State-of-the-Art Reactor Consequence Analyses (SOAR-CA)
Frequently Asked Questions and Answers (Q's & A's)
OEDO Revision - 12/13/06

Q.1) What is the State of the Art Reactor Consequences Analyses (SOAR-CA) project?

A.1) The SOAR-CA project is a three-year effort to develop a realistic estimate of the risk involved in nuclear power plant accidents, where low-likelihood scenarios could release radioactive material to the environment and potentially cause offsite consequences. The project will also evaluate and improve, as appropriate, methods and models for realistically evaluating both the plant response during such severe accidents and the potential effects on the public.

Q.2) Why is the NRC performing this study?

A.2) Over the past 25 years, the NRC, industry and international nuclear safety organizations have completed substantial research on plant response to hypothetical accidents that could damage the core, as well as potential offsite effects from these accidents. That research has significantly improved our ability to analyze and predict how nuclear plant systems and operators would respond to severe accidents. During that same time, plant owners have improved the plant design, emergency procedures, inspection programs and operator training - all of which has improved plant safety. Emergency preparedness measures have also been refined and improved to further protect the public in the highly unlikely event of a severe accident. Applying this research, taking into account the enhancements to plant safety and emergency preparedness, will result in an improved and more realistic evaluation of both the probability and the consequences of severe accidents.

Q.3) How will this study improve upon earlier studies?

A.3) This updated realistic analysis, incorporating all the insights we have gained through research, can provide a better basis from which the public and decision makers can assess the safety of nuclear power plants. Modern computer resources and advanced software will reduce the need for conservative assumptions and will yield more realistic results. Past studies of plant response and offsite consequences were extremely conservative, to the point that the predictions were not useful for characterizing results or guiding public policy. Overly conservative results were often caused by either conservative assumptions or simple worst-case analyses. Misuse or misinterpretation of these earlier results further reinforces our belief that communication of risk from reactor accidents must be based on realistic analyses.

Q.4) What are the potential uses of the SOAR-CA study?

A.4) The overarching purpose of this study is to provide more realistic information on nuclear power plant risks to the public, stakeholders including federal, state and local authorities and licensees, and the NRC. This study will increase understanding of the value of defense-in-depth features of plant design and operation, including mitigative strategies. This study will also replace some earlier studies, such as NUREG/CR- 2239, “Technical Guidance for Siting Criteria Development,” dated December 1982, and NUREG/CR-2723, “Estimates of the Financial Consequences of Reactor Accidents,” dated September 1982. Other uses could include potential improvements to regulatory analyses for backfitting decisions, prioritization and resolution of generic safety issues and resource allocation. This study will also provide insights to current emergency preparedness (EP) evacuation and sheltering strategies.

Q.5) Why were the six plants chosen for the initial set of studies?

A.5) Six plants are being selected for the first analysis so that the NRC can obtain early insights and experience with the analytical models, methods and assumptions used for the assessment prior to undertaking analysis of the entire fleet of reactors in the US. The initial assessments will help the NRC assess the study’s analytical tools and methods, and help us decide if any revisions are necessary . The remaining U.S. nuclear power plants will be scheduled for subsequent evaluation.

The individual plants were chosen based on two major considerations. First, the plants are members of two of the largest generic groups of reactors: large Westinghouse pressurized water reactors with dry containments, and Mark I General Electric boiling water reactors. Secondly, the plants chosen represent a cross section of population densities. The six plants were not selected because of any concern over the potential consequences of a severe accident at that site.

Q.6) How will the SOAR-CA project be conducted?

A.6) Existing models will identify those accidents which have at least a one in a million chance per year of releasing radioactive material into the environment. This screening process is needed to avoid scenarios which have vanishingly small probabilities (one in ten billion reactor years or less). While it is mathematically possible to assign probabilities to such events, these events are so remote that any consequences associated with such events are not meaningful. After identification of the dominant severe accident scenarios, and the response of plant operators to those scenarios, detailed analyses will be performed with state-of-the-art analytical models to predict the plant response and offsite consequences.

Q.7) What is the basis for the state-of-the-art analyses?

A.7) The insights on severe accident phenomena accumulated through worldwide extensive experimental and analytical research over the last 25+ years has been incorporated into the MELCOR computer code. The MELCOR code, developed at Sandia National Laboratories, contains models for both active and passive plant features and the important physical processes associated with severe reactor accidents. MELCOR analyses will be used to predict, in a consistent integrated fashion, the timing and progression of the severe accidents (e.g., timing of reactor core melt, timing of containment failure, and the magnitude of the radioactivity release to the environment).

