

35 Overhead Transmission

Program Overview

Program Description

The Electric Power Research Institute's (EPRI's) Overhead Transmission Program offers a focused portfolio of products and technologies to support today's most important corporate objectives for transmission companies: improve safety and reliability as well as cut operations and maintenance (O&M) costs and reduce capital expenditures for new/refurbished equipment.

The program has projects focused on specific components, e.g. compression connectors, crossarms, etc. as well as projects focused on issues, e.g. lightning and grounding, live working, etc. The programs delivers a blend of short term tools such as software, reference and field guides together with longer term research such as aging tests and the development of inspection technologies.

Industry Needs and Issues Addressed

- Ensure safety of utility workers and public
- Increase and ensure reliability and availability of transmission lines
- Reduce operations and maintenance (O&M) costs
- Reduce design and construction costs of new transmission lines
- Reduce the footprint of existing transmission lines
- Use new lower cost or high-performance components
- Aging of transmission lines assets
- Loss of institutional knowledge

Impact

- Improved management of aging transmission line components
- Improved inspection and assessment tools and techniques
- Enhanced lightning performance reliability
- Tools to increase efficiency of transmission line design
- New live working techniques and procedures
- Improved approaches to selecting, applying, inspecting, and assessing insulators

Key Accomplishments

- EPRI Transmission Line Reference Book, 200-kV and above, 3rd Edition (Red Book)
- Daytime Corona Camera (Daycor)
- Guide to Grounding of Transmission Lines and associated software (EGGS)
- Accelerated Aging of Transmission Line Polymer Insulators
- Field Guides: Wooden Structures, Steel Structures, Steel Structure, Foundations, Polymer Insulators, Corona Rings, Daytime Discharge Inspection, Porcelain and Glass Insulators.
- Transmission Line Design Work Station (TLW)
- TFlash (Lightning Performance Prediction Software)

Current Year Objectives

- Updated Inspection and Assessment Guidelines for Transmission Lines (Yellow Book)
- Tools to address sub-grade and conductor corrosion
- Thresholds for Infra-red Inspection of Compression Connectors
- Transmission Line Workstation (TLW)
- Transmission Line Surge Arrester (TLSA) Guide
- Composite component accelerated aging results

- Software to aid in selection of corona rings (EPIC)
- Guidance on Specifying for Porcelain and Glass Insulators

Industry Involvement

- Estimated 2009 funding: \$5.0M

Program Technical Lead

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Summary of Projects

PS35A Inspection and Assessment of Overhead Transmission Lines (062094)

Project Set Description: This project set aims to reduce overhead transmission line (OHTL) O&M costs and extend the life of this equipment. The focal point of this effort is the *Inspection and Assessment Methods Guideline* (Yellow Book) and the associated pictorial field guides.

Work on line components and inspection technologies is undertaken through separate projects, and results will be condensed into a single inspection and assessment (IAM) repository: the Yellow Book. Overtime the components being researched change with the 2009 effort focusing on conductors, subgrade components, compression connectors (splices) and crossarms).

Project Number	Project Title	Value
P35.001	Overhead Transmission Line Inspection and Assessment Methods Guideline	Increases the reliability of overhead transmission lines and lowers maintenance costs by illustrating best practices for overhead transmission equipment inspection, assessment, and maintenance, leading to a consistent approach
P35.002	Conductor and Shield Wire Corrosion Management	Reduces unplanned outages, improves reliability, and reduces associated repair costs by providing corrosion control and management practices for both overhead ground wires and phase conductors; also provides a more accurate picture of the status of the power delivery infrastructure, enabling more informed maintenance and fiscal decisions
P35.003	Sub-Grade Corrosion Management of Transmission Line Structures	Reduces outages and decreases O&M costs by providing optimal corrosion control and management practices for sub-grade infrastructure; reduces costs of major repairs through improved maintenance practices; reduces costs associated with unplanned outages; defers costs of inspection or even replacement; and mitigates the corrosion process impact on utility assets
P35.004	Compression Connector Management	Increases safety of transmission lines by reducing line droppings; reduces sustained unplanned outages due to compression connector failure; optimizes spending of O&M funding; improves productivity of field personnel with training and field tools; and addresses loss of institutional knowledge by providing training
P35.005	Crossarm Management	

Project Descriptions

P35.001 Overhead Transmission Line Inspection and Assessment Methods Guideline (052001)

Issue

Increasing the reliability, safety, and life of overhead transmission equipment necessitates timely and effective maintenance, which in turn requires inspection and knowledge of equipment condition. To achieve these objectives, personnel need to understand components and their degradation and failure modes, as well as current industry inspection and assessment practices. Availability of new technology, coupled with loss of institutional knowledge, heightens the challenge facing transmission organizations. Engineering staff need to remain abreast of the latest inspection developments, assessment information, and industry practices to effectively establish or refine an inspection and assessment program, as well as select appropriate inspection techniques and technologies. In addition, field personnel need field tools and training to ensure that correct and consistent decisions are made.

Description

In order to address these issues, this project provides the following:

- Overhead Transmission Lines (OHTL): Inspection and Assessment Methods (IAM) Reference Guide
- Pictorial Field Guides for Inspection and Assessment of OHTL
- Training System for Inspection and Assessment Personnel
- OHTL Equipment, Inspection, and Maintenance Practices Conference

Value

- Increases the reliability of OHTL and lowers maintenance costs by illustrating best practices for overhead transmission equipment inspection, assessment, and maintenance, leading to a consistent approach
- Avoids and delays costs by providing members with tools to set up or refine an effective inspection and assessment process
- Improves reliability by identifying and assessing high-risk components prior to failure

How to Apply Results

By assisting in the development or enhancement of maintenance practices, the reference guide provides transmission engineers with tools to set up or refine an effective IAM process. The field guides and computer-based training is intended to be used by field personnel. This project also improves the expertise of the workforce and addresses the loss of knowledge in the industry. This will culminate in reliability improvement by identifying and assessing high-risk components prior to failure.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
New Versions of OHTL Inspection and Assessment Methods (IAM) Reference Guide: This guide helps members initiate a new or refine an existing OHTL inspection and assessment program. New sections on components and technologies will be added.	12/31/2009	Technical Report

Product Title & Description	Planned Completion Date	Product Type
New Set of Pictorial Guides: These field guides will be published both in printable and software form. The guides are designed for field use: pocket book size (8"x4"), and printed in color on glossy paper. Electronic versions are also available. Many members are distributing these guides to all field personnel, and they are forming the backbone of their inspection program.	12/31/2009	Technical Update
Future On-line E-Learning Modules, Workshop and Webcasts: On-line self-paced learning modules will continue to be developed either around components or inspection technologies. This software can be used with member utilities current learning management systems.	12/31/2009	Software
Inspection and Assessment Workshop: A workshop will be held for member utilities which will expose utility personnel to the latest technologies and approaches.	12/31/2009	Workshop, Training, or Conference

