

Risk and Safety Management

Program Overview

Program Description

Risk and safety assessment techniques provide information that enable nuclear plant owners to make technically sound design, maintenance, and operational decisions, contributing to safer and more cost-effective plant operation. Risk models are being used in a growing number of applications, including online maintenance, surveillance interval extensions, flexible allowed outage times, and risk-informed performance-based fire protection. Risk technology also is being used in regulatory performance assessment programs such as significance determination and reactor oversight protection. Continuous refinement of risk and safety models and application approaches is necessary to ensure decisions based on these models reflect industry operating experience and state-of-the-art computational advances.

The Risk and Safety Management Program develops risk assessment tools to enhance the safety and improve the economics of existing and future nuclear power plants. Electric Power Research Institute (EPRI) risk and safety software codes assist utilities in performing detailed analyses to quantify the level of risk, contributing to increased plant safety, more efficient and flexible plant operations and maintenance, and reduced electricity production costs.

Research Value

Risk-informed performance-based approaches provide a “win-win” for the regulator, the nuclear plant owner, and the public. The regulator can focus on issues truly important to safety benefiting the public, while the plant owner gains operational flexibility and an opportunity for cost reduction. Since 1992, overall industry core damage frequency has dropped by a factor of five. This improvement has been driven by risk-informed initiatives, continued plant and equipment performance improvements, and probabilistic risk assessment model improvements. Risk and Safety Management Program members gain access to the following:

- Research results and technical input that foster a risk-informed performance-based regulatory environment.
- Tools and methodologies that increase plant safety and reduce plant and resource requirements.
- Shortened outages, fewer unnecessary shutdowns, reduced inspections and testing, and less-intensive treatment of low-safety significant safety-related equipment.
- Robust, plant-specific framework for more focused and stable regulatory interaction.

Approach

The Risk and Safety Management Program conducts research to facilitate the development of a risk-informed framework that can provide both operational flexibility and safety benefits to nuclear power plants. Operational flexibility encompasses on-line maintenance, flexible testing, flexible technical specifications, and enforcement discretion. Safety benefits include tangible and measured risk reductions as well as intangible items such as improved safety focus.

- Refine probabilistic risk assessment (PRA) models to guide effective design, operation, and asset management decisions for critical plant issues.
- Provide technical analyses supporting continued regulatory acceptance of risk-informed activities.
- Develop analytical and software tools for safety evaluations, configuration risk management, fault tree analysis, and security assessments.
- Support the development of a larger pool of trained nuclear risk professionals.

Accomplishments

EPRI's Risk and Safety Management Program supports industry efforts to ensure risk-informed approaches can be used in making operational, maintenance, and regulatory decisions impacting nuclear power plants.

- Formulated guidelines for developing consistent high-quality PRAs and risk-informed regulatory submittals.
- Developed state-of-the-art computational software tools that reduce the burden of developing and maintaining PRAs.
- Developed a formal program for training the next generation of risk professionals. Two classes will have graduated by end of 2009.
- Developed much of the technical bases and supporting tools for implementation of the Maintenance Rule, which provides a risk-informed environment for on-line maintenance.
- Assisted nuclear plants in pursuing regulatory relief through individual and emergency technical specification changes such as diesel generator "allowed outage time" modifications.
- Facilitated smoother startup and shutdown operations through Risk-Informed Mode Changes, providing a risk basis for the case where all mode change conditions are not met.
- Developed technical basis supporting in-service inspections, reducing risk-insignificant testing to a minimum.

Current Year Activities

Risk and Safety Management Program R&D for 2010 will focus on the continued socialization of risk technology with both regulators and industry management and staff. Specific efforts will include the following:

- Continued development of the next generation of risk professionals through the Education of Risk Professionals course
- Computer-based training overview of PRA fundamentals and risk-informed regulation suitable for management and the end users of risk information
- Update of the *Safety and Operational Benefits of Risk-Informed Initiatives* report (1016308)
- Continued improvements and enhancements of PRA and risk technology, most notably in the fire and seismic hazard areas

Estimated 2010 Program Funding

\$10.0 M

Program Manager

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Summary of Projects

Project Number	Project Title	Description
P41.07.01.01	Fire Risk Methods	There is a strong interest for risk-informed fire protection at existing and new nuclear power facilities. The Fire Risk Methods project develops risk-informed/performance-based methods and tools to effectively and efficiently analyze the impact of fire events on nuclear plant safety risk and to support reduced compliance costs, provide regulatory stability, and improve safety
P41.07.01.01a	PHOENIX Technology Development	PHOENIX is an all modes and all hazards advanced risk tool that provides an integrated risk profile of the plant. PHOENIX will be forward looking and capable of interfacing with inspection and automated log books, remote equipment monitoring devices, and the materials degradation matrices to provide the most current information to the operators and other decision makers when these tools and interfaces become available. PHOENIX represents the next generation of integrated risk tools to support current operations and expansion beyond traditional risk analysis.
P41.07.01.02	PRA Scope and Quality	Risk-informed initiatives depend on high-quality probabilistic risk assessments (PRA) of appropriate scope to support regulatory changes. The PRA Scope and Quality projects provide the clearest opportunity to achieve maximum cost-beneficial changes to the regulatory environment while maintaining or increasing the level of safety.
P41.07.01.04	PRA Scope and Quality (Supplemental)	Risk-informed initiatives depend on high-quality probabilistic risk assessments (PRA) of appropriate scope to support regulatory changes. The PRA Scope and Quality projects provide the clearest opportunity to achieve maximum cost-beneficial changes to the regulatory environment while maintaining or increasing the level of safety.
P41.07.01.05	NFPA 805 and Fire PRA Support Group	Due to increased regulatory attention to evaluation and management of risks due to fires and the transition to NFPA-805 by a number of nuclear plant operators, there is a significant need for EPRI to develop technology enhancements and support industry implementation of risk-informed/performance-based fire protection methods. This project addresses both the base fire PRA methods as well as application of those methods to NFPA 805.
P41.07.01.06	Advanced PRA Methods	Logic models built to support probabilistic risk assessments, risk monitors, and trip and generation risk models are based on technology developed during the 1970s. Modern applications of risk technology have introduced issues not easily solved using traditional techniques. This project develops next-generation PRA methods and software tools to address these complex issues.
P41.07.01.07	Technical Support to Industry on Risk-Informed Regulation	Sustained use of risk-informed and performance-based approaches for nuclear plant applications depends on detailed technical analysis. This project supports both industry generic applications and those plant-specific exemption efforts that possess a high degree of generic applicability.
P41.07.01.08	Risk Management Modeling and Assessment	In 2010, the Electric Power Research Institute (EPRI) will continue to support industry initiatives to address effective risk management and safety culture. This will include interactions with industry working groups such as the Nuclear Energy Institute.

