UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

April 30, 2015

Mr. Mark A. Satorius
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: INTERIM STAFF GUIDANCE JLD-ISG-2015-01, "COMPLIANCE WITH PHASE 2 OF ORDER EA-13-109, ORDER MODIFYING LICENSES WITH REGARD TO RELIABLE HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS"

Dear Mr. Satorius:

During the 623rd meeting of the Advisory Committee on Reactor Safeguards, April 9-11, 2015, we reviewed draft Interim Staff Guidance (ISG) JLD-ISG-2015-01, "Compliance with Phase 2 of Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions," dated March 2015. Our Fukushima Subcommittee also reviewed this matter during a meeting on March 20, 2015. During these meetings we had the benefit of discussions with the NRC staff and representatives of the industry. We also had the benefit of the documents referenced.

CONCLUSION AND RECOMMENDATIONS

1. The staff should address our comments, achieve reasonable closure to the open items identified for discussion with the industry, and answer the public comments before issuing JLD-ISG-2015-01. We would like the opportunity to review the final version of JLD-ISG-2015-01 and its supporting documents.

2. The draft ISG and NEI 13-02, Revision 0E2, versions we have reviewed provide reasonable guidance on system design and implementation on a generic basis. Substantial work remains to evaluate, justify, and implement the plant-specific designs.

3. The staff has taken steps to address our recommendations and concerns from the Phase 1 program review that also apply to Phase 2. Each of these will require additional attention from the staff during their review of plant-specific hardened containment venting system designs.

4. Because of inherent severe accident model uncertainties, especially for Mark II boiling water reactors (BWRs), all methods of water addition during a severe accident should be considered, including drywell sprays, to take full advantage of reductions in radioactive source terms during wetwell venting.

BACKGROUND

The accident at the Fukushima Dai-ichi nuclear power station demonstrated the importance of reliable operation of hardened vents when containment heat removal capability is lost. The recommendations of the NRC Fukushima Near-Term Task Force included the proposal to have licensees of operating BWRs with Mark I and Mark II containments provide capable and reliable hardened containment venting systems (HCVSs).

Order EA-12-050, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents," issued on March 12, 2012, required these licensees to install reliable HCVSs capable of removing heat and lowering pressure within containment. In June 2013, this Order was rescinded and replaced with a new Order, EA-13-109, which included additional requirements to ensure that venting functions be available during postulated severe accident conditions. A phased approach was recommended to ensure implementation with minimal delays. Phase 1 involves upgrading the facilities to install a wetwell HCVS that provides capability for reliable heat removal and pressure reduction to prevent core damage and, if necessary, to provide venting capability during severe accident conditions. Phase 2 involves providing additional protection during severe accident conditions using a reliable drywell HCVS or, as an alternate approach, developing a reliable venting strategy that makes it unlikely that a licensee would need to vent from the drywell under these conditions.

In October 2013, we reviewed JLD-ISG-2013-02, which was developed to achieve compliance with Phase 1 of Order EA-13-109. We issued a letter to the NRC Executive Director for Operations on October 18, 2013, providing the following conclusion and recommendations:

1. JLD-ISG-2013-02 should be issued.

2. The staff should better define accident scenarios during which drywell venting would be necessary or preferred over wetwell venting.

3. Additional combustible gas control measures should be given higher priority.

4. Venting procedures must be developed that do not compromise long term core cooling which depends on containment accident pressure.

Recommendations 2, 3, and 4 describe issues that are applicable to both the Phase 1 and Phase 2 venting strategies. The staff's response agreed with our recommendations and committed to address them within the implementation of the Phase 2 requirements and in related rulemaking activities, which are currently in process: the Mitigation of Beyond-Design-Basis Events rulemaking and the Containment Protection and Release Reduction rulemaking. The staff has indicated that the Phase 1 implementation and the guidance for the Phase 2 approaches have been informed by the technical bases developed for these programs.