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
New Versions of OHTL Inspection and Assessment Methods (IAM) Reference Guide: This guide helps members initiate a new or refine an existing OHTL inspection and assessment program.	2010	Technical Report
New Set of Pictorial Guides: These field guides will be published both in printable and software form. The guides are designed for field use: pocket book size (8"x4"), and printed in color on glossy paper. Electronic versions are also available. Many members are distributing these guides to all field personnel, and they are forming the backbone of their inspection program.	2010	Technical Update
Future On-line E-Learning Modules, Workshop and Webcasts: On-line self-paced learning modules will continue to be developed either around components or inspection technologies. This software can be used with member utilities current learning management systems.	2010	Software
Bi-Annual Overhead Transmission Lines Conference: Bi-Annual Overhead Transmission Lines Conference will be organized held.	2010	Workshop, Training, or Conference

P35.002 Conductor and Shield Wire Corrosion Management (063280)

Issue

Corrosion is a natural and unavoidable phenomenon that all utilities must face to some degree at some point. For some utilities, failure of overhead wires due to accelerated atmospheric and galvanic corrosion is an immediate concern and major cause of unplanned outages and increased maintenance costs. One utility surveyed reported that failed shield wires were the foremost cause of unplanned outages. Reliability and availability of overhead transmission systems are a major concern in an ever-growing market with anticipated load growth.

Description

This project provides tools and processes for inspecting and assessing overhead shield wires and conductors, as well as management and engineering guides. This project's goals will be achieved via research in the following task areas over the lifetime of project:

- *Inspection*: This task addresses the question of how to gather data and information regarding the state and dynamics of corrosion activity.
- *Assessment of Population*: This task addresses the "what next?" questions stemming from an effective inspection and detection program. This task will address how to inspect, what to sample, how to test, how to analyze results, and how to make a decision.
- *The Selection and Application of Wires*: This task provides results to aid designers in the selection of the most appropriate conductor and shield wires to extend the life of these components in their specific environment and application.
- *Shield Wire and Phase Conductor Management Program*: Progressive actions will proceed in a deliberate step-wise manner from year to year towards the completion of the tasks listed above. Eventually the tasks will culminate and integrate into a comprehensive management program applicable to designers, specification writers, engineers, operators, inspectors, and management.

Value

- Reduces unplanned outages, improves reliability, and reduces associated repair costs by providing corrosion control and management practices for both overhead ground wires and phase conductors
- Provides a more accurate picture of the status of the power delivery infrastructure, enabling more informed maintenance and fiscal decisions

How to Apply Results

Transmission designers, engineers, operators, and inspectors will use the results of this project to inspect and assess overhead shield wires and conductors. Employing the knowledge gained from the project's results will help members develop a cost-effective maintenance program that will improve reliability by identifying and assessing high risk shield wires and conductors prior to failure.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Assessment of Phase Conductors : This task focuses on techniques and methodologies used to assess the condition of phase conductors in both an under energized and unenergized condition.	12/31/2009	Technical Report
Overhead Shield Wires Management Guide (Draft) : This draft guide culminates the project and serves as a management reference guide for engineers for overhead transmission wire corrosion effects.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Overhead Shield Wires Management Guide - Final: A final guide will be published on assessing overhead shield wires and the appropriate technologies	2010	Technical Report
Assessment of Shield Wire Inspection Technologies: The final results of the technologies assessed to evaluate overhead shield wires will be published.	2010	Technical Update

P35.003 Sub-Grade Corrosion Management of Transmission Line Structures (063281)

Issue

The total cost of corrosion to U.S. industry is more than \$276 billion annually, of which more than 30% could be prevented through the use of optimum corrosion-management practices. Even within the electricity industry, the costs associated with corrosion range from \$5-\$10 billion each year. Transmission and distribution lines are also greatly impacted by the effects of sub-grade corrosion. These effects are manifest in costly outages and increased O&M costs. Visual inspection by excavation is the current predominant method of inspection, but is costly and labor intensive. Thus research is needed to provide member utilities with methods for effective sub-grade corrosion management.

Description

This project addresses the issues surrounding sub-grade corrosion of transmission line structures by providing O&M staff tools and techniques to make the most informed and cost-effective decisions. This will be achieved through development and refinement of inspection techniques and methodology, informed assessment, and effective remediation techniques. This project will culminate in the production of a comprehensive corrosion management program, with the ultimate goal of reducing total O&M costs associated with sub-grade corrosion.

EPRI will divide the project into the following sub-tasks:

- *Sub-grade Corrosion Inspection.* This task will research practices and tools used by the industry, as well as develop new technologies centered on sub-grade inspection.
- *Sub-grade Corrosion Assessment Tools and Techniques.* This task will research all environmental effects impacting on sub-grade components, including soil properties, climate, industrial proximity, shared right-of-way, and stray current issues. Ultimately, degradation mechanisms and failure mechanisms will be more fully understood.
- *Sub-grade Corrosion Remediation and Prevention.* This task will research available treatment options when corrosion is discovered or detected. It will also address how corrosion may be prevented from a design and construction perspective by building innate resistance into structures and components.
- *Overarching Sub-grade Corrosion Program.* Finally, the research will culminate in a comprehensive sub-grade corrosion management program.

Value

- Provides new tools and inspection methods to address sub-grade corrosion problems
- Defers inspection and replacement costs
- Reduces O&M costs
- Reduces outages
- Mitigates the corrosion process impact on utility assets (new construction)

How to Apply Results

Transmission Operations and Maintenance staff will use the tools and knowledge delivered in this project to develop a cost effective maintenance program to inspect, assess, and refurbish sub-grade infrastructure, hence extending life. This will improve reliability by identifying and assessing high risk sub-grade components prior to failure.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Sub-grade Corrosion Management Guide: Sub-grade Corrosion Management Guide: This technical update reports and summarizes the project's findings and provides a sub-grade corrosion reference book for engineers, designers, and planners.	12/31/2009	Technical Update
Sub-grade Corrosion Inspection Guide: Sub-grade Corrosion Inspection Guide: This technical report summarizes the project's findings and provides a sub-grade corrosion reference book for maintenance and inspection personnel.	12/31/2009	Technical Report
Demonstrate Best Available Sub-grade Corrosion Inspection Technology: Demonstrate Best Available Sub-grade Corrosion Inspection Technology: The best available sub-grade inspection technology will then be demonstrated on both laboratory prepared samples and in situ at member's sites. A final demonstration best available corrosion inspection technology will represent the most advanced useful technology from a utility perspective.	12/31/2009	Technical Resource
Sub-grade Corrosion Workshop: Sub-grade Corrosion Workshop: At this workshop, utilities can share experiences in a conference environment. This workshop also serves as a forum where vendors are also encouraged to present and display new inspection and assessment technologies.	12/30/2009	Workshop, Training, or Conference

