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Communication Plan for the State-of-the-Art Reactor Consequences Analyses (DRAFT - Revision 3)

Overview

The State-of-the-Art Reactor Consequences Analyses (SOARCA) research project is a U.S. Nuclear Regulatory Commission (NRC) initiative to develop realistic estimates of the potential health effects to the public 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 evaluated and improved, as appropriate, methods and models for realistically evaluating the plant response during such severe accidents, including public evacuation and sheltering. NRC performed this study to calculate realistic information about possibilities for how severe accidents at nuclear power plants could be mitigated and the harm to the public could be prevented or minimized.

The first phase of SOARCA analyzed examples of two major types of nuclear reactor in the United States: (1) Peach Bottom Atomic Station, a boiling water reactor (BWR), and (2) Surry Nuclear Power Plant, a pressurized water reactor (PWR). The first phase has been completed and a summary of the results was provided to the Commission. The staff is now developing a draft NUREG for peer review. Upon completion of the independent external peer-review, the staff will incorporate the peer-review comments and release the results of SOARCA in the form of a technical report (NUREG) and a risk communication information booklet (NUREG/BR). NRC will then consider whether analyses are needed for other reactor types and sites.

Goals

The goal of SOARCA 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 those 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, SOARCA will supercede previous NRC severe accident analyses and become the primary reference for accident progression and consequence estimates.

Background

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 modified plant designs, emergency procedures, maintenance programs, and operator training, all of which have an impact on plant safety. Plant owners and local governments also have revised emergency preparedness measures used to protect the public in the event of a severe accident. The SOARCA team applied this

accumulated research and incorporated plant changes to achieve a more realistic evaluation of consequences from severe nuclear accidents. The results of this research will become the foundation for communicating aspects of severe accidents and updating information from older research studies.

The NRC staff used the above 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 in these analyses:

1. Design-specific reactor accident sequence progression, taking into account the plant's current design configuration.

2. Design-specific potential containment failure timing, location, and size.

3. Site-specific emergency planning assumptions, including evacuation and sheltering.

4. 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.

5. Site-specific meteorological conditions and updated population data.

The agency could learn more by rigorously and realistically quantifying a relatively few important events. 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 (one in a million) or greater. Also, bypass scenarios having an estimated core damage frequency of 10^{-7} per reactor year or greater were included.

As noted above, the accident analysis for each scenario included credit for operator mitigation actions. Also, to quantify the benefits of the mitigation measures ~~and to provide a basis for comparison to past analyses of unmitigated severe accident scenarios~~, these same scenarios were analyzed in the SOARCA project assuming the event proceeded as unmitigated, leading ultimately to an offsite release.

An independent, external peer-review committee will examine 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 of commercial nuclear power plant operation to the public. The SOARCA research project realistically estimates the potential consequences to the

public given the best possible understanding of accident phenomena and plant performance under accident conditions.

- The results of this project indicate 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.
- Both mitigated and unmitigated cases predict that no early fatalities will occur and average individual latent cancer fatality risks are very low for the unmitigated scenarios examined.
- Our analyses indicate that potential radiation releases would occur several hours later than earlier thought, and they would be substantially smaller; as a result, ~~offsite consequences~~ from severe accidents at nuclear power plants would be smaller than previously predicted.
- The results of this consequence analysis provide the public, NRC, and other government agencies with a more realistic picture and a better understanding of potential consequences in the unlikely event of an accident.

Additional Key Messages for the Scientific Community

- Information developed from years of research has been incorporated into the tools that NRC uses to evaluate potential accidents. These tools are the SPAR, MELCOR, and MACCS2 computer codes. These codes were used to select the scenarios, to model nuclear power plant systems and operator responses to severe accident conditions, and to produce a best estimate of 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 approximately equal to or greater than 10^{-6} per reactor year). SPAR models will be used to identify those potential scenarios that will be further evaluated.
- In addition, the project placed emphasis on sequences that may be a little 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. The project teams used the SPAR models to identify the included potential bypass scenarios.
- Plant-specific MELCOR analyses reflected design-specific features. 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.
- Structural analyses determined the expected containment performance during accidents.

updated dose and risk coefficients; and updated non-site specific parameters

- MACCS2 calculations used site-specific actions, emergency planning, weather data, population data, ~~and evacuation times (including sheltering)~~ to estimate consequences such as early fatalities and latent cancer injuries.