DISCUSSION

The development process for Phase 2 extends the Phase 1 ISG approach. The industry has updated the guidance document, NEI 13-02, adding new approaches designed to achieve compliance with Phase 2 of Order EA-13-109. Therefore, the revised document includes the guidance for implementation of both phases of the Order, including the Overall Integrated Plans (OIPs), as well as the technical basis and evaluation to fully satisfy all requirements of the Order. As in Phase 1, the staff held numerous public meetings during the development of the guidance, which includes acceptable approaches to achieve compliance, their bases and scope, and the processes required for implementation. The draft ISG endorses the methodologies described in NEI 13-02 with exceptions and clarifications to assure that all Phase 2 objectives are met.

To support our March 20, 2015 Subcommittee meeting, the staff provided and we reviewed the draft ISG and guidance documents that were released for public comment in early March: draft ISG JLD-ISG-2015-01 and NEI 13-02, Revision 0E2. The staff reviewed this version of NEI 13-02 to assure that the industry guidance met the Order requirements. In this draft ISG, the staff identified several areas of concern with comments such as: "required further discussion between the staff and industry" or "this will be a topic of ongoing discussions on the completion of the guidance for Phase 2 of the Order EA-13-109".

At our Subcommittee meeting, several of these topics were explored with the staff and industry. It was apparent that the staff and industry were making strides to resolve many of these differences. At our Full Committee meeting, we were briefed orally on a Draft-2 version of the ISG and an interim Revision 0F4 of NEI 13-02. We understand that the final version of the ISG will endorse Revision 1 of NEI 13-02. The interim documents appear to resolve many of the earlier issues and concerns. However, due to the timing of their submittal to us and their interim status, we cannot make final conclusions or recommendations regarding those versions of the guidance. Thus, due to the evolving nature of these reports, our deliberations regarding the ISG were based primarily on the documentation provided for our March 20, 2015 Subcommittee meeting. We have used the available interim written material and the oral committee briefings to reinforce our conclusions that the staff and industry are reaching closure on these several important differences.

The draft ISG and NEI 13-02, Revision 0E2, versions we have reviewed provide reasonable guidance on system design and implementation on a generic basis. The OIPs require translation to plant-specific applications for each licensee. Substantial work remains to evaluate, justify, and implement these plant-specific designs.

PHASE 2 GUIDANCE

The Phase 2 technical approaches and supporting analyses, along with the design of the Phase 2 implementation plan, were based on the staff's successful experience in Phase 1. The staff continued an open dialogue with industry to identify and resolve issues in a public forum. Many analyses required to develop and evaluate the design options were performed by both the

industry and the staff using different modeling approaches and the MAAP and MELCOR severe accident computer codes. The staff performed technical and quality reviews to assure that the implementation guidance will be achievable, pending certain facility evaluations or analyses that are required by the guidance. This work provided a formal, open approach to identify and resolve issues. Industry has been successful in meeting all milestone commitments for Phase 1 of the Order. Accordingly, the staff stated at our meeting that their reviews of licensees' Phase 1 OIPs are complete, providing interim staff evaluations to document open items associated with implementation. The Order states that the NRC plans to issue the final ISG for Phase 2 of the Order by April 30, 2015. This will support licensees' updated OIP submittals to the Commission by December 31, 2015.

The Order provides two compliance approaches for Phase 2. The first compliance approach requires a drywell vent supported by plant-specific analysis to demonstrate drywell venting system capability at high temperature conditions in severe accident scenarios (Method 1). A licensee choosing to pursue this option would be required to justify their design for NRC acceptance. For the second compliance approach, industry proposed two options (Methods 2 and 3) that rely on Severe Accident Water Addition (SAWA) as a common element. Method 2 uses the wetwell vent as long as available with SAWA to the containment. When the wetwell vent floods, venting is transferred to a Severe Accident capable Drywell Vent (SADV). Use of SAWA and the SADV would be maintained until alternate reliable decay heat removal and pressure control is established. Method 3 uses the wetwell vent with SAWA to the containment and monitored control of water addition using Severe Accident Water Management (SAWM). Capability to vent directly from the wetwell is to be preserved until alternate reliable decay heat removal and pressure control is established. Method 3 does not require the installation of an SADV.