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Sub-grade Corrosion Guide: Sub-grade Corrosion Management Guide: This technical update reports and summarizes the project's findings and provides a sub-grade corrosion reference book for engineers, designers, and planners.	2010	Technical Report
Assessment of Remediation Techniques: This report will evaluate different techniques to remediate corrosion concerns such as coatings and sacrificial anodes technologies.	2010	Technical Update

P35.004 Compression Connector Management (065547)

Issue

Predicting the remaining life of compression connectors (splices and dead-end) is a major challenge to electric utilities. Splice failures are expected to increase with increased demand for heavier loading operations. Due to the limitations of existing inspection techniques, isolating the components early enough to reliably avoid failure is difficult. Inspection techniques and population evaluation methodologies are therefore needed.

The performance of compression connectors is directly related to installation practices and procedures. Conductor cleaning and field personnel training remain two key priorities to address these issues.

Description

The project tasks are as follows:

- *Inspection of Compression Connectors.* Technologies currently used to inspect splices include micro-ohm measurement and infra-red inspection. However, the reliability, repeatability, application methods, and threshold levels for these technologies are not well defined. In addition, each of these techniques provides limited information or is costly to implement. This task will increase understanding of the currently available techniques, their performance, and their application. Guidelines will be provided for their application, and promising new techniques will also be sought and identified.
- *Compression Connector Population Management.* This task aims to develop a methodology to evaluate an entire population of connectors. An approach will be developed and documented, potentially including high risk design, application, and environment identification, as well as inspection techniques, sampling, laboratory testing, analysis of results, and decision making.
- *Connector Installation Techniques.* This task will develop training for field personnel and tools to improve the reliability of newly installed connectors. The task will leverage the DVD-based training developed and conductor cleaning techniques currently being developed under supplemental projects.

Compression Connector Refurbishment

This task will evaluate the application of “shunt” type devices that are being proposed to address compression connectors that have been identified as high risk by field inspection. Issues such as the performance of these devices, life expectancy, application concerns and inspection and assessment.

Value

- Increases safety of transmission lines by reducing line droppings
- Reduces sustained unplanned outages due to compression connector failure
- Optimizes spending of operations and maintenance (O&M) funding
- Improves productivity of field personnel with training and field tools
- Addresses loss of institutional knowledge by providing training

How to Apply Results

Members will modify their current inspection practices as a result of the research. O&M personnel can implement the developed EPRI population assessment methodology themselves or as part of a supplemental project. Field personnel will be able to use the provided training material (e.g., DVD) as part of their in-house training programs.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Connector Inspection Technologies: Application and Threshold Limits: The limitations of existing technologies currently used to inspect splices are not fully understood. This task increases understanding of the currently available techniques, their performance, and their application.	12/31/2009	Technical Update
Compression Connector Population Management: This task aims to develop a methodology to evaluate an entire population of connectors. An approach will be developed and documented, potentially including high risk design, application, and environment identification, as well as inspection techniques, sampling, laboratory testing, analysis of results, and decision making.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Identification of New Compression Connector Inspection Technologies: This task focuses on identifying new compression connector inspection technologies and demonstrating promising ones.	2010	Technical Update
Compression Connector Population Management: This report is the final compression connector management document.	2010	Technical Report
Evaluation of Remediation Techniques: This report will document the investigation and testing of different techniques used to remediate compression connectors that have been identified as high risk.	2010	Technical Update

P35.005 Crossarm Management (067437)

Issue

Predicting the remaining life of structure crossarms is a major challenge to electric utilities. An increase in crossarm failures should be expected as the age of transmission structures increases. Due to the limitations of existing inspection techniques, identifying the components early enough to reliably avoid failure is difficult. Improved Inspection techniques and population evaluation methodologies are therefore needed.

The cost and physical performance of crossarm assets is directly related to inspection practices and decisions. Identification of cross-arm degradation and timely replace decisions by field personnel remain two key priorities.

Description

Inspections of Crossarms. Technologies and techniques currently used to inspect Crossarms consist primarily of visual or sounding techniques. However, the reliability, repeatability, application methods, and results for these processes are not well defined. In addition, each of these processes provides limited information and not well defined results. This task will increase understanding of the currently available

techniques, their performance, and their application. Guidelines will be provided for their application, and promising new techniques will also be sought and identified.

Crossarm Population Management. This task aims to develop a methodology to evaluate an entire population of Crossarms. An approach will be developed and documented, potentially including high risk design, application, and environmental issues, as well as inspection techniques, sampling, laboratory testing, analysis of results, and decision making.

Value

- Increases safety of transmission lines by reducing crossarm failures
- Reduces sustained unplanned outages due to crossarm failures
- Addresses loss of institutional knowledge by providing training
- Optimizes spending of operations and maintenance (O&M) funding
- Improves productivity of field personnel with training and field tools

How to Apply Results

By assisting in the development or enhancement of maintenance practices, members will modify their current inspection practices as a result of the research. This project also improves the expertise of the workforce and addresses the loss of knowledge in the industry. This will culminate in reliability improvement by identifying and assessing high-risk components prior to failure. O&M personnel can implement the developed EPRI population assessment methodology themselves or as part of a supplemental project.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Literature Survey of Crossarm Inspection Tools and Techniques: This technical update will document the currently available inspection tools and published information on their application. A survey of utility practices and experiences may also be performed.	12/30/2010	Technical Update
Report on Crossarm Degradation Modes: This technical update will summarize literature on cross-arm degradation and outline a research plan to investigate and understand degradation further. This will form the foundation of the population management that will be developed.	12/30/2010	Technical Update
Test step up for Evaluation of Crossarm Inspection Technologies: A test setup will be developed to evaluate crossarm inspection technologies. An initial evaluation of some limited technologies will be performed to assess the test setup.	12/30/2010	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Evaluation Of Crossarm Inspection Technologies: Technologies used for Inspection and Evaluation of Crossarms will be evaluated and a report prepared detailing the findings for members.	2011	Technical Update
Development of Crossarm Failure Database: A database of utility crossarm failures will be implemented to help better understand the failure modes and frequency's on Crossarms. A standard format for the reporting on Crossarm failure will be developed to support the gathering of information.	2011	Technical Resource
Report on Crossarm Inspection Tools, Techniques and Evaluations: A report will be prepared providing information on the failure modes, inspection tools and techniques and evaluation considerations for the inspection of crossarms.	2011	Technical Update
Field Guide on Crossarm Inspections and Evaluations: A field guide for use by personnel in the field will be prepared covering the failure modes, inspection tools and techniques and evaluation considerations for the inspection of crossarms.	2012	Technical Report
OTLOT Module on Crossarm Inspections and Evaluation: An On-Line training module will be developed for use in the training of field personal in the failure modes, inspection tools and techniques and evaluation considerations for the inspection of crossarms.	2012	Software

