Communication Plan for the State-of-the-Art Reactor Consequence Analysis (Revision 5)

Overview

The State-of-the-Art Reactor Consequence Analysis (SOARCA) project involves the analyses of severe reactor accidents and the development of the best estimate of the offsite radiological health consequences that result from the accidents. The objective of the project is to develop a body of knowledge regarding the realistic outcomes of severe reactor accidents. In addition to incorporating the results of over 25 years of research, a supporting objective of the SOARCA study is to include in the updated analysis the significant plant improvements and updates (e.g., system improvements, training and emergency procedures, and offsite emergency response) that have been made by plant owners and are not reflected in earlier U.S. Nuclear Regulatory Commission (NRC) assessments. These improvements to plant safety also include those enhancements recently made in connection with security-related events.

The pilot phase of the SOARCA project analyzes two plants that are typical examples of the two types of commercial nuclear power plants used in the United States today. The Peach Bottom Atomic Power Station (Peach Bottom), a boiling-water reactor (BWR) near Lancaster, Pennsylvania, and the Surry Power Station (Surry), a pressurized-water reactor (PWR) near Newport News, Virginia.

The NRC staff completed a detailed technical evaluation of both Peach Bottom and Surry and provided a summary of the preliminary results to the Commission in March 2009. The draft NUREG report, containing the details of the evaluation, was reviewed by an independent external peer review panel of subject matter experts. The staff has also met with the Advisory Committee for Reactor Safeguards (ACRS) to discuss the SOARCA results. The staff is revising the report to address the peer review panel's comments before initiating internal and external reviews. After all internal and external comments have been addressed, the staff will provide the SOARCA NUREG to the Commission along with a recommendation on whether the objectives of the SOARCA project have been met and if and how to proceed with additional analyses of other plants.

Goals

The goal of the SOARCA project is to determine best estimates of the offsite radiological consequences for severe accidents at U.S. operating reactors using a methodology based on state-of-the-art analytical tools and to present the results using risk communication techniques to achieve informed public understanding of the important factors. These factors include the extent and value of defense-in-depth features of plant design and operation as well as mitigation strategies that are employed to reduce risk. As a result, the SOARCA project will update analyses such as NUREG/CR-2239, "Technical Guidance for Siting Criteria Development," dated November 1982.

Background

To develop information that will help in its regulatory mission to protect the public, NRC has performed several research studies to understand probabilities and potential consequences of severe accidents at nuclear plants. They were based on then existing information and assumptions about how the plants would behave. The SOARCA project seeks to produce updated and more realistic estimates.

Over the past 25 years, NRC, industry, and international nuclear safety organizations have completed substantial research on plant response to hypothetical accidents that could damage the core and containment. That research has significantly improved NRC's ability to analyze and predict how nuclear plant systems and operators would respond to severe accidents. During that same time, reactor owners have improved plant designs, the emergency procedures, maintenance programs, and operator training, all of which have enhanced plant safety. Plant owners and local governments also have refined and improved emergency preparedness measures to further protect the public in the event of a severe reactor accident. Often, research has increased our understanding of how radiation exposure affects humans. The SOARCA team applied this accumulated research and accounted for plant changes to achieve a more realistic evaluation of consequences from severe reactor accidents. The results of this research will become the foundation for communicating aspects of severe reactor accidents and updating information from older research studies.

The NRC staff used state-of-the-art information and computer modeling tools to develop best estimates of accident progression and, for scenarios in which accidents proceed to core damage, what radioactive material could potentially be released into the environment. The staff then assessed those releases to realistically estimate the potential consequence to the public. The staff considered the following data in these new analyses:

- Design-specific reactor accident sequence progression, taking into account the plant's current design configuration.
- Design-specific potential containment failure timing, location, and size.
- Credit for operator actions based on emergency operating procedures, severe accident management guidelines, and post-9/11 and other mitigation measures that were in place at the time of the assessment.
- Site-specific emergency planning assumptions, including evacuation and sheltering.
- Site-specific meteorological conditions and updated population data.