If a drywell venting system is used to vent the containment atmosphere and control containment pressure in Method 1 or Method 2, the Order specifies the same functional requirements (reflecting accident conditions in the drywell), quality requirements, and programmatic requirements as were established for the wetwell venting system in Phase 1. According to the Order, a licensee choosing Method 3 shall (a) incorporate an overall accident management plan that makes it unlikely that venting from the drywell during severe accident conditions is necessary, (b) document that containment failure can be prevented under these conditions without a drywell vent, and (c) prepare the necessary procedures, define and fulfill the functional requirements for installed or portable equipment, and install the needed instrumentation.

The guidance establishes a maximum design allowable temperature requirement for Mark I and Mark II containments at 545 $^{\circ}$F. In our previous letter, we challenged the staff to examine further the selection and rationale for this design temperature value and its implications. We conclude that the work performed in Phase 2 demonstrates the validity of selecting this criterion and sets the limit value with appropriate judgment and consideration of uncertainties. As stated earlier, the containment performance in response to severe accidents for Mark I and Mark II containments was evaluated by the staff and the industry using the MELCOR and MAAP analysis methods. Specific analyses were performed for typical facility designs. Additional insights were developed from the work done to support development of the regulatory basis for the proposed Containment Protection and Release Reduction rulemaking. Each of the proposed HCVS methods was evaluated against the requirements of the Order.

Use of the drywell vent without water addition, as proposed in Method 1, results in conditions that exceed the containment temperature limit requirements. The staff and the industry have retained this option as it is described in the Order, but have not developed further guidance as to how it would be implemented as a part of NEI 13-02 or the ISG. A licensee choosing to pursue this option would be required to justify their design for NRC acceptance.

Method 2 and Method 3 depend on water addition capability to maintain containment temperature below 545 °F. The Method 2 strategy relies additionally on the availability of an SADV designed to meet Order requirements B(1) and Section B.1. We agree with the staff's conclusion that this is an acceptable approach to satisfy the rule. Analyses for a typical facility have demonstrated that using an accessible water addition point and flow rate capability of 500 gpm is sufficient to maintain the temperature limit requirement. Each licensee will need to provide plant-specific evaluations and analyses to determine the required approach for their facility. The Method 3 strategy uses water addition and wetwell venting management to maintain containment conditions for a time period sufficient to allow additional decay heat removal and pressure control capability to be placed into service. As with the Method 2 approach, typical facility analyses have been performed to demonstrate the SAWM capability to achieve Order requirements B(2) and Section B.2. Again, plant-specific evaluations will be needed to demonstrate that the required equipment, protocols, and procedures are established.

Based on the clarification and exception positions provided by the staff in the draft ISG, the staff requirements for these plant-specific SAWA and SAWM evaluations need to be robust. In our Subcommittee meeting, we discussed the need to determine the mass of water reaching the vessel and core material under severe accident conditions, and its impact on heat removal and temperature. Considerations included plant-specific analysis of capability, as well as instrumentation availability and direct and indirect measurement techniques. In several instances in the draft ISG, the staff concluded that plant-specific evaluations are required. The staff has recommended areas where the industry should provide more specific guidance and templates in NEI 13-02 to clarify those evaluations required to demonstrate compliance. This would help assure the OIP submittals contain licensee programs with the required scope, assumptions, and quality of the calculations and evaluations. We agree with the staff recommendations.

The HCVS functional requirements for instrumentation specify that the system "controls and indications shall be accessible and functional under a range of plant conditions, including severe accident conditions, extended loss of AC power, and inadequate containment cooling." The draft ISG identified three areas where discussions regarding instrumentation requirements were ongoing with the industry. For SAWA and SAWM, the staff points to the lack of industry guidance on how instrumentation designed to monitor wetwell level will be powered during the first 24 hours of the event. An additional issue for SAWM is the industry position in NEI 13-02, Revision 0E2, that the 24-hour capability for dedicated and installed equipment does not apply to water addition and control equipment that is not part of the HCVS vent line flow path. We understand that progress has been made and closure is expected before the ISG is finalized.

