renewable resources. AMI, which includes automatic meter readers and home area networks, will become increasingly widespread within residences and communities. Questions have already arisen from the public sector about RF exposures associated with these technologies. Other devices introduced into the home, such as wireless chargers, may also prompt questions from the public. Electric vehicles (hybrids and all-electric) are penetrating the public motor vehicle fleet. The operation of such vehicles, to some extent, will generate EMF within the passenger compartment, which is likely to draw questions about health and safety. The associated charging infrastructure in homes and public areas will also result in a new exposure environment. Accurate exposure characterization is essential for addressing such concerns.

Furthermore, unidirectional and bidirectional dc-to-ac converters may be used to incorporate renewable energy sources, such as solar photovoltaics, into existing utility infrastructure. As a result of the dc-to-ac conversion, nonsinusoidal waveforms of higher-order frequency may be created. To reduce uncertainties about exposure to the public as well as workers and to address related public health and safety concerns, scientifically rigorous exposure assessment is required.

To enable the most efficient integration of renewable energy resources, EPRI will conduct comprehensive assessments of power frequency (60 Hz), harmonics, and high-frequency magnetic field exposures in the renewable environment; evaluate exposure for a representative range of system loads and operational conditions; and model the geomagnetic environment.

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.

Approach

This project characterizes ELF and RF electromagnetic fields emitted by AMI devices in residential settings, electric vehicles and related charging infrastructure, and other potential exposure settings related to the new smart grid infrastructure.

The project will also characterize the electromagnetic environment in proximity to renewable energy infrastructure, such as technologies using power electronic dc-to-ac converters. Measurements of power frequency will capture waveform distortions at the source and for a range of representative system loads and operational conditions.

Impact

- This research provides characterization of EMF exposures related to emerging energy technologies, specifically to address residential exposures to RF electromagnetic fields from wireless emitters within residences, in electric vehicles, and from devices that produce distorted waveforms due to dc-to-ac conversion. Depending upon results, further research may focus on exposure reduction strategies for the public and workers.

How to Apply Results

EMF issue managers can communicate EMF characterization results to address growing public concerns about smart grid and renewable technologies and electric vehicles. In addition, EPRI researchers will aid broader use and awareness of results by briefing key stakeholders, including policymakers and policy researchers; developing materials for the trade press, public and the media; presenting at meetings and seminars; developing software tools; organizing topical workshops and webcasts; and continuing participation on various advisory panels.

2013 Products

Product Title & Description	Planned Completion Date	Product Type
RF Exposure from Wireless Sources: The developing smart grid, along with many other residential and industrial sources, include an increasing numbers of two-way communication devices. The report will summarize results of a measurement campaign including these sources.	12/31/13	Technical Update
EMF from Electric Transportation Charging Infrastructure: The study will report on measurement results near residential and commercial electric vehicle charging stations.	12/31/13	Technical Update
EMF from Renewable Energy Generation: This report will present results from EMF exposure assessment near renewable energy generation.	12/31/13	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
EMF from Underwater Cables : This report will present results from EMF exposure assessment near underwater cables.	12/31/14	Technical Update

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 is also concerned with the technical 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. In addition to its contribution to guideline science, EPRI will continue to monitor revisions to guidelines 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 also includes development of an RF safety reference book and further refinement of the RF exposure modeling software suitable for modeling occupational exposure from RF sources at electric utility workplaces. As the use of implanted medical devices is rapidly expanding both in the general population and among active workers, the issue of potential interference from exposure to ELF and RF EMF remains a concern. The Occupational Studies Project Set will systematically review medical literature on this issue and will identify research gaps in the area for potential future research.

Project Number	Project Title	Description
P60.006	EMF and RF Occupational Health and Safety	<p>This project provides a comprehensive assessment of potential links between EMF exposure and health effects among electrical and other workers. In accord with WHO research priorities, work in 2013 will continue to focus on neurodegenerative diseases. This project also includes monitoring of occupational exposure guidelines for EMF and contact currents and investigation 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 2011 in RF exposure characterization (source description, measurement techniques, and exposure modeling), dosimetry, and safety program design. Work will begin on organizing and producing the <i>RF Safety Reference Book</i>. Additional work will include refinement of the RF exposure modeling software.</p>

P60.006 EMF and RF Occupational Health and Safety (070652)

Key Research Question

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, WHO assigned a high priority to research on ALS in electrical occupations. WHO also assigned a high priority to research on magnetic field exposure in relation to Alzheimer's disease. Well-conducted research is critical in order to address these issues and develop work practices that protect health and safety. Cutting-edge research forms the bases for appropriate exposure guidelines. As such, the EPRI EMF and RF program will begin to explore the possible role of occupation and occupational exposures in the context of 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 developing an iPad tablet computer version in the Apple iOS 4.3 will also 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 renewable energy resources. Possible health effects from exposure to the ELF EMF associated with the electric power system continue to generate concern. The use of implanted medical devices is expanding in conjunction 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.