Project Number	Project Title	Description
P41.07.01.09	Grid Risk and Reliability	Loss of offsite power (LOOP) events and grid unreliability can impact plant safety, curtail power to emergency equipment, and result in lost generation. Recent events have heightened regulatory concern relative to availability of offsite power for emergency equipment. This project assesses the probability of LOOP, develops methods to monitor real-time LOOP potential, and improves communication between transmission providers and nuclear plants. The project coordinates with various groups to identify specific industry needs and works with EPRI's Power Delivery & Utilization sector to develop innovative technologies to address the spectrum of issues caused by LOOP events.
P41.07.01.10	Configuration Risk Management	Through continued sponsorship of the Configuration Risk Management Forum in 2010, the Electric Power Research Institute (EPRI) will continue to support research and development of configuration risk management (CRM) enhancements. Research will focus on 1) risk management during low-power / shutdown conditions, 2) evaluation of the impact of external events on configuration risk and plant maintenance activities, and 3) support Nuclear Management and Resources Council (NUMARC) 93-01 revisions to address maintenance rule (a)(4) issues.
P41.07.01.11	Seismic Risk Methods	Seismic issues arise periodically due to regulatory concerns or actual seismic events such as the 2007 earthquake in Japan. This project maintains and improves seismic risk assessment methods and applies them to resolve issues. It also leverages these methods in a collaborative approach to decrease the cost of seismic equipment qualification.
P41.07.01.13	Risk Framework for New Plants, 10CFR50-53	In 2010, the Electric Power Research Institute (EPRI) will continue to support industry initiatives to develop a technology-neutral, risk-informed plant licensing framework applicable to advanced nuclear power plants. This will include interactions with industry working groups (for example, NEI) and support of ASME/ ANS standards development, review, and approval.
P41.07.01.14	RSM Qualifications and Curriculum	Risk and Safety Management (RSM) Qualifications and Curriculum has led to the development of the Education of Risk Professionals program. This program is comprised of a series of 6 one-week-long courses designed to provide the formal instruction necessary to qualify an engineer to work on the level 1 probabilistic risk assessment. The intent of the program is to accelerate the qualification time for new risk professionals from 3 years using on-the-job training to 18 months or less following the training, with mentoring and signoff by supervisors at his or her workplace.
P41.07.01.14d	PRA Documentation Assistant Software Development	This project develops software and compiles best practices to reduce the resource burden associated with PRA documentation and associated risk-informed applications.
P41.07.01.18	SQUG and SEQUAL (QA)	Unresolved Safety Issue (USI) A-46 required seismic re-evaluation of the equipment in older operating plants to render plant seismic ruggedness comparable to newer plants (in which the equipment was qualified to more recent standards). This project provides a cost-effective methodology for evaluating the seismic ruggedness of nuclear plant equipment.

Project Number	Project Title	Description
P41.07.01.20	Security Vulnerability Assessment	Nuclear plant security must be assessed for all types of threats, including an armed attack or the deliberate crashing of a commercial aircraft into a nuclear plant. This project assesses the potential range of security threats to nuclear plants and supports the design and deployment of effective mitigation strategies.
P41.07.01.20a	Risk-Informed Option 2 Users Group	10CFR50.69 allows nuclear plant licensees to reduce the “nuclear special treatment” requirements currently imposed upon structures, systems, and components (SSCs) for those SSCs determined to be of low safety significance. This project will develop technical bases and implementation guidance to support the reduced treatment of low safety significant SSCs.
P41.07.01.21b	HRA/PRA Tool Users Group (QA)	This user group supports enhancements to and application of the HRA Calculator software tool. Due to the importance of human actions to nuclear plant safety risk and the impact of these actions on PRA results, the HRA User Group also provides training on HRA methods and the HRA Calculator software at least twice per year. HRA Calculator software is developed and maintained by EPRI under a Quality Program complying with ISO 9001.
P41.07.01.21e	Risk and Reliability Users Group (QA and ISO 9001)	The Electric Power Research Institute (EPRI) has developed a diverse suite of computer software tools to support risk evaluations and plant operations, including fault tree codes (CAFTA), scheduling and risk mitigation tools (EOOS), and software for specialized analyses (for example, FRANX for fire PRA). This project provides software training and user support for these applications. Additionally, industry meetings are conducted to promote effective software use and to provide a forum for sharing results and methods among the user community.
P41.07.01.22	Emergency Planning Protective Action Strategies	In 2010, EPRI will continue to support industry initiatives to address risk-informed emergency planning protective action recommendations via support of the NEI Emergency Planning Working Group.
P41.07.01.22a	MAAP 5 (QA) (10CFR50 Appendix B and ISO 9001)	MAAP5 was developed to model the core, primary system, and balance of plant of a nuclear reactor following a postulated severe core damage accident. The software follows core melt and relocation, primary system thermal hydraulics, and fission product transport. This software is benchmarked against numerous physical experiments. It provides finer nodalization than MAAP4 and will be particularly useful for designing and licensing new plants. The software is developed under 10CFR50 Appendix B QA requirements for regulatory applications. Both Windows and Linux versions of the software are available.
P41.07.01.22a	GOTHIC Advisory Group (QA--10CFR50 Appendix B)	GOTHIC performs thermo-hydraulic safety analyses of reactor containment buildings for regulatory applications, including three-dimensional analyses of reactor containment buildings under accident conditions. GOTHIC also is widely used in sophisticated heat transfer models such as those associated with containment spray, service water, or spray pond system evaluations. The GOTHIC Version 7.2b (QA) and prior versions of software (QA) were developed and are being maintained by EPRI in a manner compliant with Title 10 of the Code of Federal Regulations Part 50 (10 CFR 50) Appendix B Quality Assurance and 10 CFR 21.