PS35B Improve Transmission Line Lightning Performance (056061)

Project Set Description: The objective of this project set is help members achieve the best possible lightning performance and effective, safe grounding of transmission lines while minimizing costs. The focus remains on modeling, improving approaches to grounding, deeper understanding of the design and use of transmission line surge arrestors, and line shielding. Each year, the results are documented in formal Electric Power Research Institute (EPRI) reports. From time to time these results are implemented in suitable software models and included in EPRI's flagship Transmission Line Lightning Performance Prediction Software: TFlash. In 2009 a new focus is on the development of new ground electrode materials that are less costly and attractive to vandals but have the correct electrical performance characteristics.

Project Number	Project Title	Value
P35.006	Lightning Performance of Transmission Lines and Transmission Line Surge Arresters	Cost effective improvement of the reliability and safety of transmission lines

Project Descriptions

P35.006 Lightning Performance of Transmission Lines and Transmission Line Surge Arresters (051989)

Issue

Lightning activity is the leading cause of momentary outages on transmission lines. Addressing numerous aspects of a transmission line—shielding, grounding, insulation, and transmission line surge arresters—can improve lightning performance. However, identifying the most effective and lowest cost aspects is difficult. Transmission line grounding influences both the lightning performance and safety of transmission lines. The most effective ground electrode design is dependant on many factors.

Description

The tasks addressed in this project are as follows:

- *Field Tool to Evaluate Transmission Line Grounds (EPRI ZED Meter®)*. Commercial ground electrode measurement techniques do not allow accurate measurement of structures that are grounded in multiple locations, such as transmission lines with overhead groundwires, steel lattice structures with grillage foundations, and two-pole structures. From 2004–2008, a technology was developed, demonstrated and an application guide developed that enables effective measurement of transmission line ground electrodes. In 2009, research will focus on instrument improvement, training and refinement of application guide.
- *TFlash*. As understanding of lightning-related phenomena increases, the TFlash lightning performance prediction software is updated. In 2006 and 2007, TFlash was updated to version 5.0 with improved grounding models, an interface to utility databases, and bug fixes. In 2008 TFlash was compared against real line performance and provided guidance on effective TFlash use. In 2009 the research will address methods to improve lightning performance of transmission lines utilizing TFlash and other tools and develop computer based training for TFlash. In 2009 a new version of TFlash will be developed that will be compatible to Microsoft™ Vista
- *Transmission Line Surge Arrestors (TLSA) Research*. This task develops the information for and publishes a TLSA application guide. In 2008 fundamental research was done on the placement and energy handling capabilities. A draft TLSA guide was developed. In 2009 research will continue and an application workshop based on the guide will be provided
- *Grounding Guide*: In 2008 a final version of the EPRI overhead transmission grounding guide was delivered together with EPRI grounding guide software EGGS. In 2009 a workshop will be developed
- *Alternative Ground Electrode*: Utilities are currently struggling with issues surrounding the theft of copper. This task will investigate the use of alternative materials and electrode designs. Issues such as life expectancy, corrosion and material compatibility and current handling capabilities will be addressed.

Value

- Improves the lightning performance and safety of transmission lines by providing utility engineers effective tools and an improved knowledge base
- Addresses the loss of institutional knowledge by providing guides and tools for engineering staff that are new to the field of lightning and grounding
- Reduction of cost by providing improved tools for both field inspection and engineering staff, e.g. Zed-Meter, EGGS, and TFlash
- Improved public and worker safety as well as reliability by identifying alternative ground electrodes

How to Apply Results

Operations and maintenance personnel can confidently apply the EPRI Zed-Meter to measure the tower footing resistance of structures on their systems. Transmission line engineers can use the TFlash software to optimize the lightning performance of transmission lines with internal resources or they can outsource this work to the EPRI Lightning and Grounding Team. The TSLA workshop will provide design, operational and maintenance personnel with the knowledge on the application of TSLA's.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Alternative Grounding Electrodes: This work will explore alternative grounding methods and materials to overcome problems caused by ground electrode theft whilst maintaining performance and safety. Issues regarding life expectancy, corrosion and material compatibility will be covered	12/31/2009	Technical Update
Grounding Guide Workshop: A workshop will delivered based on the grounding guide delivered in 2008	12/31/2009	Workshop, Training, or Conference
TLSA workshop: A workshop will delivered based on the TLSA guide delivered in 2008 and will cover the application of TLSA's	12/31/2009	Workshop, Training, or Conference
EPRI Zed-Meter Training: This workshop will cover the Zed-Meter basic principle of operation, software operation and how measurements should be taken. The workshop will also include a practical session.	12/31/2009	Workshop, Training, or Conference
Approach for improving the performance of Transmission Lines and other tools: There are a number of EPRI tools available for improving the performance of transmission lines or optimizing ground electrodes. This report will document the tools available, how they applied them and document the approach.	12/31/2009	Technical Report
Computer based training for TFlash: A computer based training module will be developed to assist new and experienced TFlash users. The training will be on-line and self-paced, and will include worked examples.	12/31/2009	Technical Update
New version of TFlash: A new version of TFlash will be developed incorporating the latest research work and that will be compatible with the Microsoft Vista operating system.	12/31/2009	Software
TLSA Guide: A report detailing the application of TLSA. This will include selection, placement and energy handling capabilities.	12/31/2009	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Alternative Grounding electrodes: Continued work into alternative designs and materials for grounding electrodes.	2010	Technical Update

Product Title & Description	Planned Completion Date	Product Type
TLSA Testing: There are a number of issues related to the long-term performance of TLSA. These relate to attachment methods, housing etc. This work will focus on deriving specific tests to address these issues.	2010	Technical Update

PS35C Overhead Transmission Design for Optimized Life Cycle Costs (062095)

Project Set Description: This project set helps clients stay abreast of the most current information and technology, enabling improved overhead transmission line design and component selection to optimize life cycle costs. Capital savings of 5–10% can be achieved through optimization of new designs. In addition, enhanced understanding gained through new technologies will help clients reduce risk and increase the life of new components.

