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

Program Overview

Program Description
The safe and reliable operation of the power delivery system 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. In addition, the anticipated large-scale introduction of rechargeable electric vehicles and charging infrastructure will require significant investment in new grid infrastructure. Construction of new or upgraded transmission lines may fuel public concern about possible human health risks from exposure to electric and magnetic fields (EMF) and could lead to regulatory decisions that affect project schedules and costs. With the expansion of smart grid technology and its reliance on continuous two-way wireless communication between user and supplier, radio-frequency (RF) exposure sources will become ever more common in residential locations and others shared by the general public as well as by personnel who work on the facilities. At the same time, revisions to guidelines for public and worker EMF and RF exposures could result in altered exposure limits. Over the past 5–10 years, power companies have addressed concerns about RF exposure from antennas installed on grid infrastructure and have adopted practices for compliance with Federal Communications Commission exposure limits. These needs often require safety awareness training for the workers. Further communication is necessary to help inform various constituencies about the distinction between power frequency and radio frequency, and the issues unique to each.

Despite their differences, EMF and RF increasingly share common physical environments. Accordingly, EPRI’s EMF and RF Health Assessment and Safety program now incorporates EMF and RF research under a common focus. The program research and information helps power companies address both EMF and RF issues as they arise. Program research and staff scientific expertise contribute to the body of scientific knowledge, better enabling accurate health risk evaluations and state-of-the-science 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 supports power companies with ongoing or proposed transmission line and substation projects by providing timely information for improved risk communication and issue management. The program delivers research aimed at resolving high-priority EMF and RF health questions and provides input for science-based exposure guidelines to address worker and public safety. EPRI expertise and research results also contribute to risk assessments and other activities that inform EMF policy. The program's RF safety research contributes to accurate RF exposure assessment, enhanced worker safety, and compliance with RF safety regulations. The scientific work of the program is also aided by a blue-ribbon scientific advisory committee composed of leading independent experts in various disciplines ranging from medicine, through epidemiology and statistics, to engineering. The program as well maintains an active public communications effort, providing accurate public information on both EMF and RF.

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

- timely, reliable EMF and RF research information, including communication materials, relevant background information, and analyses of key external studies;
- access to web-based and distributed e-mail communications for the latest 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 electric and magnetic fields in residential and occupational settings;
• EMF and RF exposure characterization research and exposure assessment software; and
• educational materials, including instructional DVDs dealing with a range of EMF and RF topics, including tutorials and RF safety awareness training.

Accomplishments

Through its peer-reviewed scientific publications, staff presentations at scientific meetings and seminars, and staff service on various advisory panels, the EMF and RF Health Assessment and Safety program has established a reputation within the international scientific community for rigorous, independent, objective research. EMF/RF issue managers report that supporting EPRI EMF research is in itself an appropriate response to public concern.

• Program research results and information help issue managers address public and worker concerns about EMF/RF, take appropriate steps to ensure health and safety, and avoid unnecessary costs.
• Scientific input contributes to accurate EMF health risk evaluations and exposure guideline development, domestically and internationally.
• EPRI software and instrumentation have proved essential for characterizing residential and occupational EMF and RF.
• The program’s communication efforts provide objective public information resources.
• RF safety information has been used to guide electric power company safety program development and aid compliance with RF safety standards.

Current Year Activities

High-priority research and effective communication form the foundation for the 2011 program. Specific efforts will
• use both epidemiologic and laboratory research strategies to investigate the basis for the epidemiologic association between residential magnetic fields and childhood leukemia;
• continue a feasibility assessment for an innovative epidemiologic study of EMF and miscarriage;
• investigate the feasibility of laboratory biological models that can address potential links between EMF and childhood leukemia, and between EMF and neurodegenerative diseases (Alzheimer’s, amyotrophic lateral sclerosis);
• investigate occupational health and safety issues relevant to power-frequency EMF as well as RF environments, including neurodegenerative disease risk and interference with implanted medical devices (such as cardiac pacemakers);
• conduct research relevant to EMF exposure guideline formulation, develop exposure monitoring instrumentation relevant to the safety of workers with implanted medical devices, and monitor guideline revisions and related developments;
• investigate cutting-edge RF safety issues, such as RF burns, and create relevant RF safety products, including RF safety tutorials;
• develop an educational DVD as part of a series that provides a comprehensive background on all aspects of the EMF health issue;
• address emerging concerns about potential EMF effects on animal behavior and health; and
• maintain a vital and creative communications effort that reaches both EMF/RF program members and the larger stakeholder community.