Project Number	Project Title	Description
P41.07.01.22c	MAAP 4 (QA) (10CFR50 Appendix B and ISO 9001)	Modular Accident Analysis Package version 4 (MAAP4) computer software models the core and primary system of a nuclear reactor following a postulated severe core damage accident. The software models accident sequence analysis through core heat-up, core melt and relocation, primary system thermal hydraulics, and fission product transport. This software is benchmarked against numerous physical experiments as well as other thermal-hydraulic and severe accident codes. MAAP4 remains one of the few integrated thermal-hydraulic severe accident codes available. The software is developed under 10CFR50 Appendix B QA requirements for regulatory applications. Both Windows and Linux versions of the software are available.

Fire Risk Methods (052482)

Key Research Question

There is a strong interest for risk-inform fire protection at existing and new nuclear power facilities. This is evident from various regulatory and industry documents such as the voluntary risk-informed fire protection rule and Nuclear Energy Institute (NEI) 00-01—*Fire Protection Significance Determination Process and Guidelines for Post-Fire Safe Shutdown Analysis*. In addition, need is arising in other risk-informed applications (for example, the Maintenance Rule and Risk-Informed Technical Specification, or RITS) to address the potential contribution from fire. The National Fire Protection Association (NFPA) has developed NFPA 805 to define deterministic and probabilistic rules for nuclear plant fire protection, and the American Nuclear Society is developing a Fire Probabilistic Risk Assessment Standard. The Nuclear Regulatory Commission (NRC) has developed a new rule to allow nuclear plants to transition to the NFPA methodology.

Approach

The Fire Risk Methods projects develop and maintain the following:

- Consistent and robust methods for fire risk analysis
- A state-of-the-art fire events database to provide actual fire data for establishing fire probabilistic risk assessment parameters
- Risk-informed applications methods that provide the industry with guidance for using risk information
- Automation tools that can make time-efficient and cost-effective use of these products
- Training to encourage and facilitate product use

The approach is to develop fire modeling and probabilistic risk assessment methods and associated guidance and training to establish use in routine maintenance and improvement of plant fire protection programs.

Impact

- Reduce compliance costs, provide regulatory stability, and improve safety through use of risk-informed/performance-based approaches to fire protection
- Facilitate assessments of plant fire programs and define the fire risk significance of plant changes

How to Apply Results

Members will participate in training courses to learn how to develop fire scenario models and perform fire probabilistic risk assessments (PRAs) in-house. The results of these efforts will be used to make risk-informed decisions on plant changes and program aspects and to concentrate effort on the most risk-significant areas. NRC is expected to require such techniques in the immediate future.

PHOENIX Technology Development

Key Research Question

As the use of risk technology permeates the design, maintenance, and operation of plants, the need for advanced tools capable of reflecting the current plant configuration and condition (including the operation state, ambient conditions, any degraded equipment or states) becomes increasingly important.

Approach

PHOENIX is an all modes and all hazards advanced risk tool that provides an integrated risk profile of the plant. PHOENIX will be forward looking and capable of interfacing with inspection and automated log books, remote equipment monitoring devices, and the materials degradation matrices to provide the most current information to the operators and other decision makers when these tools and interfaces become available. PHOENIX highly leverages existing technology and is the first step in the integration of various probabilistic risk assessment (PRA) software, both model building and risk monitoring, into a more powerful and consistent platform. Following the integration of platforms, new technology capable of integrating additional databases and information archives can be added.

Impact

PHOENIX represents the next generation of risk tools that are consistent, integrated, and capable of expansion beyond traditional risk analysis.

How to Apply Results

PHOENIX will be used by existing staff in a similar manner as existing risk tools and monitors.

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
PHOENIX - Integrated Platform - Release 1: PHOENIX highly leverages existing technology, and the first step is the integration of various probabilistic risk assessment (PRA) software, both model building and risk monitoring, into a more powerful and consistent platform. Release 1.0 provides the first version of the fully integrated risk tool platform, including risk-model development and risk-monitoring software.	12/31/11	Software

PRA Scope and Quality (057868)

Key Research Question

Risk technology and probabilistic risk assessments (PRAs) are currently being used in design, maintenance, and operational decisionmaking as well as in various regulatory interactions. A significant issue in the use of risk technology is the scope and quality, or technical adequacy, of PRAs supporting these uses. In addition, for the PRAs to have maximum utility, technology improvements need to be captured and transmitted to PRA practitioners. The PRA Scope and Quality projects provide a vehicle for the development of PRA guidance based on the state-of-the-art technology. These projects also provide the means (for example, seminars, workshops, and web casts) for transmitting this technology to the end users.

Approach

The PRA Scope and Quality project solicits input from nuclear plant operators, regulators, and the public on the current technical issues facing risk-informed regulation. These issues are prioritized by the PRA Scope and Quality Committee and then resolved through a combination of research and development and consensus building among the stakeholders. The result is a consensus guide that provides a clear, cost-

effective and consistent approach for addressing specific technical issues. The PRA Scope and Quality project includes both base-funded research and supplementally funded research. The supplemental research is conducted through a separate project.

Impact

- Enable risk-informed applications
- Create consistency and stability in the regulatory environment
- Foster a safety and risk-informed culture

How to Apply Results

Through workshops and seminars on the more significant products of the PRA Scope and Quality Committee, members and their utility risk analysts incorporate guidance into the plant-specific PRA. Members also can request individual expert support for more sophisticated guidance.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Resolution or Update of One PRA Scope and Quality Issue: Continue to resolve issues of Probabilistic Risk Assessment (PRA) Scope and Quality, including those associated with Internal Event PRAs and fire and seismic risk studies	12/24/10	Technical Report

PRA Scope and Quality (Supplemental) (52470)

Key Research Question

Risk technology and probabilistic risk assessments (PRAs) are currently being used in design, maintenance, and operational decision making as well as in various regulatory interactions. A significant issue in the use of risk technology is the scope and quality, or technical adequacy, of the PRAs supporting these uses. In addition, for PRAs to have maximum utility, technology improvements need to be captured and transmitted to PRA practitioners. The PRA Scope and Quality projects provide a vehicle for the development of PRA guidance based on the state-of-the-art technology. These projects also provide the means (for example, seminars, workshops, web casts) for transmitting this technology to end users.