Project Number	Project Title	Value
P35.007	Transmission Line Design Tools	Provides design data to engineers quickly and accurately for evaluation of alternatives
P35.008	Foundation Analysis and Design	Provides the state-of-the-art design methods and a new methodology to improve designs
P35.009	Optimization of Transmission Design by Life-Cycle Costing	Provides a valuable tool in the selection of a design that produces the optimal overall cost for capital and maintenance expenses

Project Descriptions

P35.007 Transmission Line Design Tools (060457)

Issue

In the early 1990s, EPRI developed a comprehensive transmission line design package, Transmission Line Workstation (TLW), which has a large number of users. TLW contains numerous design modules, many of which are based on sources that may be outdated, such as the previous version of the Red Book. The TLW is a useful and productive tool that facilitates effective design of transmission lines. With the increase in transmission line construction activities, the software modules need to be updated.

Revision of the software began in 2005. First, modules associated with the Red Book have been updated with information from the most recent version of the Red Book, published in 2004. The module ACDCLINE for electrical designs has been updated and is the end March 2008. In addition to new information, the new module provides improved user interface with graphical feedback. The new software also provides architecture that can be linked to other software packages.

Description

This project will continue to update different modules of the TLW, including the foundation design and analysis (FAD) module—a popular design tool. The algorithms and methodologies will be reviewed, and the most current information will be incorporated, including applicable codes and standards. Additional foundation types that are not covered in the existing FAD software will be added. The user interface, input/output, and database will all be examined for improvements. If required, new features will be added

to enhance the application of the software. The goal is to produce the most current, effective, and easy-to-use design and analysis software for foundations. Other modules will be updated in future years.

Value

- Enables designers in selecting optimal transmission line design parameters and designs
- Improves productivity of designers
- Improves reliability of overhead transmission lines
- Reduces maintenance and repair costs

How to Apply Results

The new module for foundation analysis and design enables transmission line designers to analyze existing structure foundations and develop new structure foundations for transmission lines. Prototype software is to be developed first in 2008, followed by thorough user testing and finalization in 2009. A workshop will cover the principles of foundation analysis and design, as well as application of the software.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
<p>Workshop for Foundation Analysis and Design and Software Application: The foundation analysis and design (FAD) software is commonly used by designers to evaluate existing foundations and design new foundations for transmission lines. The training course provides hands-on experience to the participants on the use of the software and the theories behind the software, FAD. The training course reduces the “trial and error” time for the user to apply the software to designs efficiently.</p>	10/31/2009	Workshop, Training, or Conference
<p>Module for Foundation Analysis and Design: The module for foundation analysis and design (FAD) is a popular and powerful design tool for overhead transmission line foundations. The updated module includes new foundation types and revisions to comply with new foundation standards. The software will enable a designer to both analyze the integrity of existing foundations and to perform foundation designs for new and existing transmission lines.</p>	12/31/2009	Software

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
<p>New Module for Transmission Line Designs - Prototype Software: The DYNAMP module will be updated. DYNAMP is used by utilities to determine the current ratings of a transmission line under various weather conditions. Algorithms used in the modules will be reviewed and revised to conform to FERC Mandatory Facility Rating Standards FAC-008/009 requirements for line ratings. User interface will be improved and will be consistent with other upgraded modules such as ACDCLINE and FAD.</p>	2010	Software

P35.008 Foundation Analysis and Design (067438)

Issue

Construction of new transmission lines is increasing recently due to lack of activities in the past and the continuous increase in demand of electric power. A major cost of a transmission line is the foundation for the supporting structures. Over designing the foundation is costly. Besides, over-designed foundations do not improve the reliability of the transmission line if they are not compatible with other line components or soil conditions. On the other hand, under-designed foundations not only lower the overall reliability of the transmission line but may also require maintenance that could have been avoided. It is therefore crucial that proper foundations be selected for a transmission line to accommodate the mechanical loading, the soil condition and the environment to produce structures that perform well initially as well as in the long term. The project will provide the state-of-the-art information and design tools to assist foundation designers in evaluating, selecting and designing foundations suitable for each type of transmission line structures. This project will take advantage of the knowledge gained in past research conducted by EPRI including the FAD design tool and a report published in 2007 on Management of Transmission Line Structure Foundations (PID 1013783).

Description

The objective of the project is to provide transmission line designers the state-of-the-art tools for the design of transmission structure foundations. Tools include design methods and associated assumptions, approaches, formulae, sample calculations and data that are required to design structure foundations properly and efficiently. The project will start with a review of current information on the design of transmission line from publications, standards and manuals such as those from American Society of Civil Engineers and, the Institute of Electrical and Electronic Engineers. A survey will be conducted among electric power utilities on transmission structure foundations and establish common practices in transmission structure foundation design such as strength or safety factors applied to computed foundation nominal capacities. The goal of the project is to produce a guide for the design of transmission structure foundations. Knowledge gaps will be identified for future research.

Value

- Provide state-of-the-art methods for the design of transmission structure foundations
- Provide information to evaluate risks of certain type of foundation designs
- Avoid expensive maintenance and repair costs
- Improve and provide uniformity to overall transmission line reliability

How to Apply Results

The project will provide the electric power utilities the most current practice on the design of foundation for overhead lines. Transmission line foundation designers can use this information to fine-tune their own design practice to produce reliable and cost effective transmission structure foundations. The transfer of knowledge to the utilities especially those with less experienced staff is enhanced by attending training offered under this project.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Training for Foundation Designs: The training for foundation designs presents theories, methods and approaches used in the design of transmission structure foundations and provide the designers with "hands-on" experience with case studies. The designers will also be given most up-to-date information on common design practices and knowledge gaps that required future research.	12/31/2009	Workshop, Training, or Conference

Product Title & Description	Planned Completion Date	Product Type
State-of-the-Art Foundation Designs: The technical update provides common methods assumptions used in transmission structure foundation designs and data that designers can use in their design. It provides information on common design practices within the electric power industry including safety factors used, assumptions made etc.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Methodology to Improve Transmission Structure Foundation Design Approach to Enhance Overall Line Reliability: Foundations are designed with a number of uncertainties. Safety factors are generally used to cover these uncertainties resulting in higher cost. Often the safety factor provides unknown reliability and false sense of security due to variations of strength of the foundation and loads imposed on it. A methodology will be developed to improve the evaluation of performance of the design and thus the overall reliability.	2010	Technical Update

P35.009 Optimization of Transmission Design by Life-Cycle Costing (066075)

Issue

When an overhead line is designed, all costs incurred during the expected life of this future line should be considered. The total cost during the life or life-cycle cost of a transmission line is a combination of initial capital cost, operation and maintenance (O&M) cost, and cost of electrical losses over its entire life. The design is optimal when the life-cycle cost is the lowest. A tool is required by utility engineers to help them select readily an appropriate design option instead of picking the lowest capital cost. Without such a tool, options with higher line component costs could be overlooked. These components may offer a longer life span, lower O&M costs, and reduced energy losses. Thus, a transmission line with higher capital cost may be more cost-effective over its entire life than the lower capital cost option. The life-cycle costing method helps designers and planners evaluate design alternatives based upon the present value of all costs on a common lifetime basis and to choose the best overhead line in the design stage.