Estimated 2011 Program Funding

$5.0M
Summary of Projects

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

Project Set Description
The Community and Residential Studies Project Set offers scientific research and information on high-priority community and residential health issues related to EMF and RF. Foremost is childhood leukemia, which continues to generate public concern in areas designated for new power line and substation projects. Epidemiologic, exposure assessment, and laboratory research in this Project Set focuses on investigating the basis for the reported association between residential magnetic fields and childhood leukemia. Research in 2011 will also investigate magnetic field exposure in relation to miscarriage and neurodegenerative diseases, and potential effects of EMF exposures on animal behavior and health.

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 concern about EMF and health.

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<th>Project Number</th>
<th>Project Title</th>
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<tr>
<td>P60.001</td>
<td>EMF and RF Information Project</td>
<td>The EMF Information Project provides timely, reliable EMF and RF research information, including communication materials, relevant background information, and “EPRI Comments” on key studies. In conjunction with Resource Strategies’ ELF and RF Gateways, this project provides e-mailed reports on new research results, scientific meetings, health risk assessments, and regulatory actions.</td>
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<tr>
<td>P60.002</td>
<td>Laboratory Studies Using Cell and Animal Models</td>
<td>The aim of this research is to study potential effects of contact current and, possibly, magnetic field exposure in an experimental mouse model of childhood environmental leukemogenesis. Work in 2010 continued to focus on developing the model with genetically engineered mice. If successful, the model would first be used in 2011 to test “positive control” exposures, followed by an EMF phase of the research. Mouse models are essential in research to identify factors involved in disease development. As an alternative, or in addition to an in vivo approach, an in vitro solicitation is under consideration. This study would consist of a bone marrow preparation exposed to both positive controls and then to EMF factors to determine whether biological effects relevant to leukemogenesis occur.</td>
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<tr>
<td>P60.003</td>
<td>Residential and Community Health Studies</td>
<td>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 avoids selection bias and to replicate a much-publicized UK study of childhood leukemia. New research will further investigate magnetic field exposure in relation to survival among children with a leukemia diagnosis. In addition, an innovative study of EMF and miscarriage is planned, following a pilot phase in 2009. Emerging concerns about potential health and behavioral effects of EMF on animals will also be addressed.</td>
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**Project Number** | **Project Title** | **Description**
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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 reported problems will be fixed. New features will be added only as requested by EPRI members.

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/ac conversion, RF exposures from a range of wireless devices, and exposures within electric vehicles.

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**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 associated with the electric power system and RF associated with a variety of sources (e.g., panel antennas, wireless networks, automatic metering infrastructure) continues to generate concern, especially as power companies plan new transmission and distribution projects to deliver electricity from new renewable energy resources and as they install smart grid technologies and wireless communication devices to maintain reliable power flow and efficiency. To address public and worker health and safety concerns and effectively manage the EMF issue, power companies need to stay current on EMF and RF research and have ready access to credible, up-to-date information.

**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 studies. In addition, this project includes a public EMF web page and a public newsletter that summarizes both EPRI EMF/RF research news and key worldwide news events. In conjunction with Resource Strategies’ ELF and RF Gateways, this project provides e-mailed reports on newly published research results, health risk assessments, scientific meetings, and regulatory actions. ELF and RF Gateway websites, with a searchable database of EMF information, are 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 take appropriate steps to ensure health and safety and to avoid unnecessary costs

**How to Apply Results**

EMF and RF issue managers will use the materials and information this project provides to stay current on 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.
2011 Products

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<tr>
<td>Continuing Updates to EMF and RF Information Project: The EMF and RF Information Project is an ongoing service providing continuous information updates via <a href="http://www.epri.com">www.epri.com</a> and e-mail alerts. The project may also provide hard-copy documents.</td>
<td>12/31/11</td>
<td>Technical Resource</td>
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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 counterbalance 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 contact current and magnetic fields, on childhood leukemia development and progression. Further research on 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 as well.