Approach

The PRA Scope and Quality project solicits input from nuclear plant operators, regulators, and the public on the current technical issues facing risk-informed regulation. These issues are prioritized by the PRA Scope and Quality Advisory Committee and then resolved through a combination of research and development and consensus building among the stakeholders. The result is a consensus guide that provides a clear, cost-effective, and consistent approach for addressing specific technical issues. The PRA Scope and Quality project includes both base-funded and supplementally funded elements. Base-funded research is conducted through a separate project.

Impact

- Enable risk-informed applications
- Create consistency and stability in the regulatory environment
- Foster a safety and risk-informed culture

How to Apply Results

The PRA Scope and Quality committee meets several times a year to review, prioritize, and resolve PRA scope and quality issues. The research and development activities are accomplished using a collaborative process to develop issue-specific guidance, subject to peer review and pilot evaluation. Members apply the resulting risk guidance in plant-specific PRAs and risk-informed applications.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Two Additional PRA Scope and Quality Guides: Two additional probabilistic risk assessment (PRA) scope and quality guides will be developed to resolve PRA technical issues.	12/31/10	Technical Report

NFPA 805 and Fire PRA Support Group (061405)

Key Research Question

As the nuclear industry addresses current and emerging fire protection issues, and as some plants begin the transition to National Fire Protection Association (NFPA)-805, technical assistance is often needed to support risk-informed, performance-based fire protection. There is an ancillary need to provide a forum for communication among utilities going through the transition.

Approach

The Electric Power Research Institute (EPRI) and Nuclear Regulatory Commission (NRC) Research published a *Fire PRA Methodology Guide* (EPRI 101989/NUREG/CR 6850) in 2006. The methods in this report have been piloted and a joint EPRI/NRC effort is in progress has been initiated to revise the *Guide*. Among the issues being addressed to date are change process change evaluations, fire-induced multiple spurious operations, fire HRA (human reliability analysis), operator manual actions, and non-conforming barriers. A Fire PRA User Group has been established to respond to technical and procedural questions on the use of fire probabilistic risk assessment (PRA) methods.

Impact

The cooperative effort between EPRI and NRC has resulted in the availability of the methodology guide and the resolution of several previously contentious issues. The project communication forum will allow for timely resolution of plant-specific issues as well as generic issues as they emerge in the transition process.

How to Apply Results

Results will be reflected in revisions to of the Guide and in individual EPRI-issue guidance reports. The first of these reports is EPRI 1013489, *Use of Fire PRA Methodology in Estimating Risk Impact of Plant Changes*. Other guidance documents will be used by utility personnel in their development of fire probabilistic risk assessments and their implementation of risk-informed and performance-based fire protection.

Advanced PRA Methods (052488)

Key Research Question

Logic models built to support probabilistic risk assessments (PRAs), risk monitors, and trip and generation risk models are based on a fault and event tree approach developed in the 1970s. Modern applications of risk technology have introduced issues not easily solved using traditional techniques. These issues include the treatment of time-phased modeling, multiple models for internal and external events, the phenomenological modeling of Level 2 PRAs, and the treatment of recovery and human actions.

Approach

This project develops next-generation software PRA tools to address complex issues not amenable to conventional techniques. These tools, developed using a long-term, low-cost, evolutionary approach, are divided into three categories: Advanced Logic Modeling (Declarative Modeling), Advanced Quantification (Direct Probability Calculation [DPC]), and Binary Decision Diagram (BDD).

Impact

- Reduce simplifying assumptions used in the analysis resulting in a higher-quality result
- Reduce the burden associated with PRA development and application
- Reduce the resources associated with PRA documentation

How to Apply Results

Members gain access to software tools that integrate the current software tools in use today and that can be applied in minor or major implementation depending on the risk analyst's desire to achieve the appropriate resource balance.

Technical Support to Industry on Risk-Informed Regulation (061357)

Key Research Question

Risk-informed and performance-based activities target generic applications (proceeding through the Nuclear Energy Institute [NEI], the Nuclear Regulatory Commission [NRC], other regulatory agencies, and pilot plants) as well as plant-specific exemption efforts with generic applicability. Sustained use of such risk-informed and performance-based approaches for nuclear plant applications depends on detailed technical analysis.

Approach

Many risk-informed industry initiatives have progressed to a critical point where their feasibility has been demonstrated, but their benefit to individual nuclear plants hinges on the technical details and timing of their implementation. Such efforts include Risk-Informed Tech Specs, 10CFR50.69, redefining the design basis large loss of coolant accident (LOCA), and applications to digital instrumentation and control systems. Furthermore, NRC decisions on probabilistic risk assessment adequacy for plant applications and compliance to Regulatory Guide 1.200 require careful industry attention. Finally, the ongoing American Nuclear Society and American Society of Mechanical Engineers (ASME) activities on probabilistic risk assessment (PRA) standards are critical elements for successful risk-informed applications.

Impact

- Demonstrate robust application of PRA methods, tools, and results to support risk-informed regulatory initiatives
- Permit plant management to effectively prioritize and allocate resources to improve plant safety and economic performance

How to Apply Results

Electric Power Research Institute (EPRI) research in risk-informed industry initiatives often results in documentation that serves as implementation guidance for members. Methods and results also are communicated in various forums, including conferences, industry meetings, and specific application workshops and training sessions.

Risk Management Modeling and Assessment (052485)

Key Research Question

Effective nuclear safety risk management provides a cornerstone for safe and economical operation. Additionally, risk-informed regulatory initiatives are increasing the importance of risk management. Use of a structured assessment process specifically designed to evaluate and trend the effectiveness of risk management provides plant management with vital information to identify process and program strengths and weaknesses, develop and prioritize improvement actions, and track implementation effectiveness.