Description

This project will develop a tool for conducting life-cycle cost analysis of transmission line projects. The project first identifies major critical components—structures, conductors, insulators, and conductor configuration—associated with transmission line design and other factors—land acquisition, site work—that influence the life-cycle cost. This project focuses primarily on three main tasks: identification of data required on various components (specifications), development of a methodology for life-cycle cost analysis, and development of prototype software as a decision tool for transmission line design.

Value

- Provides designers information on key components and factors that affect life-cycle cost
- Provides an important tool for selecting an optimal transmission lines design
- Reduces the life-cycle cost of new transmission lines

How to Apply Results

The workshop will educate transmission line planners and designers on the life-cycle concept applied to transmission line designs. The software module enables them to select the best alternative for the construction of a new transmission line. A supplemental project will develop a case study in which EPRI will work closely with members to identify issues related to the life-cycle analysis. The outcome will demonstrate the value of the project and provide a platform for additional research to improve the life-cycle model.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Workshop for Life-Cycle Cost Analysis: In 2009, there will be another training/workshop on life-cycle cost analysis with few case studies. A methodology will be finalized with input from the workshop.	10/31/2009	Workshop, Training, or Conference
Methodology for Life-Cycle Cost Analysis: Various methodologies for life-cycle analysis will be evaluated and the one most suitable for optimizing design for overhead transmission lines will be adopted. The methodology will include a data bank containing information collected according to the specifications developed in 2008. The methodology can be used in analyzing the life-cycle cost of a transmission line based on certain line components and design parameters.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Life-Cycle Cost Analysis - Prototype Software: In 2010, prototype software will be developed based on the methodology from the previous year. The prototype software demonstrates the input/output features and ease of using of the software. It allows users to test-run the software in conducting life-cycle analysis for optimization of design of transmission lines. Participating members may volunteer to test the software. Input from users for improvements to the software will be made. The software will then be beta-tested and the final version produced in 2011.	2010	Software

PS35D Improve Live-Line Maintenance Work Practices (056063)

Project Set Description: This project set develops new techniques, tools, procedures, and training materials to ensure economic execution of live-line work on transmission lines and to promote safety during both energized and de-energized work.

Project Number	Project Title	Value
P35.010	Live Working Research for Overhead Transmission Equipment	Improves reliability and availability by enabling timely maintenance of transmission lines; increases worker safety; and decreases maintenance costs

Project Descriptions

P35.010 Live Working Research for Overhead Transmission Equipment (051995)

Issue

Deregulation and the economic realities of today's electric utility business are forcing utilities to ensure that transmission and distribution lines remain in service every day of the year. Outages for maintenance are more difficult to obtain, and the associated congestion costs are becoming prohibitive. In search of solutions, transmission owners are increasingly turning to live-line working techniques as standard practice to perform required maintenance. When work on de-energized lines is possible, hazards of step-touch-transfer and induced voltages must be recognized and mitigated. New techniques, tools, and procedures are needed to ensure economic execution of live work, and training is vital to promoting safety during both energized and de-energized work.

Description

Over the last two decades, EPRI has helped many transmission companies achieve significant savings in the areas of live working and de-energized work by developing and implementing new technologies and training materials for the maintenance and refurbishment of transmission lines. The results of this effort were consolidated with industry practices into a practical and comprehensive *Live Working Guide for Overhead Lines* (1008747) and the on-line Live Working Resource Center. Building on the foundation, project activities in 2009 address specific issues in live and de-energized work:

- Performance and use of rope in live working
- Aging and retirement criteria of live working tools and equipment
- Unique live work procedures documentation
- Technology transfer through training videos/DVDs, conferences and seminars

Value

- Improves reliability and availability by enabling timely maintenance of transmission lines
- Improves transmission performance
- Increases worker safety
- Decreases maintenance costs

How to Apply Results

Participation in this project will help overhead transmission owners and maintenance service providers improve transmission performance and enhance reliability by supporting worker safety when conducting live-line and de-energized maintenance on overhead transmission equipment. Tools and equipment developed in this project will be commercialized and made available to the industry. New methods will be documented in written reports and the on-line Live Working Resource Center. Training materials will be developed in electronic media using live action videos, computer generated scenarios, and live narration.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
<p>EPRI Live Working Resource Center EPRI Live Working Resource Center: In this continuing project, new materials will be added to the EPRI Live Working Resource Center. The Resource Center is a repository of information on common and unique live working and de-energized work procedures and tools and provides a forum for exchange of experiences among funders. The Resource Center is maintained in this project on periodic basis.</p>	12/31/2009	Technical Resource

Product Title & Description	Planned Completion Date	Product Type
<p>Aging and Retirement Criteria of Live Working Tools and Equipment: Aging and Retirement Criteria of Live Working Tools and Equipment: The condition of live working tools used over the years is assessed to establish aging patterns and develop retirement criteria, replacement programs, and possible service environment modifications to control aging.</p>	12/31/2009	Technical Report
<p>Live Working Rope Pocket Guide: Utilizing excerpts from the recent research on rope for live working, this Pocket Guide will contain essential information for linemen to identify ropes by their specific characteristics, select appropriate rope for the task at hand, describe several most commonly used knots, and provide guidance for care, maintenance and retirement of rope.</p>	12/31/2009	Technical Report
<p>Ropes for Live Working: This report marks the completion of research on ropes for live working was reported previously in 2006 Technical Update 1013603 and 2007 Technical Update 1013897.</p>	12/31/2009	Technical Report
<p>Live working with high-temperature conductors: This report will identify issues of performing work on energized lines that employ high temperature conductors (conductors that can operate at 200⁰C or so). The following areas will be addressed:</p> <ul style="list-style-type: none"> • Work using insulating tools (“hotsticking”) • Work requiring direct contact with hot energized conductors (barehanding) • Possible effect of high conductor temperatures on the integrity of live working tools • Special tools and procedures that may be needed to work on high-temperature conductors due to their special construction (for example, soft annealed aluminum strands) • Possible additional system and safety effects of using high-temperature conductors, such as increased load and fault currents and possible effects on equipotential zones and step-touch voltages 	12/31/2009	Technical Update
Future Year Products		
Product Title & Description	Planned Completion Date	Product Type
<p>Qualification of Contractors: Qualification of Contractors: This project produces recommendations on screening and qualifying contractors who perform energized and de-energized work, addresses contractors’ practice of substituting workers on short notice, and provides training to contractor’s employees unfamiliar with the member’s system. The work at the Institute of Electrical and Electronics Engineers (IEEE) level on this subject will be monitored and reported to the EPRI Live Working Task Force for consideration.</p>	2010	Technical Update