The agency has found that a rigorous and realistic evaluation of a few important events provides better and more detailed accident consequence information than a less intense assessment of a larger number of events. With this in mind, the project set technical criteria to determine which scenarios were important and focused its resources accordingly. The project team included scenarios having an estimated core damage frequency of 10^{-6} per reactor year (1 in a million) or

greater. Also, containment bypass scenarios having an estimated core damage frequency of 10^{-7} per reactor year (1 in 10 million) or greater were included.

As noted above, the accident analysis for each scenario included credit for operator mitigation actions (mitigated). Also, to quantify the benefits of the mitigation measures the SOARCA project analyzed these same scenarios assuming the event proceeded unmitigated.

An independent external peer-review committee has examined the approach and underlying assumptions and results obtained for Peach Bottom and Surry to ensure that they are defensible and state of the art.

Key Messages

General Messages

- In carrying out its mission to protect public health and safety, NRC performs research to determine the risk to the public from commercial nuclear power plant operation. The SOARCA project develops the best estimates of the health consequences to the public using state-of-the-art understanding of accident phenomena and plant performance under accident conditions and understanding of radiation effects on humans.

- The results of this project indicate that, for the plants analyzed, reactor safety has improved over the years as a result of efforts by industry to improve plant design and operation and by NRC to develop improved regulations to enhance safety. In addition, our understanding of reactor response has improved which has led to more realistic estimates of the radiological releases.

- The SOARCA individual latent cancer risk values for the selected scenarios in total are significantly smaller than the NRC-established safety goal that "individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health."

- Both mitigated and unmitigated cases predict that essentially no early fatalities will occur and average individual latent cancer fatality risks are very low for the unmitigated scenarios examined.

- The analyses indicate that potential radiation releases would occur several hours later than earlier thought, and they would be substantially smaller; as a result, the best estimate of early fatalities from severe accidents at the nuclear power plants analyzed is far fewer than previously calculated.

- The results of this consequence analysis should provide the public, NRC, and other government agencies with a more realistic picture and a better understanding of potential health consequences in the unlikely event of the severe accidents analyzed.

Additional Key Messages for the Scientific Community

- Information developed from years of research has been incorporated into the tools and the input that NRC uses to evaluate potential accidents. These tools are the Standardized Plant Analysis Risk (SPAR), Method for Estimation of Leakage and Consequence of Release (MELCOR), and MELCOR Accident Consequence Code System, Version 2 (MACCS2) computer codes. These codes were used to select the scenarios, model nuclear power plant systems and operator responses to severe accident conditions, and develop the best estimate of the health consequences to the public.

- This study focuses on those accidents estimated to have a one in a million chance per year or greater of core damage (a core damage frequency of about equal to or greater than 10^{-6} per reactor year). SPAR models were used to identify those potential scenarios for further evaluation.

- In addition, the project considered sequences that may be slightly less likely to occur but with the potential for more severe consequences. Containment bypass events have the potential for more severe consequences and, therefore, those bypass sequences estimated to have a 1 in 10 million chance per year or greater to result in core damage (a core damage frequency equal to or greater than 10^{-7} per reactor year) were included within the scope of SOARCA.

- Plant-specific MELCOR analyses reflected design-specific features. The MELCOR code modeled the nuclear power plant behavior, the progression of the accident, and the radioactive material released into the environment. This includes the timing of fuel damage, component failures, and releases to the environment.

- The project included structural analyses to determine the expected containment performance during the severe reactor accidents.

- MACCS2 calculations used updated risk information; site-specific actions, emergency planning, weather data, population data, and evacuation times (including sheltering) to estimate the health consequences in terms of individual risk of early fatalities and latent cancer fatalities.