Q.8) How is this state of the art analysis different from past analysis and evaluations?

A.8) Earlier studies, which did not have integrated analytical methods such as MELCOR available to them, often resorted to conservative assumptions (in some cases unrealistic and extremely conservative ones) regarding the timing and magnitude of radioactivity releases. Using the more realistic MELCOR prediction of radiation release, the study will then use the MACCS2 code to predict the offsite consequences of the radioactivity release. The MACCS2 code contains models for dispersion of radioactive plumes, emergency planning responses (evacuation and sheltering of the public) and uptake of radioactive material by the public and related health effects. Unlike some earlier studies which assumed a generic, emergency planning response, this new study will incorporate updated site-specific emergency planning in its prediction of potential offsite consequences.

Q.9) Why is it appropriate to use the criteria of one in a million chance per year for selection of accidents for analysis?

A.9) Realistic and risk-informed regulatory decisionmaking focuses on the value of preventive and mitigative features for the more likely scenarios. We will therefore conduct consequence analyses only for scenarios that have a radiological release frequency (due to containment failure or containment bypass) greater than or equal to one in a million per year of reactor operation.

The threshold value selected for screening individual scenarios represents a risk which is about 10 times smaller than the combined risk associated with the NRC's safety goal. Thus, in this study we are examining all of the events which would normally be important in a risk assessment.

Using such a criteria allows us to concentrate our resources and detailed analyses on those events which while remote, are more likely to realistically contribute to public risk. Scientific knowledge, combined with theoretical projections, allows us to assign probabilities to extremely remote events (e.g., massive destruction from meteors). But the estimate of the probability of such events is highly suspect since there is no human experience from which to judge the accuracy of such estimated probabilities. The study of unrealistically extreme events with incredibly low probabilities sheds no useful information on the safety of nuclear reactors. There is far greater value in focusing on events which bear some credibility. The particular probabilistic threshold value chosen for SOAR-CA is quite low and represents a minimal level of risk to the public.

Q.10) What consequence measures are being estimated?

A.10) This study assess the health effects of a potential radiation release on the general public. State-of-the-art analytical models will be used to estimate the number of prompt fatalities and the number of latent cancer fatalities 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 will realistically account for the emergency planning measures in place at each reactor site, unlike some of the past studies which used overly conservative generic assumptions that did not account for site specific planning. Consistent with our overall approach, in order to more realistically estimate health effects, the prediction of latent cancers will account for a threshold dose (up to 5 rem per year) below which no observable health effects have been determined.

Q.11) Who is participating in the SOAR-CA project?

A.11) The SOAR-CA project is being performed by the NRC with assistance from Sandia National Laboratories. Sandia National Laboratories is the principal NRC contractor for severe reactor research and has developed much of the computer modeling to be used in this study. At NRC, the study is a joint effort among the Offices of Nuclear Regulatory Research, Nuclear Security and Incident Response, and Nuclear Reactor Regulation.

Performing the SOAR-CA project requires a wide array of disciplines. Staff working on the project include experts in reactor accident probabilistic assessment, human factors, severe core damage accident phenomena and modeling, emergency planning, and offsite consequences. Information will be required from all of the operating power plants to obtain realistic input for the calculations. Six plants (Peach Bottom, Duane Arnold, Seabrook, Fermi, Salem, and Diablo Canyon) will be asked to supply information during the first phase of the study. Information from the remaining plants will also be requested.

In addition to the NRC and its contractors participating on this project, peer reviewers of the results will include nuclear safety experts from a wide range of organizations. Independent experts from other national laboratories (e.g., Oak Ridge National Laboratory, Brookhaven National Laboratory) as well as industry experts and researchers from other countries participated in the initial assessment of the analytical methods.

Q.12) Are terrorist acts, such as aircraft impacts, being analyzed as part of SOAR-CA? (If so, how? If not, why not?)

A.12) No. The focus of this study is on normal operational scenarios that could potentially lead to radiological release to the environment. If there are important security related events which are not captured by the spectrum of scenarios identified from safety analysis, they will be addressed separately from this analysis.

Q.13) Are spent fuel pools considered in this study?

A.13) No. Spent fuel pools are not considered in this study. The project is focused on evaluating the severe, and very unlikely, accidents that may occur at operating power reactors. Accidents that may occur as a result of the spent fuel pool occur much more slowly because there are much lower levels of energy (decay heat) involved. Such accidents therefore take longer to evolve and allow ample time for response by personnel to prevent any radiological release.