Product Title & Description	Planned Completion Date	Product Type
<p>Establish Tower-Top Equipotential Zones: Establish Tower-Top Equipotential Zones: This project evaluates and adapts previously developed approaches to temporary grounding of lines to protect workers on structures (including wood, concrete and polymer poles) by establishing equipotential zones over the worksite or work area.</p>	2010	Technical Update
<p>Fall protection and rescue: Fall protection and rescue: This project reviews industry practices for fall protection and rescue of workers from heights. Utilizing the results of research on live working rope, rescue from energized lines will be investigated. This should help reduce rescue time duration and speed up delivery of the victim to a medical care facility, thus increasing the chances of survival and reducing the severity of injury. The project will also address the issue of suspension trauma, which results from prolonged period of the victim hanging in the harness and may lead to circulatory complications.</p>	2010	Technical Update
<p>Live work on HVDC lines: Live work on HVDC lines: The industry has developed some crude guidelines and procedures for live work on HVDC lines, however, such work is not performed very often and little experience is available. This project will address all aspects of live work on energized bipolar HVDC lines, including tools, effects of space charge, air gap sparkover and tool flashover characteristics, and control of coupled currents. While overvoltage issues are not a significant concern on HVDC lines due to the ability for rapid switching and –de-energization, protection of workers and tools from accumulated DC space charge is an important consideration.</p>	2010	Technical Update
<p>Ergonomics in transmission live line work: Ergonomics in transmission live line work: Work on overhead lines, whether energized or de-energized, is physically demanding. This project will analyzed selected procedures and worker positions and develop alternatives or “interventions” (alternate procedures, tools, equipment, etc.) to reduce physical stress. Experience documented in ergonomics reports produced by the Environmental sector will be utilized in this project.</p>	2010	Technical Update
<p>Monitoring and managing step-touch voltages: Monitoring and managing step-touch voltages: This project will analyzed sources of step and touch voltages at the worksite and will research the feasibility of developing methods and instrumentation to monitor these voltages and to manage or mitigate them.</p>	2010	Technical Update

PS35E Overhead Transmission Insulators (062096)

Project Set Description: Although insulators generally account for less than 10% of the capital costs expended on a transmission line, they provide two vital functions that impact public safety and reliability: mechanical strength and electrical insulation. This project set addresses high-voltage line insulators, both polymer and ceramic, as well as other insulating components, including guy strain insulators, composite poles, and fiberglass cross-arms.

This project set provides tools and techniques that help members:

- Select and procure the appropriate design of insulating components
- Apply the insulating component to ensure both short and long term performance

- Identify high-risk units in-service
- Determine the end of life of populations of in-service insulating components

Project Number	Project Title	Value
P35.011	Polymer and Composite Overhead Transmission Line Components	Improves reliability and reduces cost by correctly selecting, applying, and inspecting composite components
P35.012	Ceramic Insulator Integrity Assessment	Extends life of existing populations of porcelain disc insulators

Project Descriptions

P35.011 Polymer and Composite Overhead Transmission Line Components (051993)

Issue

Due to their reduced cost, ease of handling, improved contamination performance, and resistance to vandalism—as well as a lack of availability of traditional components—composite components such as polymer insulators are proliferating on the electricity system. However, these composite components have certain disadvantages and uncertainties.

Description

This ongoing multi-year project addresses a range of composite component concerns, including selection, application, and inspection, to increase member confidence and reliability in using these components. In 2008, the project expanded its primary focus on polymer insulators to include examination of all overhead transmission line composite components, such as guy strain insulators, composite/fiberglass cross-arms, and composite poles. There are many similarities among these polymer/composite technologies.

Specific topics and tasks will be added and removed under the direction of the Insulator Task Force. Following priorities determined by the task force topics planned for 2009 are as follows:

- Multi-stress accelerated aging test for polymer insulators, guy strain insulators, fiberglass cross-arms and composite poles at 230 kilovolt (kV). A full evaluation of the insulators from the test will begin late 2009 and compared to previously evaluations of in-service units. A web-based report for the inspection results of the multi-stress accelerated aging test will be delivered.
- A guide on specifying and procuring polymer insulators for specific applications
- Short-term tests to evaluate the performance, including life expectancy, of composite components. The intention is that utilities will include these in their specifications.
- Continued maintenance of polymer insulator and fiberglass components failure databases (ongoing since 1997) to aid selection and replacement decisions.
- Continue to assess service aged insulators and maintain a database of the inspection results to help understand how insulators age and to validate the aging chamber.
- Update the information in the vintage insulator database.
- Development of software tool to aid with corona ring selection (EPIC).
- Protocol to assess an in-service population of polymer insulators and make informed decisions on replacement

Value

- Reduces construction costs and improves performance by correctly applying composite components

- Avoids sustained outages by inspecting and assessing both individual and populations of insulators
- Aids utilities develop effective specifications ensuring long term performance of composite components.
- Improves engineer productivity by providing information and tools

