STATE-OF-THE-ART REACTOR CONSEQUENCE ANALYSES (SOARCA) PROJECT PLAN

June 2007

I. Goals

The goals of the State-of-the-Art Reactor Consequence Analyses (SOARCA) project are to (1) develop a more realistic, state-of-the-art evaluation of severe accident progression, radiological releases, and offsite consequences for dominant accident sequences; and (2) replace analyses such as NUREG/CR-2239, "Technical Guidance for Siting Criteria Development," which the U.S. Nuclear Regulatory Commission (NRC) issued in November 1982.

II. Objectives

The objectives of the project are to use a methodology based on state-of-the-art analytical tools to derive "best estimates" of the radiological consequences (including early and latent fatalities) for U.S. operating reactor sites, and to present those results in a clear and concise manner that will promote a common understanding amongst all our stakeholders using risk communication techniques.

III. Project Summary

For the SOARCA project, the NRC staff will employ existing analytical research tools, in an integrated and coherent methodology to predict more realistic outcomes. The staff has evaluated and updated these analytical tools to include substantive and cost-effective improvements that reflect the state-of-the-art, and provide "best estimate" results. The staff will also use a systematic process to identify and evaluate the degree of uncertainty associated with each variable.

The project will generate more realistic consequence analyses for operating nuclear power plants in the United States. To support these results, the staff will conduct consequence analyses for sequence groupings that have a core damage frequency (CDF) approximately equal to or greater than 10^{-6} per reactor year (i.e., one in a million), or a CDF approximately equal to or greater than 10^{-7} per reactor year (i.e., one in a ten million) for sequences, such as a containment bypass, that can result in more severe consequences. The staff will truncate sequences that are considered remote and speculative, so as not to obscure the value of preventive and mitigative features for the more likely sequences.

Studies such as the industry's probabilistic risk assessments, individual plant examinations, individual plant examinations of external events, and the NRC's standardized plant analysis risk (SPAR) programs have yielded important risk insights. The staff will use the risk insights from these and other studies to identify plant-specific dominant accident sequence groupings for the plants within the initial scope of the SOARCA project. The staff will then calculate the source term for each plant-specific dominant sequence grouping, and determine the potential consequences.

The SOARCA will consider enhancements in plant design, operation, inspection, maintenance, and accident management, as well as improvements in calculation methods for accident progression and consequence analyses. The staff will integrate the latest site-specific information with state-of-the-art analytical tools into a coherent methodology that can be used to derive and better understand more realistic best-estimate radiological dose consequences (including early and latent fatalities). In addition, the staff will use plant-specific calculations, obtained using the NRC's MELCOR integral severe accident analysis code, to determine the time to fuel failure, as well as the magnitude and timing of environmental fission product releases. The staff will then use those results to perform site-specific consequence analyses using the MELCOR Accident Consequence Code System 2 (MACCS2). The staff will report all measurable consequences in terms of early and latent cancer effects. The staff will report these results and communicate them to stakeholders. Contract support for this effort will be provided by Sandia National Laboratories (SNL).

IV. Project Description

The following subsections describe the scoping and process activities involved in developing the SOARCA, and Attachment 1 to this plan augments this description with a flowchart of the SOARCA process.

A. Scoping Activities

The initial scope of the project is limited to no more than eight plants, representing a spectrum of plant vendors and containment types used in the United States.

The first two assessments will be on the Peach Bottom Atomic Power Station (a General Electric Type 4 boiling water reactor, with a Mark I containment, operated by Exelon), and the Surry Power Station (a Westinghouse three-loop pressurized water reactor, with a large dry subatmospheric containment, operated by Dominion). The staff has already begun working on these two assessments, which will help to resolve issues related to the integration of methods and details associated with simulating plant systems and procedures. The staff will then perform the assessments on the remainder of the not more than eight plants that will makeup the initial scope of the SOARCA.