Approach

Application of the Risk Management Effectiveness Assessment Application (RMEA) provides plant management with a detailed evaluation of the effectiveness of all processes and programs that impact nuclear safety risk. The process utilizes targeted interviews to obtain detailed knowledge of process interfaces, strengths, and weaknesses. From this, a prioritized set of recommendations for improvement is developed. Additionally, the RMEA provides nuclear plant operators with the capability to assess the level and effectiveness of plant safety culture.

Impact

- Provide plant management a detailed evaluation of the effectiveness of all processes and programs that impact nuclear safety risk, including plant safety culture.
- Permit plant management to effectively prioritize and allocate resources to improve plant safety and performance.

How to Apply Results

EPRI provides on-site member support in performing a RMEA. This approach facilitates effective technology transfer to plant personnel and ensures assessment findings are owned by the implementing plant, resulting in improved follow-up and implementation of the assessment recommendations.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Support utility RMEA evaluations as requested.: Support utility risk management effectiveness assessment (RMEA) evaluations	12/31/10	Technical Resource

Grid Risk and Reliability (057869)

Key Research Question

Loss of offsite power (LOOP) and grid unreliability affect plant safety, curtail power to emergency equipment, and can result in lost generation. Recent events, including the south Florida event in 2008 and the Palo Verde event in 2004, have heightened regulatory concern relative to availability of offsite power for emergency equipment.

Approach

The Grid Risk and Reliability project assesses the probability of loss of offsite power, develops methods to monitor the real-time LOOP potential, and improves communication between transmission providers and nuclear plants. The project coordinates with the Nuclear Energy Institute (NEI) to identify specific industry needs, works with Electric Power Research Institute's (EPRI's) Power Delivery & Utilization sector to develop innovative technologies to support grid voltage near nuclear units, and performs event analyses to identify trends or identify new causes of LOOPS.

Impact

- Reduce the frequency and effect of transmission-grid-related events on operations and safety
- Avoid non-beneficial hardware and operational constraints resulting from implementation of the Nuclear Regulatory Commission (NRC) generic letter, including station blackout and coping time issues
- Provide an interface between plant risk monitors and transmission grid state estimators/contingency analyzers

How to Apply Results

Members build models using EPRI software tools and databases to enable equipment configuration risk management in the plant as well as configuration risk management monitoring of the switchyard and for the transmission load center.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
LOOP Events through 2009: A review of all the transmission grid events in 2009 posing problems for nuclear plants	08/16/10	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Zone of Vulnerability for Transmission Grid Harmonic Oscillations: A method for analyzing the range of distances over which transmission grid instability can effect the integrity of large rotating components (for example, turbine generators) in nuclear units		Technical Report
LOOP events through 2010: A review of all the transmission grid events in 2010 posing problems for nuclear plants	08/15/11	Technical Report

Configuration Risk Management (057870)

Key Research Question

Continued updates and improvements to configuration risk management processes can improve the safety and efficiency of plant maintenance activities. Configuration risk management supports the planning and scheduling of equipment outages, both at-power and during plant outages. Configuration risk management enables evaluation of equipment configurations from a safety risk standpoint and provides valuable information about possible risk management actions associated with the configurations.

Approach

This project supports global dialogue on configuration risk management. The Configuration Risk Management Forum (CRMF) provides a forum for configuration risk management experts to coordinate the needs of the configuration risk management community and identify ways to enhance capabilities and benefits at nuclear power plants. This project also supports low-power and shutdown qualitative risk assessment methods, including participation in industry probabilistic risk assessment (PRA) standards development that impacts risk assessment methods.

Impact

- Improve effectiveness of plant configuration risk management programs.
- Improve regulatory compliance.

How to Apply Results

Members apply results through participation in CRMF meetings. The Configuration Risk Management Forum includes an annual meeting of all configuration risk management stakeholders, technical research, and development activities sponsored by the Risk/Safety Management Program or by supplemental funding and regular meetings of the CRMF Steering Committee to consider industry issues. The CRMF Steering Committee identifies and prioritizes areas where research and development is needed to enhance nuclear plant capabilities/competitiveness or to address emerging regulatory requirements.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Conduct Annual CRMF Meeting: Annual Configuration Risk Management Forum	12/31/10	Workshop, Training, or Conference
Configuration Risk Management – Products and Forum: Technical report describing results from configuration risk management (CRM) research performed at the direction of the Configuration Risk Management Forum (CRMF) Steering Committee and approved by the Risk and Safety Management (RSM) advisors.	12/31/10	Technical Report

Seismic Risk Methods (061358)

Key Research Question

Seismic issues arise periodically due to regulatory concerns or actual seismic events. These issues generally expose plants to significant economic risk. Although the use of risk-informed methods associated with internal events is fairly well established, those for external events are much less so. The two established methods for assessing seismic risk are seismic probabilistic risk assessment (SPRA) and seismic margins assessments (SMA). Both have been used in the past, but not on a routine day-to-day basis or to support risk-informed applications to reduce unnecessary costs. Neither has been integrated with the internal events probabilistic risk assessments (PRAs) on which they depend.

Approach

This project maintains and improves seismic methods to resolve issues and decrease the cost of seismic assessments and seismic equipment qualification. Project activities focus on simplified and extensive external risk methods integrated and "used and useful" by plant engineers and regulators, SMA methods useful for developing plant seismic risk insights without SPRA, and approved risk-informed equipment seismic qualification methods. The project also monitors and informs Nuclear Regulatory Commission (NRC) programs to ensure nuclear plants are not forced to conform to costly new programs and methods in the seismic area.

Impact

- Member ability to perform or manage seismic PRAs for their plants
- Risk-informed decisionmaking that incorporates seismic contributions
- Improvements and maintenance of other seismic efforts such as margins analysis

How to Apply Results

Member engineers will use the products to perform or manage seismic PRAs and seismic margins assessments.

Risk Framework for New Plants, 10CFR50-53 (061883)

Key Research Question

Most of the design and operational decisions at existing nuclear power plants were driven by deterministic requirements. Improved understanding of plant risk has enabled some of the licensing basis to become risk-informed, reducing costs and improving performance while simultaneously enhancing safety. By applying this capability at the design stage, both plant design and operational programs could be risk-informed from the start, minimizing initial design and construction costs, reducing subsequent operating costs, while ensuring plant reliability and safety. The Nuclear Energy Institute (NEI) recognized this possibility in its document, NEI 02-02, *A Risk-informed Framework for New Nuclear Plants*.