Communication Team

The communication team includes the following members and will be responsible for facilitating communication activities for the SOARCA project:

Team Manager:

- Jimi Yerokun, Office of Nuclear Regulatory Research

Team Members:

- Jonathan Barr, Interim SOARCA Project Manager, Office of Nuclear Regulatory Research
- Charles Tinkler, Office of Nuclear Regulatory Research
- Richard Guzman, Office of Nuclear Reactor Regulation
- Scott Burnell, Office of Public Affairs
- Susan Bagley, Office of the Executive Director for Operations
- David Decker, Office of Congressional Affairs

As the project progresses, other NRC staff members are expected to participate in communication activities as needed.

Audiences

External Stakeholders include:

- General public
- Public interest groups
- Media
- Congress
- Licensees
- Nuclear industry organizations (e.g., Nuclear Energy Institute, Institute of Nuclear Power Operations, Electric Power Research Institute)
- Department of Homeland Security, Federal Emergency Management Agency, and other Federal and State agencies
- State regulators and Agreement States
- International groups

Internal Stakeholders include:

- The Commission
- Advisory Committee on Reactor Safeguards (ACRS)
- NRC staff

Communication Tools

The following tools will be used to communicate with external stakeholders:

Public Website	SOARCA information is available on the external Web site at: http://www.nrc.gov/about-nrc/regulatory/research/soar.html
Questions and Answers	Possible questions that may be asked about the project and the answers that are deemed acceptable are provided at the end of this Communication Plan. They include information that highlights aspects of the project that audience members may inquire about. .
Fact Sheet	A fact sheet will be prepared to provide the public with an overview of the project.
Information brochure	A summary of the SOARCA project will be presented in a NUREG/BR brochure using plain language and applying risk communication techniques. This brochure is a tool to enable a good level understanding about risk, for those not interested in technical details. It will be issued in conjunction with the public release of the draft NUREG.
Public Meetings	Meetings will be held to publicly share information at key phases of the project. Meetings will be held when the draft NUREG is released for public review and comment to facilitate public awareness and review of the draft NUREG.
Press Releases	A press release will be issued after the peer review is completed and in conjunction with the NUREG public release, and at other times as appropriate. Press releases will be coordinated with the Office of Public Affairs.
Technical Reports	Technical information about the SOARCA process and results will be documented in a NUREG. The draft NUREG will be made available for public review and comment. An uncertainty analysis, to confirm the robustness of the SOARCA predictions of the most likely outcomes and determine the variability of the SOARCA results to modeling parameters and assumptions, will be documented in a NUREG/CR. In addition, the lessons learned and experiences gained from utilizing the MELCOR and MACCS2 codes for SOARCA will be documented in NUREG/CR reports.
External Briefings	Briefings will be provided to congressional and State stakeholders as requested. Briefings will also be provided to other federal agencies, such as FEMA, as required prior to release of the draft NUREG for public review and comment.
Internal Briefings	Briefings will be provided to headquarters and regional staffs, ACRS, and Commission staffs as required, to help prepare internal stakeholders to communicate the SOARCA results prior to releasing the results to the public.

MILESTONES OF COMMUNICATION ACTIVITIES

The following table identifies the planned or actual completion dates for the SOARCA documents.