Approach

The project is attempting to develop an in vivo or in vitro approach (or both) that is adaptable for studying potential leukemogenic effects of contact current and, possibly, magnetic field exposure in young mice. Full-scale experiments planned through 2011 will use laboratory models developed in 2009–2010. Previous research from EPRI’s Childhood Leukemia Survival Study and a subsequent German study points to a possible association of magnetic field exposure with leukemia progression, indicating an additional potential adaptation of the laboratory model. An additional aim is to identify the best animal model that could be used 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 current 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 concern about health risks.
- This research, combined with epidemiologic and exposure assessment studies, will provide accurate scientific information that will help address public concern 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 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 will 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.

2011 Products

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<tr>
<td><strong>Animal Models for Neurodegenerative Diseases:</strong> Animal models play an important role in risk evaluations. This research will identify the best animal model to investigate the potential role of EMF in the development of neurodegenerative diseases.</td>
<td>12/31/11</td>
<td>Peer Literature</td>
</tr>
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<td><strong>Results of the Development of a Mouse Model for Pediatric Leukemia:</strong> After development of the basic mouse model of childhood leukemogenesis with appropriate positive controls, the model system will be exposed to contact current and/or magnetic fields to determine whether this exposure stimulates leukemogenesis. In parallel, the development of an <em>in vitro</em> bone marrow model will be initiated.</td>
<td>12/31/11</td>
<td>Peer Literature</td>
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**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 carcinogen. In 2007, the World Health Organization released an assessment that supported this conclusion while noting that uncertainties remain. Uncertainties surround other health endpoints as well, including miscarriage and neurodegenerative diseases (e.g., Alzheimer’s disease). Other groups have also commented recently on EMF health research, including the self-promoted BioInitiative Working Group, which has 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.

Construction of transmission lines in rural areas and transmission lines that link offshore renewable generation facilities (e.g., wind, wave) to the mainland grid also has raised concerns about potential effects of EMF on animal health and behavior (e.g., cattle, deer, bees, and marine life).

**Approach**

This project is addressing the 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 2011 include

- continuing the TransExpo study to examine selection bias and its role in explaining the association between magnetic fields and childhood leukemia. TransExpo is an international study of children living in apartments above transformer rooms;
- replicating the 2005 Draper study, which reported a positive association of distance to power lines with childhood leukemia;
- examining the feasibility of establishing a cohort of children with Down syndrome (a group with extremely high risk of developing childhood leukemia) to evaluate the potential effect of EMF;
- investigating the relationship between magnetic field exposure and miscarriage; and
- assessing the scientific literature to evaluate possible health and behavioral effects of EMF exposure on animals (e.g., cattle, deer, marine life).
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 (e.g., cattle, deer, bees, and marine life)

How to Apply Results

Publication of the results in the peer-reviewed literature provides 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 and the media; presenting at meetings and seminars; developing software tools; organizing topical workshops and webcasts; and continuing participation on various advisory panels and professional committees.