Approach

This project involves collaboration with other organizations to inform rulemaking for a new 10CFR Part 53. It also supports ongoing work by the American Society of Mechanical Engineers (ASME) and the American Nuclear Society (ANS) to develop standards for a technology-neutral, risk-informed plant licensing framework. Project activities will address the technical issues associated with this framework and support pilot application of the concepts and specific requirements for both design and operations.

Impact

- Provide a risk-informed licensing framework for advanced nuclear plants.
- Identify and resolve technical issues associated with reliability assessment of passive safety features.

How to Apply Results

Members will review project activities for applicability to existing plants and risk-informed applications (for example, passive safety system reliability). Members also will use project results to inform regulatory issues for existing and new plants.

RSM Qualifications and Curriculum (061904)

Key Research Question

Nuclear plants face challenges in maintaining and expanding probabilistic risk assessment (PRA) staffs to support risk and safety management. Some of the nuclear industry's trained personnel have left for other industries, been hired by regulatory agencies, or will retire in the near future. Because university-based PRA training programs are rare, nuclear plants must devote resources to on-site development of engineering staffs and "conceptual" training for managers and operational personnel. Improved training and qualification programs are needed to more effectively develop trained and certified PRA personnel to perform risk management tasks, support operations through equipment configuration risk management, and support risk-informed applications and Nuclear Regulatory Commission (NRC) submittals.

Approach

The approach is to provide comprehensive training to educate the next generation of risk professionals as well as provide current decisionmakers the necessary overview training. The detailed training is accomplished through a series of six one-week courses designed to provide the formal instruction necessary to qualify an engineer to work on the level 1 probabilistic risk assessment. The qualification time for new risk professionals drops from 3 years to less than 18 months with the training, with mentoring and signoff by supervision at his or her workplace. The overview training is provided through one-hour computer-based training (CBT) modules designed to be taken by management and end users of risk technology. The courses

cover the fundamentals of probabilistic risk assessment (PRA) and risk-informed and performance-based regulation.

Impact

- Produce courses, tools, and training materials for development of PRA professionals
- Computer-based training of managers, operational personnel, and other end users of risk technology

How to Apply Results

Members access Electric Power Research Institute (EPRI) training courses and instructors to develop well-trained and qualified risk and safety management personnel. EPRI Risk Professional Training will provide the formal training portion, including “hands-on” exercises necessary to obtain a qualification card. Members will need to provide mentoring during portions of the qualification process.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Education of Risk Professionals: The 2010 objective of the Education of Risk Professionals program will be to deliver 5 courses in the series of 6. This includes completing a series that started in 2009 and starting a new series beginning with Course 1 in 2010.	11/30/10	Workshop, Training, or Conference

PRA Documentation Assistant Software Development (063062)

Key Research Question

Maintaining and upgrading a probabilistic risk assessment (PRA) is resource intensive. Specifically, documenting the PRA model changes is daunting and time consuming. Tools and technologies that minimize the manual handling of PRA documentation and data can reduce the overall resource burden associated with PRAs.

Approach

The PRA Documentation Assistant (PRA DocAssist) Project develops software tools and features that automate the documentation process. The tools and process will preserve cross-links to related information and the ability to historically trace the evolution of PRA assumptions and models. In addition, sharing industry best practices on the configuration control of the PRA model and its associated documentation leads to a more consistent industry approach and further resource reduction. The project will be modular in nature, building on existing tools such as the Electric Power Research Institute (EPRI) Electronic Probabilistic Safety Assessment (ePSA) and the Human Reliability Analysis (HRA) calculator. A committee comprised of personnel from various utilities will prioritize the development effort. Training, support, and a maintenance version of the code will be available only to those who fund this supplemental project.

Impact

Currently, the resource burden associated with the maintenance of PRAs severely strains existing PRA resources. Reductions in the required resources through automation and process improvements will significantly increase PRA staff productivity. In addition, ready access to the documentation will reduce the resource burden associated with Nuclear Regulatory Commission (NRC) interaction on risk-informed applications (for example, Significance Determination Process [SDP], Mitigating Systems Performance Index [MSPI], and others) and peer reviewers, as well as enhance the ability to demonstrate compliance with PRA standards. An additional benefit of the project will be the ability to more quickly familiarize new staff, the Nuclear Regulatory Commission (NRC), and PRA peer reviewers with the PRA model and documentation.

How to Apply Results

The software and approaches developed in this project can be immediately implemented by the plant PRA staff by importing any existing documentation into the system. Further benefits are obtained by making the software part of daily use by the PRA engineers. This project provides the tools, techniques, and plant experience support to help members best customize the software configurations and work flows to meet the needs of their PRA models and staff capabilities.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
PRA DocAssist version 4.0: Software tool to aid in the development and archiving of documentation, assumptions, and bases for the Probabilistic Risk Assessments (PRA) model.	12/23/10	Software

SQUG and SEQUAL (QA) (052489)

Key Research Question

Seismic qualification of nuclear plant equipment and components remains an ongoing concern as additional data from seismic events are collected and analyzed. In the United States, Nuclear Regulatory Commission (NRC) Unresolved Safety Issue (USI) A-46 required seismic re-evaluation of the equipment in older operating plants to render plant seismic ruggedness comparable to newer plants in which the equipment was qualified to newer standards.

Approach

The Electric Power Research Institute (EPRI) instituted the Seismic Qualification Utility Group (SQUG) to resolve NRC Unresolved Safety Issue A-46, "Seismic Qualification of Equipment in Older Nuclear Power Plants." EPRI and the nuclear plant community successfully resolved the issue through development and implementation of an experience-based method that uses equipment performance data from power and industrial facilities that have undergone actual earthquakes. The SQUG/ Seismic Experience-Based Qualification (SEQUAL) program continues to investigate earthquakes to add to the database, add new equipment classes, and develop and implement methods for experience-based seismic qualification of replacement equipment and parts. SQUG/SEQUAL also promotes the use of the experience-based methodology to its international members and to organizations beyond the nuclear community.