response actions

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: Terry Brock, 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, it is expected that other NRC staff members will 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 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	Information about project will be placed on the external website.
Questions and Answers	This contains information that highlights aspects of the project that audience members may inquire about. These questions and answers are given at the end of this Communication Plan.
Fact Sheet	A fact sheet will be prepared to provide the public with an overview of the project.
Information booklet	A summary of the SOARCA project will be presented in a separate NUREG/CR booklet using plain language and applying risk communication techniques. This booklet is a tool to enable NRC and its stakeholders to develop a common understanding about risk. It will be issued after the peer review is completed.
Public Meetings	Meetings will be held to publicly share information at key phases of the project.
Press Releases	A press release will be issued after the peer review is completed and at other times as appropriate. Press releases will be coordinated with the Office of Public Affairs.
Technical Reports	Technical information about the process and results will be documented in a NUREG and will be made publicly available through the Agencywide Documents Access and Management System (ADAMS) and the NRC's external website. This NUREG is being developed and will be issued after the peer review is completed.
External Briefings	Briefings will be provided to Congressional and State stakeholders as requested.
Internal Briefings	Prior to releasing the results, the SOARCA staff will hold briefings for technical staff in NRC Regional offices and other interested NRC staff to help prepare them to communicate about the results.

Update to new P.M.

MILESTONES OF COMMUNICATION ACTIVITIES

COMMUNICATION ACTIVITIES	RESPONSIBILITY	DATE
Semi-annual TA brief	T. Brock	ongoing
Quarterly DEDO brief	T. Brock	ongoing
Meeting with ACRS	SOARCA Team	July 2009
Independent Peer Review of documents starts – issue press release	SOARCA Team/OPA	July 2009
Steering Committee meeting	T. Brock	September 2009
Public release of SOARCA results for Peach Bottom and Surry – The following activities are planned to engage stakeholders to promote a common understanding of the SOARCA results.		
Public website update	SOARCA Team	Early 2010
Briefings on results to Regional and HQ staff prior to public release (nonpublic meeting)	T. Brock	Early 2010
Briefings on results to participating licensees	T. Brock	Early 2010
All-Agreement States and Non-Agreement States letter	T. Brock/FSME/DILR	Early 2010
Press release to coincide with the release of the SOARCA results	T. Brock/OPA	Early 2010
Chairman holds press briefing	T. Brock/OPA	Early 2010
Public release of NUREG and the NUREG/BR information booklet	SOARCA Team/SNL/ OPA	Early 2010
Public Workshop	SOARCA Team/SNL	Early 2010
Regulatory Information Conference (RIC) Presentations on final results	SOARCA Team	March 2010

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.

Questions and Answers

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

SOARCA is a research project that develops realistic 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 realistically evaluating both the plant response during such severe accidents, including evacuation and sheltering, and the potential public risk. emergency response actions

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

NRC is doing this study to develop the most realistic evaluations possible 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 modified the plant design, emergency procedures, maintenance programs, and operator training, all of which have an impact on plant safety. Emergency preparedness measures also have been revised 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~~ response modeling.
- Account for plant improvements.
- .

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). The SOARCA project will provide the latest basis from which the public and decisionmakers can assess the consequences of severe reactor accidents. in their estimates of radiological releases

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. 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 soon after exposure (days to months). Latent cancer fatalities are those resulting from the long-term effect of radiation exposure. The estimates of public health effects in this new study account for the emergency planning measures in place at each reactor site, unlike some of the past studies that used generic assumptions.

Which plants are participating in the SOARCA project?

The first 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), and (2) Surry Nuclear Power Plant, a pressurized water reactor (PWR). 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 separate, non-public 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 accidents that may occur quickly at operating power reactors.

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

NRC is providing the most realistic, most accurate estimates possible. When NRC published previous studies, the available analytical methods and data about nuclear plant operation were cruder and the results were therefore conservative. 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 all 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?

The purpose of the SOARCA project is somewhat different from the calculations done in the past because this project is a "best estimate" consequences analysis. In addition, NRC's knowledge, computational capabilities, and modeling methodologies are better now than in the past. 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 and not total cancer fatalities?

Cancer fatality risk provides easier comparison to other kinds of cancers and context to what the accident scenarios mean to individuals. In addition, this method better represents the risk due to proximity to the site. The focus on individuals from far away to close to the plant shows the increase in risk due to the postulated severe accident. The Environmental Protection Agency and others also commonly use cancer fatality risk as a way to report consequence.

If I live within one of the reported distances in the results of SOARCA, how do I interpret my specific risk relative to the average value reported?

The human health risks calculated in SOARCA are very small. To interpret the average individual cancer risk results from SOARCA, it is helpful to compare to the NRC safety goal for cancer risk of 2 in 1 million per year. The average individual cancer risks calculated in SOARCA within the 10-mile emergency planning zone are all in the 1 in a billion to 1 in a 100 billion per year range. The average individual risk numbers decrease the further the distance out from the plant (e.g., 50 and 100 miles). The SOARCA cancer risk values are all significantly smaller than the NRC-established safety goal of no significant additional risk to life and health.

Is this study being reviewed by outside experts?

Yes. In addition to the peer review afforded by NRC's Advisory Committee on Reactor Safeguards, an independent external peer review of scientific and technical experts will assess the methodological approach, underlying assumptions, and results obtained for Peach Bottom and Surry to ensure that they are defensible and state-of-the-art. This peer review is a common practice in research and will show both the strengths and weaknesses of the research project. NRC will continue to use the methods shown to be strengths of the research project, and the experts' comments on the weaknesses will help improve future research projects.