2011 Products

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<td><strong>Childhood Leukemia Survival in EMF Study Populations:</strong> Two recent epidemiologic follow-up studies reported poorer survival among children with leukemia who were exposed to measured magnetic fields of 0.2–0.3 µT. However, these results were based on very small numbers of cases and are thus imprecise. To further investigate the plausibility of this reported association, this analysis will pool cases from other studies of EMF and childhood leukemia.</td>
<td>06/30/11</td>
<td>Peer Literature</td>
</tr>
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<td><strong>Results of Miscarriage Pilot Study:</strong> This study introduces an innovative design to address potential relationships between peak magnetic field exposures and the risk of miscarriage. Previous studies suffered from the fact that most miscarriages are not reported, with only a minority of patients receiving clinical attention. This study, to be conducted as a pilot in 2010–2011, will use study subjects from artificial reproductive clinics at a noted medical center. Thus, all pregnancies will be charted through their entire history. Personal magnetic field and physical activity monitoring (with an accelerometer) will provide the data to analyze whether there is a relationship between pregnancy failure and magnetic field exposure.</td>
<td>12/31/11</td>
<td>Technical Update</td>
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<tr>
<td><strong>Childhood Leukemia among Children with Down Syndrome:</strong> This paper will discuss an expert panel’s evaluation of whether acute lymphoblastic leukemia among children with Down syndrome can serve as a model for this disease in the general population of children without Down syndrome.</td>
<td>12/31/11</td>
<td>Peer Literature</td>
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## Future Year Products

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<td><strong>Residence near Power Lines and Childhood Cancer:</strong> This study will replicate the 2005 Draper study, which reported that residing within 600 meters of overhead transmission lines increased leukemia risk among UK children. The replication study will use improved exposure assessment methods and will include calculated magnetic fields and, for houses near power lines, measured fields.</td>
<td>12/31/12</td>
<td>Peer Literature</td>
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<tr>
<td><strong>TransExpo Study Protocol:</strong> This peer-reviewed paper will describe EPRI’s TransExpo study, an international study of magnetic field exposure and leukemia in children living in apartment buildings with transformers. In this study, exposure will be determined according to the location of apartments relative to transformer rooms, which reliably predicts exposures. By knowing apartment locations, researchers can assess exposures and minimize the problem of inadvertent exclusion of study participants that can occur when participants are not traceable or refuse to participate.</td>
<td>12/31/12</td>
<td>Peer Literature</td>
</tr>
<tr>
<td><strong>Modification of Geomagnetic Environment: Impacts on Animals and Aquatic Life:</strong> This technical report will summarize literature on the potential effects of EMF on animals and marine life.</td>
<td>12/31/12</td>
<td>Technical Resource</td>
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### P60.004 EMFWorkstation (SP1246)

**Key Research Question**

EMFWorkstation is a versatile software tool for characterizing magnetic fields in residential neighborhoods and substations, neighborhoods located next to substations, and commercial and occupational environments.

**Approach**

Over the past few years, EMFWorkstation has been one of EPRI’s most frequently ordered software products. The software provides a cost-effective method for evaluating different magnetic field management options. In 2011, the software will be updated for compatibility with contemporary PC operating systems, and new features will be included as requested by members.

**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.
2011 Products

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<td><strong>EMFWorkstation 2011:</strong> EMFWorkstation 2011 will have added capabilities as members request them, maintain compatibility with operating systems (Windows 7), and incorporate any fixes required.</td>
<td>12/31/11</td>
<td>Software</td>
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**P60.005 Residential and Community Exposure Assessment (070651)**

**Key Research Question**

Advanced Metering Infrastructure (AMI) that 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. In addition, 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.

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.

**Approach**

This project characterizes electromagnetic fields emitted by AMI devices in residential settings, from electric vehicles, and in other potential exposure settings.

In 2010, EPRI published a report from an initial study of electric vehicles sampled from a company fleet. In 2011, this research will be expanded to represent the range of vehicles the public is likely to occupy and to evaluate exposure near charging 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 radio-frequency electromagnetic fields from wireless emitters within residences, in electric vehicles, and from devices that produce distorted waveforms due to dc/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 results of 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 and the media; presenting at meetings and seminars; developing software tools; organizing topical workshops and webcasts; and continuing participation on various advisory panels.