Impact

Provide an innovative and cost-effective methodology for evaluating the seismic ruggedness of nuclear plant equipment without costly seismic shake table testing or analysis

How to Apply Results

Member engineers apply the SQUG methods to assess the seismic ruggedness of plant equipment; perform seismic evaluations of plant changes for heating, ventilating, and air conditioning (HVAC) and piping; and qualify new and replacement equipment and parts.

Security Vulnerability Assessment (057871)

Key Research Question

Nuclear plant security must be assessed for all types of threats, including the deliberate crashing of a commercial aircraft into a nuclear plant and armed attack. Nuclear plants must be prepared to respond to public opinion and to potential new regulatory requirements.

Approach

This project addresses the range of security threats to nuclear plants and designs mitigation strategies. Project activities establish the relative risks of security vulnerabilities at nuclear plants compared to other energy options (for generation decisions) and compared to other infrastructure threats (for security decisions). Past projects have included structural integrity studies in response to various external attack scenarios and an analysis of risk-informed defensive strategies to lessen or thwart the effectiveness of an imminent attack. In addition, a methodology has been developed under which nuclear plant vendors can investigate the effects of aircraft impact on new designs. Project results are made available to plant owners, the Nuclear Regulatory Commission (NRC), and other security authorities.

Impact

- Evaluate the effects of aircraft impact on existing nuclear plant designs and assess inherent defensive capabilities of existing plant structures
- Evaluate the effects of aircraft impact on new nuclear plant designs and assess inherent defensive capabilities of existing plant structures
- Simplify vulnerability assessments compared to past efforts

How to Apply Results

Members apply the guidelines for evaluating plant vulnerability to assess whether there is a significant risk to the plant given an aircraft impact and to adopt or develop contingency plans for a variety of attack scenarios. For new plants, aircraft impact must be considered as a beyond-design basis condition. Electric Power Research Institute (EPRI) results are routinely cited by industry user groups and owner groups to respond to vulnerability inquiries.

Risk-Informed Option 2 Users Group (061435)

Key Research Question

10CFR50.69 allows the licensee to reduce the “nuclear special treatment” requirements currently imposed upon structures, systems, and components (SSCs) for those SSCs determined to be low safety significant. Resources have been mainly dedicated to defining and conducting trial applications of risk-informed classification criteria, responding to Nuclear Regulatory Commission (NRC) comments, and supporting issuance of the final rule language and supporting guidance (for example, Regulatory Guide 1.201, r1). Now that the rule and accompanying guidance has been approved, there is a need to investigate, develop, and document appropriate “good practice” processes for treatment of low safety significant SSCs.

Approach

A project technical steering committee consisting of licensee personnel has been established to provide a forum for plant personnel to communicate issues, discuss resolution possibilities, review best practices, and benchmark against other plants’ practices. The technical steering committee will work with the Electric Power Research Institute (EPRI) to prioritize the list of activities and provide input/direction for the program. EPRI will coordinate with other user group and industry efforts, including licensees and owners groups, and will interface with other EPRI projects addressing equipment qualification, seismic issues, pressure boundary components, procurement to develop good practice documents, and technical basis.

Impact

Defining effective treatment practices for low safety significant SSCs is an important part of achieving a successful 10CFR50.69 program. That is, it is this step in the process that allows significant cost savings while maintaining and/or improving the reliability and performance of SSCs.

How to Apply Results

Project participants will use the results to develop treatment processes for low safety significant SSCs.

HRA/PRA Tool Users Group (QA) (049250)

Key Research Question

The Human Reliability Analysis (HRA) Calculator User Group was created in response to member needs to consolidate HRA calculation methods into a singular software tool. The mission has expanded to include development of fire HRA methods and involvement in HRA benchmarking projects.

Approach

The HRA User Group has developed a software tool (the HRA Calculator) to support consistent human reliability analysis. The User Group seeks to maintain and improve the software. The HRA User Group also provides training on the software at least twice per year. In addition, the User Group seeks to advance the capabilities of the HRA Calculator in the area of fire HRA and monitors benchmarking of HRA methods.

Impact

HRA Calculator has provided users with an effective software tool that is capable of applying a variety of HRA methods such as the Cause-Based Decision Tree Method (CBDTM), the Technique for Human Error Rate Prediction (THERP), Human Cognitive Reliability (HCR), the Operator Reliability Experiment (ORE), and Standardized Plant Analysis Risk (SPAR-H). The user group is in a leadership role in the industry in human reliability analysis as recognized by the NRC and other outside entities seeking EPRI participation in this area.

How to Apply Results

The methods and software developed in this project can be immediately implemented by the plant PRA staff responsible for performance of human reliability analysis. Additionally, training on the HRA methods and the HRA Calculator software provides an efficient mechanism for members to expand resources to perform these evaluations.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
PRA Tools / HRA Calculator User Group: The Human Reliability Analysis (HRA) Calculator is a software tool to support consistent human reliability analysis. The HRA Calculator User Group seeks to maintain and improve the software and provide training to its members. For 2010, the objectives are to maintain the software and provide training support as directed by the HRA User Group Steering Committee.		Software

Risk and Reliability Users Group (QA and ISO 9001) (003888)

Key Research Question

Risk and Reliability Workstation tools provide substantial efficiencies when performing risk analyses for probabilistic risk assessment (PRA) applications. Feedback and input from users can help define needed improvements, enhance training effectiveness, and increase industry application.

Approach

A suite of computer software tools has been developed to support risk evaluation and plant operations. This includes fault tree codes (CAFTA), scheduling and risk mitigation tools (EOOS), and software for specialized analyses (for example, FRANX for fire PRA). Guidelines are produced to aid the engineer, and regular training sessions are conducted.

Impact

The project has resulted in near 100% use of the Risk and Reliability Workstation software by U.S. plants and is widely used in international nuclear units and in other industries. The project provides a cost-effective method for members to provide input into and prioritize needed enhancements to the risk tools. It also provides a useful forum from which experiences from the user community can be shared.