State-of-the-Art Reactor Consequence Analysis (SOARCA) Program
Commission Briefing – February 18, 2010

BACKGROUND

The State of the Art Reactor Consequence Analyses (SOARCA) project uses realistic analyses of severe accident progression to develop "best estimate" predictions of potential consequences. This study incorporates over 25 years of research, updated system designs and other plant characteristics, operator training, and emergency procedures and response.

This study, in part, updates many earlier NRC publications, such as the quantification of offsite consequences found in NUREG/CR 2239, "Technical Guidance for Siting Criteria Development," dated December 1982, known as the Sandia Siting Study, and NUREG/CR 2723, "Estimates of the Financial Consequences of Reactor Accidents," dated September 1982, known as the Strip Report.

The SOARCA project analyzes two reactors, the Peach Bottom Atomic Power Station and the Surry Power Station, which serve as pilot plants for the study. Peach Bottom is generally representative of a major class of U.S. operating reactors: General Electric boiling water reactor (BWR) designs with Mark I containments. Surry is generally representative of a second major class of U.S. operating reactors: Westinghouse pressurized water reactor (PWR) designs with large, dry containments. The scope of this study is limited to ~~reasonable (i.e. likely),~~ The most likely non-security related, single-unit events at reactors operating at full power, for both externally (e.g. seismic, fire, and flooding) and internally initiated events.

STATUS

The NRC completed the evaluation of Peach Bottom and Surry Nuclear Power Plants and a summary of the preliminary results was provided to the Commission in March 2009. The draft report is being reviewed by an independent peer review panel of subject matter experts. The staff is revising the report to address the peer reviewers' comments before initiating internal and external reviews. After all the comments have been addressed, the staff will provide the SOARCA NUREG to the Commission for review.

The SOARCA analyses shows that accidents progress more slowly than originally thought and successful mitigation can prevent offsite consequences. If the accidents proceed without mitigation, containment failure and radiological release occur many hours after the onset of the accident.

NEXT STEPS

Once the draft documents are revised to address peer review comments they will be technically edited before being routed to headquarters and field offices for review, comments, and concurrence. Following internal concurrence, the documents will be issued for external review by the licensees and public.

Comments received by the SOARCA team will be reviewed and the documents modified as appropriate.

Once finalized, the NUREG and NUREG/BR will be presented to the Commission along with recommendations from the SOARCA team for the next steps.

SOARCA Commission Briefing 2-18-10

CHALLENGES

The public rollout of the SOARCA NUREG requires the communication of numerical risk to the public. This can be difficult because the public often perceives "risk" differently than the technical authors intended. The Office of Nuclear Regulatory Research will work closely with the Office of Public Affairs to craft and deliver a message that strives to address the public perception of risk, people's relative tolerance of technological dangers, and their acceptance of risk analysis.

POTENTIAL POLICY ISSUES

None

KEY MESSAGES

- Reactor safety has improved in the past 25 years due to improved design, operation, and regulation.
- Accident progression is slower than previously thought, resulting in a delayed release of radioactive material.
- Accidents can be mitigated and offsite release of radioactive material can be prevented.
- When not mitigated, the modeled radiation releases are delayed and relatively small.
- As a result, early fatality consequences are essentially zero and long-term cancer fatalities are small.
- The SOARCA analysis includes predictions of individual latent cancer fatality risk for two distance intervals: 0 to 10 miles and 0 to 50 miles. The analysis indicates that individual latent cancer risk estimates generally decrease with increasing distance in large part due to fission product deposition closer to the site.
- If the probability of the severe accident itself is accounted for, the latent cancer fatality risk from an analyzed accident scenario to an individual within 10 miles is as large as 1×10^{-9} (1 in a billion) per reactor-year, which is many orders of magnitude smaller than the U.S. average risk of a cancer fatality.

State-of-the-Art Reactor Consequence Analysis (SOARCA)

- **Background**
  - **NRC studies after 9/11 showed that earlier accident consequence studies were overly conservative**
  - **SOARCA uses modern computer modeling programs and evaluation techniques to:**
    - **Perform a state-of-the-art, realistic evaluation of severe accident progression, radiological releases and offsite consequences for dominant accident sequences**
    - **Provide a more accurate assessment of potential offsite consequences to replace previous consequence analyses**
- **Status**
  - **Initial technical analysis completed**
  - **report undergoing peer review by independent panel**

SOARCA (continued)

- **Key Message**
  - **Reactor safety has improved in the past 25 years due to plant improvements, improved operations and regulation**
  - **Accident progression is slower than previously thought, resulting in a delayed and smaller release of radioactive material**
  - **Accidents can be mitigated and offsite release of radioactive material can be prevented**
  - **External events dominate accident scenarios**