2011 Products

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<tr>
<td><strong>Assessment of Exposures Related to Smart Grid Technologies:</strong> This technical report will summarize findings of planned investigation of smart grid technologies such as automatic meter readers and home area networks.</td>
<td>06/30/11</td>
<td>Technical Report</td>
</tr>
<tr>
<td><strong>Assessment of Exposures Related to Electric Vehicle and Charging Infrastructure:</strong> This technical report will summarize findings from a broadened EMF assessment of electric vehicles and associated charging stations.</td>
<td>12/31/11</td>
<td>Technical Report</td>
</tr>
<tr>
<td><strong>Assessment of Exposures Related to Renewable Energy Resources:</strong> In an effort to reduce uncertainties about EMF exposures, this technical report will discuss and characterize selected EMF exposures arising from renewable energy resources such as wind power and solar farms.</td>
<td>12/31/11</td>
<td>Technical Report</td>
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**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, radio-frequency safety, and wireless technology. 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. In addition, continuing work monitors new research on EMF interference with cardiac pacemakers and other implanted medical devices in occupational environments. EMF and RF occupational health and safety research includes development of an extremely low frequency (ELF) monitor to address concerns relevant to workers with medical implants such as pacemakers, an evaluation of personal RF exposure monitor accuracy under practical conditions, the production of an RF safety awareness DVD, and the development of an RF safety reference book.

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<td>P60.006</td>
<td>EMF and RF Occupational Health and Safety</td>
<td>This project provides a comprehensive assessment of potential links between EMF exposure and health effects among electrical and other workers. In accord with World Health Organization research priorities, work in 2011 will focus on neurodegenerative diseases. This project also includes monitoring of occupational exposure guidelines for EMF and contact current and investigation of related scientific and technical issues. In addition, the project addresses potential interference with implanted medical devices.</td>
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Research in this project builds on the foundation established through 2010 in RF exposure characterization (source description, measurement techniques, and exposure modeling), dosimetry, and safety program design. In 2011, the project will deliver DVDs on RF safety awareness and continue to offer RF safety training seminars as required. Work will begin on organizing and producing the RF Safety Reference Book. Additional work will include an evaluation of personal RF exposure monitor accuracy under practical conditions.

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, the World Health Organization (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. Another concern is EMF and contact current interference with cardiac pacemakers and other implanted medical devices. Worker and public safety also depends on accurate exposure assessment and compliance with guideline limits. Well-conducted research is critical in order to address these issues and develop cost-effective work practices that protect health and safety. In addition, cutting-edge research is essential for formulating appropriate guidelines.

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.

New work environments will be created as power companies plan new transmission and distribution projects and to cope 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 aging workforce and the proliferation of implanted medical devices converge and drive questions about potential effects from EMF environments. Power companies need to be able to anticipate the need for quantitative exposure assessment.

Approach

This project provides a comprehensive assessment of potential links between EMF exposure and health effects among electrical and other workers. Key activities in 2011 will include the following:

- An expansion of the job-exposure matrix (JEM) for electrical factors in electricity industry work environments to include a fuller inventory of workplace exposures.
- A comprehensive quantitative review of the existing epidemiologic evidence on a possible relationship between occupational EMF environments and neurodegenerative diseases, including ALS and Alzheimer's disease.
- Research on safety concerns related to potential interference with implanted medical devices in EMF environments; development of an instructional DVD on RF safety awareness, conditions in electric company environments that can lead to RF burns, and appropriate safety measures that can be taken.
- An evaluation of the accuracy of personal RF exposure monitors under real-world conditions. Work will also start on a new multiyear effort to produce the RF Safety Reference Book.
• An evaluation of the spatial and temporal aspects of electric and magnetic environments associated with renewable energy infrastructure, and measurements of power frequency (60 Hz), harmonics, and high frequency components in work environments, including potential methods to mitigate exposure such as shielding or design options.

Impact

• Addresses concerns about worker health and safety by clarifying possible health effects of EMF and RF exposures among electrical and other workers and by assessing occupational exposures. Knowledge about exposures and health effects can aid development of cost-effective, protective work practices, resulting in reduced liabilities.

• Potentially reduces costs associated with guideline compliance by providing scientific input to the formulation of guidelines that are consistent with safety for workers and the general public in EMF environments. Valid input of this nature avoids unnecessarily conservative guidelines, which can result in excessive costs (such as the cost of overly protective gear and of equipment shutdowns) and inconvenient work practices.