After completing initial scope of plants, the staff will present the results to the Commission along with a recommendation, based on insights gained from the initial studies, as to whether it is necessary to continue the assessment of some or all of the remaining plants to achieve the original objectives of the SOARCA project.

B. Process Activities

1. Internal Sequence Selection

For each plant within the scope of the SOARCA project, the staff will use the plant-specific enhanced SPAR model to identify, for an initial focus, the dominant sequence groupings with CDFs approximately equal to or greater than 10^{-6} (or 10^{-7} for potentially high consequence sequence groups such as containment bypass events). The staff will then refine the selected dominant sequence groupings using assessments of external events and mitigative measures.

It is important to note that sequence selection is an iterative process; thus, sequence groupings that fall below the CDF thresholds will be eliminated from the scope.

2. External Events Evaluation

The staff will identify the dominant externally initiated event sequences (e.g., fire, seismic, flooding, and wind), based upon available probabilistic risk assessment documentation from NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," issued in 1991; IPEEE submittals and/or external event SPAR (SPAR-EE) model information; generic insights; and any additional supporting documentation.

3. Containment System States

The staff will identify systems that impact post-core-damage containment accident progression, containment failure, and radionuclide release, and assess the availability of these systems. This task will identify the anticipated availability of containment and containment support systems not considered in the Level 1 core damage analysis, based on limited analyses and engineering judgment.

4. Mitigative Measures Analysis

The staff will perform a basic systems and operations analysis to determine the mitigative measures from emergency operating procedures (EOPs), severe accident mitigation guidelines (SAMGs), and any other procedures that are applicable to, and available during, the site-specific dominant sequence groupings to be considered in the MELCOR analyses.

5. Refinement of Sequence Selection

The staff will refine the sequences selections based on the plant-specific internal event dominant sequence groupings, external event evaluations, containment system states, and mitigative measures. The refined sequence selections will then be used as input into the MELCOR model for accident progression analyses.

6. Structural Analyses Process

The staff will determine containment leak rates as a function of pressure for reinforced, pre-stressed, and steel containment structures for each plant within the scope of the SOARCA.

7. MELCOR Analyses

The staff will perform accident progression analyses for each plant and each plant-specific dominant sequence grouping using the MELCOR computer code to determine source terms and times of release. The output will be used for input into the MACCS2 analyses.

8. MACCS2 Analyses

The staff will develop a model for each of the sites within the initial scope of the SOARCA project based on the refined source term, meteorological data, dose response, and emergency response parameters. In addition, the staff will use the MACCS2 computer code to perform consequence analyses for each site and each dominant sequence grouping source term derived from MELCOR, in order to determine early fatalities and latent cancer fatalities.

9. Meteorological Input

Licensees will provide 8,760 consecutive hours (1 year) of meteorological data, collected in accordance with Regulatory Guide 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants," and any corresponding precipitation data (not required by the guide) for the same 8,760 hours, if available. By contrast, if precipitation data are not available from the licensee, the NRC will obtain the necessary information from an alternative source, such as the National Weather Service. The NRC staff will review and adjust these data for input into the site-specific MACCS2 model.

10. Emergency Preparedness

The staff will model the protective response afforded by the licensee's current site-specific emergency preparedness program. An analysis will be used to evaluate the potential benefits of staged evacuation and increased use of initial sheltering (followed by evacuation) for a high-population site.

11. Uncertainty Analyses

The staff will perform a Monte Carlo-based uncertainty analysis with MELCOR for one sequence group for one plant to quantify the uncertainty in fission product release to the environment. In addition, a Monte Carlo-based uncertainty analysis will be performed with MACCS2 for one sequence group for one plant, in order to quantify the uncertainty in offsite radiological consequences.

12. Peer Review

A peer review of the results will be performed to ensure consistency in the information used and how it is applied, and to verify the outcome of each consequence analysis.