How to Apply Results

- Utility engineers will use the multi-stress aging test results to assess existing populations of composite components and evaluate different composite component designs.
- Transmission line design and procurement engineers will use the *Guide to Specifying and Procuring Polymer Insulators* in-house or request in-house training from EPRI as part of a supplemental project. Utilities will include the short-term tests in their procurement specifications to vendors.
- The failure database information will help evaluate aging populations of units and selection of new designs.
- The inspection of service aged insulator will aid in understanding how insulators age and what are the factors of aging. Members can use this information to improve application for better reliability and performance.
- The Corona Ring Selection Software Tool is utilized when designing new applications and evaluating the performance of existing applications in service.
- The vintage guide allows members to understand the strengths and weaknesses of the different designs they have in service.
- Either the utility or EPRI can implement the population assessment methodology whether to extend life of existing insulators in service.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Final Results from 230 kV Aging Test: This deliverable describes and includes the results of short-term tests and improvements to tests under development. It also provides updated results of the failure database on composite components.	12/31/2009	Technical Report
Short-Term Tests to Evaluate Aging Performance: This report outlines the development of a series of short term tests for polymer insulators. The tests are designed to evaluate how an insulator would perform in the field at an accelerated rate, including exposure to corona.	12/31/2009	Technical Update
Failure Database Analysis: Polymer Insulators, Fiberglass Cross-arms and Guy Strain Insulators: This deliverable compiles and analyzes failure data of polymer insulators and fiberglass components collected since 1997.	12/31/2009	Technical Update
Long Rod / Suspension Polymer Insulator Vintage Guide, Rev. 2009: This report describes the ways that polymer insulators are made and when changes in designs occurred. This is an update of the previously published vintage guide (1012328).	12/31/2009	Technical Update
Corona Ring Software (EPIC): This software is designed to calculate the E-field on insulators on transmission lines.	12/31/2009	Software

Product Title & Description	Planned Completion Date	Product Type
Approach to Assessing Aging Population of Polymer Insulators: This report described an approach to assessing a population of insulators based on a small sample size, the application, and the environment.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Software to assist in Assessing a population of polymer insulators: Excel spreadsheet based software will be developed to aid in assessing an existing population of composite insulators.	2008	Software
Short-Term Tests to Evaluate Aging Performance: Short-Term Tests to Evaluate Aging Performance will continue to be developed and assessed. It is expected in 2009 that the first set will be completed and the second set addressing outstanding issues will be developed.	2010	Technical Update
Composite Component Failure Database: An update of the polymer insulator, guy strain insulator, fiberglass cross arm and composite pole failure database will be published.	2010	Technical Update
E-field modeling Software (Update): An update of the EPIC software will be published. New vendors will be added as well added functionality and features.	2010	Software
Test Plan for Accelerated Aging Chamber: A plan for the 230kV Aging chamber will be developed based on input from the task forces.	2010	Technical Update

P35.012 Ceramic Insulator Integrity Assessment (060456)

Issue

Currently, utilities use millions of ceramic insulators that are approaching or have exceeded the end of their intended service life. Since a large number of transmission lines were built in the 1950s and 1960s, these ceramic insulators are 50 years old. While the performance of ceramic insulators has traditionally been very good, the number of problems recently observed is rising. Simultaneously, the number of ceramic insulators in service for more than 30 to 40 years has also increased significantly. Concerns are growing about performance issues with the current population of insulators and the availability of inspection techniques to identify high-risk units prior to failure.

Concerns have also been raised over the performance of new insulators acquired from manufacturing facilities that have not supplied utilities with insulators in the past. Lessons that traditional manufacturing plants have learned over the past decades of manufacturing may not have been transferred to the new plants.

Further, many utilities that have not traditionally used glass insulators are considering this technology. Glass and porcelain insulators that are coated with silicone rubber in manufacturing are also being considered. However, utilities lack experience with this technology

Description

This project will initially focus on suspension porcelain insulator bells, addressing the following three tasks:

- *Inspection and Assessment Tool:* This task investigates the development of field tools to assess the condition of insulator strings. In 2006, a promising technology was identified that could provide an indication of mechanical and electrical (M&E) strength without removing units from service. The technology also showed promise as a standoff technique to identify cracked porcelain insulators.
- *Evaluation of New Porcelain Discs Units:* This task assesses issues with porcelain disc insulators procured from new manufacturing plants. In 2007 and 2008, simple M&E tests were performed and compared against standards. This testing will be expanded in 2009, and issues and concerns will be documented.
- *Procurement of Glass and Porcelain Disc Insulators:* This task will develop a selection and procurement guide for glass and ceramic insulators. The document will review the fundamentals as well as provide guidance on how to write a specification.
- *Contamination Performance:* This task will address the following two topics:
 - 1) Develop a guide to maintaining insulators in a contaminated environment.
 - 2) Evaluate best practices for dimensions insulators in a contaminated environment.

Value

- Helps members evaluate and identify high-risk ceramic insulator strings or populations of insulator strings prior to failure.
- Provides members with a greater choice of vendors and technologies, enabling lower cost or improved technical solutions.
- Assist members in addressing both existing and new insulation applied in contaminated environments

How to Apply Results

- Utility operation and maintenance personnel can apply the new inspection technologies developed to evaluate in-service populations of porcelain insulators.
- Design and procurement personnel will utilize the information provided on the testing of new porcelain discs and glass insulators to make better-informed decisions when selecting and procuring insulators.
- The guide to maintenance of insulators in a contaminated environment will provide utilities with options on how to improve the performance of existing installations.
- Members will be able to dimension insulators with confidence in a contaminated environment by applying the state of the art approaches.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Performance Testing of New Porcelain Disc Insulators: This report documents issues with porcelain disc insulators procured from new manufacturing plants and provides testing results.	12/31/2009	Technical Update

Product Title & Description	Planned Completion Date	Product Type
Guide to Specifying Glass Insulators: This report documents the fundamental knowledge of glass and ceramic insulators and provides guidance on how to select them.	12/31/2009	Technical Update
Tool for Non-destructive Evaluation of Porcelain Disc Insulator: Demonstration Results: This report will describe the results of testing and demonstration of a tool that performs non-destructive evaluation of porcelain disc insulators. This tool can be used to judge the M&E strength of a porcelain disc insulator.	12/31/2009	Technical Update
Guide to Maintenance of Insulators in a Contaminated Environment: This guide to maintenance of insulators in a contaminated environment will provide utilities with options on how to improve the performance of existing installations.	12/31/2009	Technical Update
Workshop on maintaining and dimensioning insulators in a contaminated environment: This workshop will provide training to utility engineers on how to apply the information developed in the “ Guide to Maintenance of Insulators in a Contaminated Environment ”.	12/31/2009	Workshop, Training, or Conference

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Guide to specifying and procuring glass and porcelain insulators: This report will finalize the draft guidelines developed in the previous years.	2010	Technical Report
Tools to aid in assessing and addressing contamination concerns: Excel type tools will be developed to help assess contamination environments and select the appropriate insulation.	2010	Software
Assessment of Aged and New Porcelain Insulators: This report will summarize the testing of new and aged porcelain insulators that has been ongoing since 2007 providing a benchmark for members to compare their populations against.	2010	Technical Update