Approach

This project provides a comprehensive assessment of potential links between EMF exposure and health effects among electrical and other workers. Key activities in 2013 will include

- A comprehensive review of the literature on EMF/RF interference with implanted medical devices;
- A multiyear effort to produce the *RF Safety Reference Book*;
- An evaluation of the spatial and temporal aspects of electric and magnetic environments associated with occupations in renewable energy infrastructure, including measurements of power frequency (60 Hz), harmonics, and high-frequency components in work environments and identification of potential methods to mitigate exposure (such as shielding or design options); and
- Refinement of the RF exposure modeling software.

Impact

- Addresses concerns about worker health and safety by clarifying possible health effects of EMF and RF exposures among electrical and other workers and assessing occupational exposures. Knowledge about exposures and health effects aid development of cost-effective, protective work practices and can reduce liabilities.
- Potentially reduces costs associated with guideline compliance by providing information from state-of-the-art science consistent with safety for workers and the general public in EMF environments. Valid input of this nature can avoid unnecessarily conservative guidelines, which can result in excessive costs (such as the cost of overly protective gear and of equipment shutdowns) and impractical work practices. Research may also identify areas where additional protection is required.
- Enables development of more-effective maintenance practices, minimizes worker exposures, and permits work near RF and wireless installations without costly interruptions and delays.
- Aids commercially viable renewable energy sources by delivering informed, accurate exposure assessments.

How to Apply Results

Electric company occupational health and safety staff will use this work to assess worker exposures to EMF, contact currents, and spark discharges and RF and to assess potential risk of interference with implanted medical devices. Using this information will enable the occupational health and safety staff to make informed decisions on any interventions that may be necessary or advisable. Health effects research results will help EMF and RF issue managers address concerns about potential health risks. EPRI researchers will facilitate broader use and awareness of the results by briefing key stakeholders, including policymakers and policy researchers; developing materials for the trade press, public and the media; presenting at meetings and seminars; and continuing participation on various advisory panels.

Electric company occupational hygienists, managers, and safety specialists will be able to assess worker EMF exposures in renewable technology environments. EPRI research will bridge gaps in worker health knowledge surrounding renewable technologies by communicating with key stakeholders, developing materials for the trade press, public and media, presenting at meetings and seminars, and continuing participation on advisory panels.

2013 Products

Product Title & Description	Planned Completion Date	Product Type
EMF Interference with Implantable Cardiac Devices: In a series of peer-reviewed papers, experts will summarize the issues related to EMF interference with implanted medical devices, including device response, potential exposures, and clinical significance.	12/31/13	Peer Literature
EMF Interference on cardiac implant devices: Workplace Considerations: This technical update will summarize issues related to EMF interference with implanted medical devices and provide an outline for potentially useful workplace practices (e.g., warnings, instructions) to aid companies in protecting their workers.	12/31/13	Technical Update
Epigenetics of Neurodegenerative Diseases: This issue brief will provide an overview of recent developments in epigenetics, technological changes, and epidemiologic methods that have advanced understanding of the natural history of neurodegenerative diseases, as their etiology may relate to occupational EMF exposures.	12/31/13	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
RF Safety Reference Book: The <i>RF Safety Reference Book</i> will provide comprehensive information on a wide range of RF safety topics in a practical format. The reference book will include a CD or DVD containing EPRI's RF modeling software and RF measurement training video. Together, the reference book and CD will compile and update all EPRI RF safety work in a convenient source of RF safety information for utility worker populations.	12/31/14	Technical Report
RF Exposure Modeling Software Version 3.0: Refinement of the RF exposure modeling software version will incorporate fixes, maintain compatibility with current PC operating systems, and add capabilities as members request them.	12/31/14	Technical Report