NUCLEAR ENERGY INSTITUTE

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Mr. David L. Skeen
Director, Japan Lessons Learned Project Directorate
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Filtration of Containment Vents

Project Number: 689

Dear Mr. Skeen:

In the NEI[1] May 15, 2012 letter on filtration of containment vents, we requested that the U.S. Nuclear Regulatory Commission (NRC) and staff evaluate the question of vent filters as part of a more comprehensive analysis that considers other alternatives for precluding and mitigating potential releases from core damage events. In doing so, we observed that the evaluation of containment vent filters and alternatives is a complex issue that requires careful consideration in a holistic context. Also mentioned were the techniques the industry is evaluating to mitigate potential releases that would go beyond existing filtering capability.

The purpose of this letter is to provide an update and additional detail on these matters, including some preliminary thoughts stemming from industry evaluations to date.

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[1] NEI is the organization responsible for establishing unified industry policy on matters affecting the nuclear energy industry. NEI's members include all entities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, nuclear material licensees, and other organizations and entities involved in the nuclear energy industry.

Holistic Analyses

By the term "holistic analyses," we mean evaluations of containment vent filters and alternative systems that consider the net safety benefit of different options in the context of the following:

- *Protecting facilities from extreme natural phenomena* to provide assurance that designed safety systems will function properly following rare, but postulated, conditions.

- *Preventing fuel damage through design-basis measures* that maintain the fission product barriers: the fuel cladding, reactor coolant system boundary, and containment through inclusion of substantial safety margins in the design-basis measures and provision of emergency core cooling systems. This includes emergency operating procedures, operator training, and command and control structures that provide the basis, knowledge and management to respond to events that challenge the plant.

- *Preventing fuel damage through beyond-design-basis measures* instituted by the industry and the NRC based on the lessons learned thus far from the Fukushima Daiichi accident.[2] This includes the additional systems being added by the industry, such as the diverse and flexible coping strategy (FLEX) that expands on the provisions to deal with extensive plant damage that were added following the 2001 terrorist attacks to provide a means to deal with extreme events that result in an extended station blackout, as well as enhancements to procedural guidance and operator training to deal with beyond design-basis events.

- *Arresting the accident progression* with severe accident management actions to interdict fuel damage by quenching the damaged fuel; and

- *Minimizing radionuclide release* with severe accident management actions to capture and retain fission products *within* the containment, which would involve considerations of all scenarios that might lead to releases, including the many scenarios[3] that would bypass the vent. Keeping the radionuclides inside containment protects both the public and the environment, as well as plant personnel responding to the accident.

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[2] In this regard, an important lesson learned from the Fukushima Daiichi accident – as demonstrated by accident timelines – is that a containment vent filter would have not significantly altered the progression of the accident. Pending further forensic analysis of the accident, it is accepted that the bulk of the release of radionuclides (and hydrogen) from containment was not via the vent.

[3] It is instructive to note that NRC's recent state-of-the-art reactor consequence analysis (SOARCA) provides results for the dominant BWR accident scenario at a plant with a Mark I containment that demonstrates that a containment vent filter would not have been effective in reducing the magnitude of the radioactive release due to containment failure that resulted in releases by-passing the vent.

Such analyses should be risk-informed and should address a full spectrum of applicable alternative concepts, technical issues, advantages and disadvantages, designs, and operator actions. Further, previous NRC evaluations and determinations on the use of containment vent filters should be reviewed to provide insights into the performance of filters in minimizing radionuclide releases under all scenarios.

One important expected outgrowth of holistic analyses would be a better understanding of the contribution to risk reduction of radionuclide filtering to the general public. While the industry and the NRC will continue to consider radionuclide filtering strategies, as stated in our May 15 letter, the best and most effective way to protect people and the environment near nuclear energy facilities is to prevent fuel damage. Therefore, it is important that both the NRC and the industry give resource priority and focus to critical activities that enhance the protection of the reactor core and the spent fuel pool whether or not they are Fukushima-related.

Alternatives to Containment Vent Filters

As mentioned on our May 15 letter, the most appropriate question is not whether a vent filter system should be installed, but rather what the most effective means are to reduce or preclude potential releases during a severe accident. Existing severe accident management guidelines already include a variety of strategies that directly relate to accident interdiction and release mitigation. Any evaluation of alternatives should build upon this existing capability. The industry has been pursuing a review of how best to retain radionuclides in BWR Mark I and II containments, including strategies for managing a damaged core following a severe event.

While we are still developing the analyses, there are some preliminary insights that can be shared that might assist the NRC staff in its analysis.

Performance Basis
An objective evaluation of containment vent filter systems and alternatives requires a performance basis. To this end, we looked at the severity of releases from containment to determine a range of decontamination factors (DF) to use as a basis for filtering system performance. According to the information gathered by the NRC staff mission to study containment vent filters in Europe, performance requirements for filter systems are expressed in DFs for particulates.

Retention of Radionuclides within Containment
A key lesson learned from the Fukushima Daiichi accident is that the management of a damaged core is paramount. Managing the damaged core is accomplished by providing adequate cooling water to the core debris. If any portion of the damaged core exits the reactor vessel, systems that spray water into containment or provide water to flood the containment become vital. This water is

also critical to prevent radioactive releases that may bypass the vent. Without water, as indicated by SOARCA (see footnote 2), containment vent filters may be ineffective in reducing radioactive releases. The optimum way to inject water into the right locations in containment and how the containment temperature and pressure are controlled are the subject of ongoing industry analyses. To date, our evaluations are showing that the water[4] from containment spray and flooding systems also filter particulate, which then remains within containment. Studies are being completed that will identify the DF attainable with different combinations of water systems.

Alternatives
The most effective method of preventing release of radionuclides is to prevent fuel damage. In the unlikely event that fuel damage occurs, severe accident management strategies come into play to arrest the progression of fuel damage and manage the damaged core. Based upon industry evaluations and past NRC research on severe accidents, we have identified a number of ways to capture and retain fission products to minimize the release of radionuclides. Techniques that influence the effectiveness of fission product retention within containment include:

- Containment spray strategies
- Containment flooding strategies
- Alternate containment heat removal systems
- Containment venting strategies
- Enhanced operator and emergency response actions
- Filtered containment vents

The ongoing industry evaluation is considering these items, in appropriate combinations, to develop an understanding of the way to identify the optimal accident management strategy. Such a strategy would use a performance-based approach that centers on the overall integrated containment DF.

In summary, there is growing evidence in the industry evaluations that there are alternatives to containment vent filters that should be included in the NRC's evaluation. We again urge the NRC to conduct detailed holistic evaluations. Only through such complete analyses can the NRC and the industry determine a proper accident management strategy that protects the general public and the environment during a severe event. We intend to provide additional input to the NRC when the industry analyses for BWR plants that have Mark I and Mark II containments are complete and we have developed more definitive conclusions in the next few months.

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[4] The information the NRC staff gathered on the European mission (as discussed with the Fukushima Subcommittee of the Advisory Committee on Reactor Safeguards on May 22, 2012) identified that the filters reviewed in Europe are, in fact, tanks of water.

We would be pleased to meet with you to further discuss this matter. If you have any questions, please contact me or Steven Kraft (202-739-8116; spk@nei.org).

Sincerely,

Adrian Heymer

c: Mr. Michael R. Johnson, Deputy Executive Director for Reactor and Preparedness Programs, EDO, NRC
Mr. Eric J. Leeds, Director, NRR, NRC