How to Apply Results

Software, training, and user support are available to members of the Risk and Reliability (R&R) Users Group. Meetings held several times a year promote training on the use of the software and provide a forum for sharing results and methods among peers.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Electronic PSA (ePSA) version 2.0 : Software documents and manages probabilistic risk assessment (PRA) conforming to American Society of Mechanical Engineers (ASME) Standard	05/15/10	Software
FRANX 2.0 : Extension of FRANX software to handle flooding events	11/15/10	Software

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
FRANX Version 3.0 : Extension of FRANX software to handle seismic events	11/19/10	Software

Emergency Planning Protective Action Strategies (061655)

Key Research Question

The Nuclear Energy Institute (NEI) Emergency Planning Working Group (EPWG) has recognized the need to update the Emergency Planning (EP) technical basis, which is currently rooted in analysis technology 30 years old. An updated EP technical basis would be risk-informed and would account for the great increase in knowledge built from 30 years of experience.

Approach

Over the past several years, the Electric Power Research Institute (EPRI) has supported industry efforts (via NEI) to apply risk-informed methods to emergency planning. This includes improved modeling of plume radionuclide concentrations, dose rate tracking, evacuation modeling, and health effects assessment. The research also evaluates the effectiveness of enhanced protective action strategies, including shelter-in-place, away from reactor evacuation, away from plume evacuation, and keyhole evacuation. During 2010, EPRI will continue to support these industry efforts via support of the EPWG.

Impact

- Provide the basis for a risk-informed methodology quantifying the relative effectiveness of various offsite protective action strategies. These strategies then can be considered for use in the EP process for nuclear plants (including both existing and new plants).
- Provide an updated technical basis for EP, including consideration of a risk-informed approach and quantification of the margin in the required 10-mile emergency planning zone (EPZ).
- Permit industry engagement with the Nuclear Regulatory Commission (NRC) to improve EP effectiveness and reduce unnecessary licensee burden.

How to Apply Results

Members will apply research results in developing advanced EP protective action strategies, coordinated through the NEI Emergency Planning Working Group.

MAAP 5 (QA) (10CFR50 Appendix B and ISO 9001) (050159)

Key Research Question

An improved version of the Modular Accident Analysis Package, Version 4 (MAAP4) is needed for new regulatory applications and new plant designs. The software is for safety analyses related to the post-accident behavior of the core and thermal hydraulics of the primary and secondary systems, including fission product release and transport.

Approach

MAAP5 was developed to model the core, primary system, and balance of plant of a nuclear reactor following a postulated severe core damage accident. The software follows core melt and relocation, primary system thermal hydraulics, and fission product transport. This software is benchmarked against numerous physical experiments. It provides finer nodalization than MAAP4 and will be particularly useful for designing and licensing new plants. The software is developed under 10CFR50 Appendix B QA requirements for regulatory applications. Both Windows and Linux versions of the software are available.

Impact

MAAP5 will be extensively used for the design of current and new generations of nuclear reactors. The analytical results generated by MAAP5 will be important in the final licensing of the new designs.

How to Apply Results

The software comes with a complete users manual, including solved examples. An applications manual has been developed to provide users guidance for specific, frequently encountered analyses. User Group meetings and training (both in person and web-based sessions) are provided.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
MAAP5.1: MAAP 5.1 is an improved version of MAAP 5.0 released in 2009. This version will extend MAAP5 capacities to analyze the balance of plant. It also will contain improved numerical solutions and stability, along with more detailed modeling of the elements of the reactor primary system.	10/15/10	Software

GOTHIC Advisory Group (QA--10CFR50 Appendix B) (004444)

Key Research Question

Software codes are used to perform thermo-hydraulic safety analyses of reactor containment buildings for regulatory applications. Feedback and input from users can help define needed improvements, enhance training effectiveness, and increase industry application.

Approach

Develop software, procedures, and applications guidance for conducting three-dimensional analyses of reactor containment buildings under accident conditions. The user group provides guidance on new software features, as well as training and user support for the software.

Impact

GOTHIC is the code most widely use by utilities in the United States for this application. It has a large user group and is the code of choice for members to address regulatory applications and to respond to Nuclear Regulatory Commission (NRC) Requests for Additional Information (RAIs).

How to Apply Results

The Gothic User Group provides the software, upgrades, technical support, and training required to use GOTHIC.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
GOTHIC 8.0: Extensively upgraded version of the GOTHIC 7.0 series to include new physical thermal-hydraulic models and expanded water properties (including heavy water)	12/15/10	Software

MAAP 4 (QA) (10CFR50 Appendix B and ISO 9001) (003068)

Key Research Question

In performing severe accident analysis in support of regulatory and safety applications, the ability to model and assess the behavior of the reactor core and fission products is required (for example, probability risk assessment (PRA) success criteria and accident sequence time, human reliability analysis). MAAP4 software and applications guidance were developed to fill these needs.

Approach

Modular Accident Analysis Package Version 4 (MAAP4) computer software was developed to model the core and primary system of a nuclear reactor following a postulated severe core damage accident. The software models accident sequence analysis through core heat-up, core melt and relocation, primary system thermal hydraulics, and fission product transport. This software is benchmarked against numerous physical experiments as well as other thermal-hydraulic and severe accident codes. MAAP4 remains one of the few integrated thermal-hydraulic severe accident codes available. The software is developed under 10CFR50 Appendix B QA requirements for regulatory applications. Both Windows and Linux versions of the software are available.

Impact

Utilities use MAAP software to assess the Final Safety Analysis Report (FSAR) Chapter 15 analyses and to identify appropriate success criteria, perform accident sequence analysis, and identify human reliability timing in probabilistic risk assessments (PRAs). It has a large user group and is the code of choice for members to address regulatory applications and to respond to Nuclear Regulatory Commission (NRC) Requests for Additional Information (RAIs).

How to Apply Results

The software comes with a complete users manual, including solved examples. An applications manual has been developed to provide user guidance for specific, frequently encountered analyses. User group meetings and training (both in person and web-based sessions) are provided.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
MAAP4 Applications Guide, Rev 2: A technical report that provides experienced and new users on how to use the MAAP4 software and how to provide consistent results that match experiments and benchmarks	10/12/10	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
MAAP4 version 4.0.8: Updated version of MAAP4	09/15/11	Software