• Enables development of more-effective maintenance practices that minimize worker exposures and permit work near RF and wireless installations without costly interruptions and delays.

• Improves exposure assessment through advanced specific absorption rate (SAR) modeling using accurate computer models of the human body, to facilitate safe work practices near operating RF emitters and allow work in locations where existing standards for RF exposure may be unnecessarily conservative.

• Aids commercially viable renewable energy sources by delivering informed, accurate exposure assessments.

How to Apply Results

Power company occupational health and safety staff will use this work to assess worker exposures to EMF, contact current, and spark discharge and RF and to make informed decisions on any interventions that may be necessary or advisable. For workers with cardiac pacemakers and other implanted medical devices, exposure assessment can identify work areas that should be avoided. Further, a personal monitor that alerts a worker as to proximity to exposures that approach conservative device interference thresholds will prevent any mishaps due to device interference. In addition, 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 and the media; presenting at meetings and seminars; and continuing participation on various advisory panels.

Power company occupational hygienists, managers, and safety specialists will be able to assess worker EMF exposures in renewable technology environments. Workers with implanted medical devices will be able to identify avoidable work areas. EPRI researchers will bridge gaps in worker health knowledge surrounding renewable technologies by communicating with key stakeholders, developing materials for the trade press and media, presenting at meetings and seminars, and continuing participation on advisory panels.

Industrial hygienists and other occupational health and safety staff will use the video on RF safety awareness to train workers to recognize and avoid situations where RF burns may occur. RF burn safety is an important component of a comprehensive RF safety program. The new RF Safety Reference Book can be introduced in a series of safety training seminars. Personal RF exposure monitor testing will help users optimize monitor use to achieve accurate readings. This work may also point the way to development of improved monitors.
2011 Products

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<th>Product Title &amp; Description</th>
<th>Planned Completion Date</th>
<th>Product Type</th>
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<td><strong>De-energized Transmission Line Maintenance Risk Analysis:</strong> When workers perform tasks on de-energized transmission lines, equipotential grounds are installed to prevent injury from inadvertent fault currents. These grounds must be heavy enough to shunt the current necessary to ensure safety, yet light enough to be handled in a practical manner. An EPRI member has developed a risk analysis tool designed to specify conditions that virtually eliminates the probability that any fault current would exceed cardiac fibrillation thresholds. To address the critical missing data component for this model, EPRI has published two studies whose results permit the establishment of a human impedance model that includes both the body and, equally or more important, workers’ footwear. In 2011, working with the EPRI member that developed the model, EPRI will support the incorporation of the human impedance model, thus completing the risk analysis.</td>
<td>12/31/11</td>
<td>Technical Report</td>
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| **Evaluation of RF Exposure Monitor Accuracy:** A 2011 technical report will summarize the results of an evaluation of personal RF exposure monitor accuracy under practical conditions (everyday wear, wear with tool belts, and effects of different body postures and monitor placement on the body). | 12/31/11 | Technical Report |

Future Year Products

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<th>Product Title &amp; Description</th>
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<td><strong>ELF Personal Monitor:</strong> The number and variety of implantable medical devices is rapidly proliferating, with a correspondingly growing population of workers who use them. Cardiac pacemakers and defibrillator/pacemakers remain the most prevalent of these devices. Such devices permit many workers to return to the work they were doing prior to receiving implants. However, it is essential that such individuals avoid locations with electric or magnetic fields at levels that approach interference thresholds. The ELF Personal Monitor will be designed to permit preprogrammed thresholds to be set for both electric and magnetic fields, with a method to alert (without startling) a worker that he/she is approaching an area that contains exposures near conservatively determined interference thresholds.</td>
<td>12/31/12</td>
<td>Hardware</td>
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| **RF Safety Reference Book:** The *RF Safety Reference Book* 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. | 12/31/12 | Technical Report |

| **Occupational EMF Characterization of Renewable Energy Sources:** This 2012 technical report will describe the occupational EMF environment of selected renewable energy environments. | 12/31/12 | Technical Report |