Action	Finish Date
Semi-annual briefing of Commission TAs	Ongoing
Quarterly briefing of Deputy EDO	Ongoing
Periodic SOARCA Steering Committee briefing	Ongoing
First review of draft SOARCA NUREG by independent peer reviewers	Completed 07/29/2009
Second review of draft SOARCA NUREG by independent peer reviewers	Completed 09/17/2009
Revise SOARCA NUREG per reviewer comments	Completed 02/15/2010
Provide draft SOARCA NUREG to Surry & Peach Bottom for fact checking	Completed 3/29/2010
Third review of draft SOARCA NUREG by independent peer reviewers	Completed 5/13/2010
Provide draft NUREG to ACRS for review	Completed 5/21/2010
Brief ACRS Subcommittee on SOARCA results	Completed 6/21/2010
Update external SOARCA Web site	October 2010
Brief Commissioners Magwood and Ostendorff on SOARCA (as requested)	10/06/2010
Provide the plan for the SOARCA uncertainty analysis to the independent external peer reviewers	October 2010
Complete technical analysis and incorporate ACRS comments, peer review comments, internal staff comments, and licensee fact-check comments into the draft NUREG	6/22/2010 – 10/15/2010
Complete technical editing and formatting of the draft NUREG report	10/18/2010 – 10/28/2010
Provide draft NUREG report to Commission for awareness/information	10/29/2010
Begin SOARCA uncertainty analysis code runs and analysis	October 2010
Meet with FEMA to discuss techniques used in SOARCA to model the results prior to public release	October/November 2010
Distribute updated draft SOARCA NUREG to headquarters and regional offices for review	11/30/2010 – 12/17/2010
Brief regional and HQ staff before public release of draft NUREG	11/30/2010 – 12/17/2010
Inform Surry and Peach Bottom of the pending release of draft NUREG	Dec. 2010 – Jan. 2011
Brief state and Federal agencies, and congressional staffs (coordinating through OCA) as needed on draft NUREG prior to public release	Dec. 2010 – Jan. 2011
Publish SOARCA information brochure, NUREG/BR	January 2011
Release draft SOARCA NUREG for public review and comment along with press release and federal register notice	January 2011
60-day Public review and comment period	January – March 2011
Conduct public meetings at Surry, Peach Bottom and Headquarters areas	January – March 2011
Address public comments	March - April 2011
Review of draft SOARCA NUREG by ACRS and OGC	04/29/2011 – 05/15/2011
Conduct final ACRS Full Committee meeting on SOARCA	May 2011

Action	Finish Date
Incorporate ACRS comments on draft NUREG	May 2011
NRC review of final SOARCA NUREG	06/01/2011 – 06/21/2011
Final SOARCA Steering Committee meeting on SOARCA – final SOARCA NUREG and final SOARCA uncertainty analysis NUREG/CR	06/22/2011
Proposed final NUREG to OEDO with recommendations	06/23/2011
Proposed final NUREG to Commission with recommendations on next steps for SOARCA	06/30/2011

Evaluation and Monitoring

The communication plan continues to be updated to reflect key ideas being communicated to stakeholders and key decision points in the project's progress. Communication from these venues will be reflected in responses to key questions and ideas during the project's progress. As communications with stakeholders take place, key questions and their responses will be revised and expanded as necessary, based on feedback during stakeholder interactions. New versions of the communication plan will be posted in ADAMS and on the agency's internal Web site list of active communication plans.

Questions and Answers

What is the State-of-the-Art Reactor Consequences Analyses (SOARCA) project?

SOARCA is a research project that develops best estimates of the potential public health effects from a nuclear power plant accident where low-likelihood scenarios could release radioactive material into the environment and potentially cause offsite consequences. The project also evaluates and improves, as appropriate, methods and models for evaluating outcomes of such severe accidents.

Why is the U.S. Nuclear Regulatory Commission (NRC) performing this study?

NRC is doing this study to develop the most realistic evaluations for the potential consequences of severe nuclear accidents. Over the years, NRC, industry, and international nuclear safety organizations have completed substantial research on plant response to hypothetical accidents that could damage the core and containment. The results have significantly improved NRC's ability to analyze and predict how nuclear plant systems and operators would respond to severe accidents. Also, plant owners have improved the plant design, emergency procedures, maintenance programs, and operator training, all of which have improved plant safety. Emergency preparedness measures also have been refined and improved to further protect the public in the highly unlikely event of a severe accident. Combining all of this new information and analysis will improve the realism of accident consequence evaluations.

How will this study be different from earlier studies?

The SOARCA project will:

- Use an improved understanding of source terms and severe accident phenomenology.
- Credit the use of severe accident mitigation strategies and procedures.
- Use updated emergency preparedness modeling.
- Account for plant improvements.
- Use modern computer resources and advanced software to yield more accurate results.

In addition, the SOARCA project is designed to be a more realistic estimate. Some of the earlier studies also were designed to be best estimates; however, because they were limited by the available knowledge of accident phenomenology, these older studies were conservative (particularly the very improbable severe accidents) in their estimates of off-site releases and early fatalities. The SOARCA project will provide the latest basis from which the public and decision makers can assess the consequences of severe reactor accidents.

