

Enclosure 5
Technical Analysis

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To support the staff's assessment of the quantitative costs and benefits of severe accident capable vents (Option 2) and filtered containment venting (Option 3), the Office of Nuclear Regulatory Research (RES) performed an analysis of selected accident scenarios for a boiling-water reactor (BWR) plant with a Mark I containment. The analysis was conducted using the NRC's severe accident analysis code MELCOR, and its companion code, the MELCOR Accident Consequence Code System, Version 2 (MACCS2). RES staff was assisted by Sandia National Laboratories. The staff used the MELCOR code to calculate fission product release estimates for each of the selected accident scenarios, and this information was used to calculate health consequence and offsite property damage assessments using MACCS2. The staff used the results to inform the cost-benefit analyses of various accident prevention and mitigation options. The NRC's regulatory analysis guidelines in NUREG/BR-0058 and NUREG/BR-0184 recommend the use of MACCS2 to estimate the averted "offsite property damage" cost (benefit) and the offsite averted dose cost elements.

The selected scenarios are illustrative of potential accident sequences and serve as a means to provide comparisons of the quantifiable benefits for each of the proposed options. Selected cases are not meant to provide any insights into what the staff may believe is "the next accident" or even what it considers as bounding. Additionally, the staff notes that uncertainty always accompanies specific plant responses and timing during potential accident scenarios. Therefore, the most useful information stemming from this analysis are not individual results or consequences; rather, the "deltas" or comparisons between the selected cases.

The staff also performed a risk evaluation to estimate the reduction in risk resulting from the installation of a severe accident (SA) capable venting system in a BWR with either a Mark I or Mark II containment design. This information provides a major input to the regulatory and backfit analyses of the SA and filtered containment venting systems.

Finally, on September 25, 2012, the Electric Power Research Institute (EPRI) published a study relating to BWR Mark I and Mark II containment venting. The report titled, "Investigation of Strategies for Mitigating Radiological Releases in Severe Accidents - *BWR Mark I and Mark II Studies*," (EPRI Final Report 1026539), was made available to the NRC staff through EPRI's public web site (http://my.epri.com/portal/server.pt?Product_id=000000000001026539).

The purpose of the report was to document research on investigations into potential strategies for reducing the environmental and public health effect consequences of severe reactor accidents. The results of the report were also the subject of two public meetings. On August 8, 2012, the staff held a public meeting where representatives from EPRI provided an overview and preliminary results of the research efforts documented in the September 25 report. In addition, EPRI briefed the Advisory Committee on Reactor Safeguards (ACRS) Fukushima Subcommittee on September 5, 2012, and provided information relating to its preliminary evaluation of strategies for mitigating radiological releases during severe accidents at BWRs with Mark I and II containments.

The MELCOR analysis and results are generally consistent with the insights provided in the EPRI report with one notable exception. MELCOR calculations do not show vent cycling to be any more effective than once-open venting. The release estimates in both cases are on the same order of magnitude. The EPRI calculations concluded vent cycling to be more effective. Even if vent cycling is demonstrated to be effective, the feasibility of its operation needs to be carefully examined. Note the insights in the EPRI report recognize that an external filter can

further reduce the fission product release to the environment – consistent with the conclusion from MELCOR/MACCS analysis.

In summary, the staff's technical analysis provided relevant insights into the merits of severe accident capable venting and filtered containment venting. The results were used to help quantify the benefits of various options under the NRC's current regulatory framework. As such, the reader is cautioned in drawing additional insights and conclusions from the results of the staff's analysis. The following sections describe the NRC staff's technical analysis:

- Enclosure 5a - MELCOR Accident Analysis
- Enclosure 5b - MACCS Analysis
- Enclosure 5c - Probabilistic Risk Evaluation