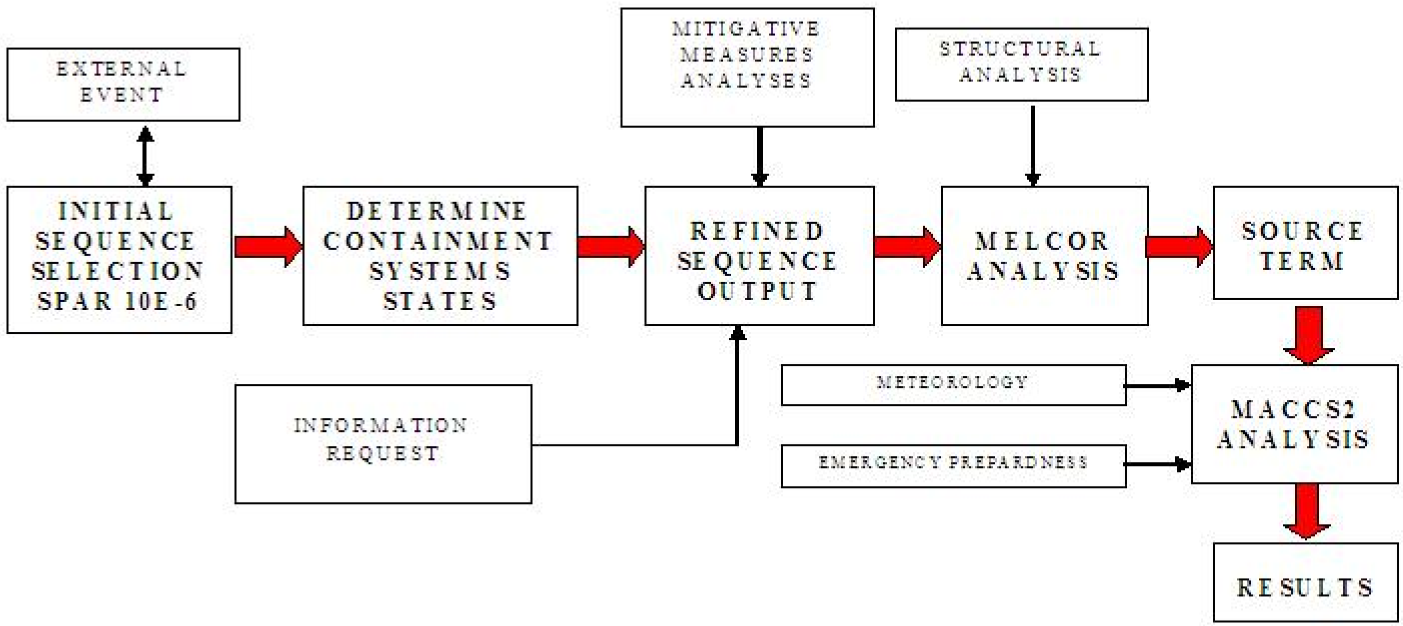
13. Risk Communication

The results of the SOARCA will be presented and documented using risk communication techniques to achieve public understanding of the extent and value of defense-in-depth features, including current mitigative strategies, and important analytical assumptions. In presenting these results, the staff will substantially improve upon the communication and presentation techniques that were used previously in NUREG/CR-2239 (1982 siting study); and will include a discussion of the differences between the state-of-the-art analysis and the NUREG/CR.

V. Schedule

The staff is working to complete the analyses on the first two plants by the end of 2007. The schedule for the remaining plants within the initial scope of SOARCA will be finalized based on the experience gained from the first two plants. The staff projects that the next three plant analyses will be completed by the end of 2008. At that time, the staff will report the results to the Commission with a recommendation on how to proceed with the remaining plants that makeup the fleet of U.S. operating nuclear power plants to meet the original intent the SOARCA. Because the SOARCA analyses are an iterative process, meaning that each analysis may identify new insights that previous analyses can benefit from, no results will be considered final until all the analyses are complete. Therefore, no results will be released until all the analyses are completed.

SOARCA Process Diagram



Attachment 1