What are the potential uses of the SOARCA study?

The overarching purpose of this study is to provide more realistic information about potential nuclear power plant consequences to the public and other stakeholders including Federal, State, and local authorities. This study also will increase understanding of the value of defense-in-depth features of plant design and operation, including the use of mitigative strategies.

What consequence measures are being estimated?

This study assesses the health effects of a potential radiation release to the general public. State-of-the-art analytical models estimate the individual risk of prompt fatality and latent cancer fatality that could occur in the remote event that a severe reactor accident occurs. Prompt fatalities are those resulting from exposure to very high doses of radiation as the result of a release. These fatalities occur days to months after exposure. Latent cancer fatalities are those resulting from the long-term effect of radiation exposure. The estimates of public health effects in this new study realistically account for the emergency planning measures in place at each reactor site, unlike some of the past studies that used generic assumptions.

The results from both mitigated and unmitigated cases predict that essentially no early fatalities will occur and average individual latent cancer fatality risks are very low for the unmitigated scenarios examined.

Which plants are participating in the SOARCA project?

The pilot phase of SOARCA analyzes examples of two major types of nuclear reactor in the United States: (1) Peach Bottom Atomic Station, a boiling-water reactor (BWR) in Pennsylvania, and (2) Surry Nuclear Power Plant, a pressurized-water reactor (PWR) in Virginia. After the first phase has been completed, NRC will consider whether analyses are needed for other reactor types and sites.

Does this study consider new reactors that may be built?

No. New reactor designs and containments are not part of the project. The project analyzes existing reactors.

Are terrorist acts, such as aircraft impacts, being analyzed as part of SOARCA?

No. The focus of this study is on accident scenarios—not terrorist-related ones—that could potentially lead to a radiological release into the environment. NRC addresses security-related events in a separate, nonpublic analysis.

Are accidents at spent fuel pools considered in this study?

No. This study does not consider spent fuel pools. The project is focused on evaluating the severe and very unlikely reactor core accidents that may occur at operating power reactors.

Why are the early fatality numbers different from the results predicted by earlier research?

NRC is providing the most realistic, most accurate estimates calculated to date. When NRC published previous studies, the available analytical methods and data about nuclear plant operation were cruder and the source terms for offsite releases were generally larger for the risk important scenarios. Since then, NRC and the industry have improved safety and mitigation measures in the plants. In addition, NRC has improved methods to calculate consequences. Therefore, the SOARCA project is an update to the previous research based on the information known today.

How much different would the numbers be if NRC did the calculations the same way they were done in the past?

So many things have changed in the source terms and consequence analyses that it is not obvious what few parameters to change to provide a "comparison" to past analyses. A detailed report (available through Agencywide Documents Access and Management System [ADAMS]) will describe the justifications for the changes in both input values and calculation methods—regardless of their impact on the final number.

Why does NRC report individual latent cancer fatality risk from the selected scenarios and not total cancer fatalities?

Reporting the individual latent cancer fatality risk from the selected scenarios promotes better understanding and meaning to individuals. Latent cancer fatality risk from the selected scenarios provides easier comparison to other kinds of cancers and context to what the accident scenarios mean to individuals. The U.S. Environmental Protection Agency and others also commonly use individual latent cancer fatality risk as a way to report consequences from scenarios.

Is this study being reviewed by outside experts?

Yes. In addition to the peer review afforded by NRC's Advisory Committee on Reactor Safeguards (ACRS), an independent external peer review of scientific and technical experts has assessed the methods used in this study, its underlying assumptions, and results obtained for Peach Bottom and Surry to ensure that they are defensible and state of the art. This peer review cycle is a common practice in research and is used to identify the strengths and weaknesses of the techniques used in this research project and improve the final output of this task as well as future research activities. This type of independent assessment helps the agency produce a superior product in a more efficient manner.