ACRS CONCERNS

The staff has taken a number of steps to address our recommendations and concerns from the Phase 1 program review that also apply to Phase 2:

(1) To assure that venting procedures will not compromise long-term core cooling which depends on containment accident pressure (CAP), the staff has endorsed a white paper developed by the Nuclear Energy Institute (NEI) and the Boiling Water Reactor Owners Group, "BWR Containment Venting," Revision 1. In summary, anticipatory containment venting is permitted only if pressure reduction is required to restore and maintain adequate core cooling or to reduce the total offsite dose. For many design basis accidents, the motor-driven emergency core cooling system pumps are available for core cooling. In such cases, anticipatory venting would not be authorized. In addition, the NEI 13-02 guidance emphasizes that plants relying on CAP should prevent inadvertent actuation of venting. These measures for ensuring long-term core cooling are adequate.

(2) We expressed a concern that additional combustible gas control measures should be given higher priority. The staff has endorsed an NEI white paper, "Hydrogen/Carbon Monoxide Control Measures," Revision 1, that addresses the expectation in the Order which requires that "[t]he HCVS shall be designed and operated to ensure that the flammability limits of gases passing through the system are not reached." The technical approach assembles an experience and knowledge base regarding combustible gas control to define attributes that should be used in developing an HCVS design to limit the likelihood of gas combustion. The paper describes and evaluates several design options to demonstrate that these objectives can be met. We are concerned that this form of guidance may be too general to assure that plant-specific designs will be satisfactory. The staff should ensure that detailed evaluation requirements for the plant-specific design and review process are included in the NEI guidance document.

(3) In our Phase 1 review, we discussed with the staff the importance of proper evaluation of radiological dose for required or potential operator actions. The staff has endorsed the industry white paper, "Sequences for HCVS Design and Method for Determining Radiological Dose from HCVS Piping," Revision 0. While we commend this work, we note that proper application will require careful reevaluation of doses corresponding to plant-specific HCVS design, installation, and operational features. The final integrated guidance should provide the means to assure that consistent, quality dose predictions are determined.

Each of these will require additional attention from the staff in their review of plant-specific HCVS designs.

Severe accident analyses performed by the industry and the staff for Mark II BWRs in support of the strategies used for Order EA-13-109 do not reflect the full range of model uncertainties. These uncertainties are broad because there are limited data to validate models of extended

core degradation in BWRs. Current analyses rely on model predictions that the majority of the core debris and its accompanying heat load is quickly transported to the drywell, and water addition to the drywell will help mitigate source term releases, even in a Mark II design where a wetwell bypass release is likely to occur. There are alternative models of core degradation that could lead to wetwell bypass for a Mark II design, but do not displace a majority of the core debris quickly, and thus water addition to the drywell floor would not be as beneficial. These models are not inconsistent with the limited observations now available from the Fukushima accident. A more robust examination of the full range of plausible core behaviors is needed and a full range of water addition strategies, including drywell sprays, should be considered to help mitigate source terms.

During our discussions with the staff and NEI, we also questioned how some elements of the severe accident venting strategies are integrated with the objectives and guidance in the FLEX Support Guidelines and the Severe Accident Management Guidelines. We intentionally avoid further consideration of those questions in the focused context of this letter. They are better addressed and resolved as examples of our broader concerns and recommendations regarding the integration of response capabilities that extend beyond the Emergency Operating Procedures, as discussed in our letter report on "Draft SECY Paper, 'Proposed Rulemaking: Mitigation of Beyond-Design-Basis Events (RIN 3150-AJ49)'."

SUMMARY

The staff and industry guidance identifies a set of features to fulfill the requirements of Order EA-13-109. The staff should address our comments, achieve reasonable closure to the open items identified for discussion with the industry, and answer the public comments before issuing JLD-ISG-2015-01. With these improvements, the ISG should provide a pathway for licensees to complete robust Phase 2 OIPs for enhanced venting capability. We would like the opportunity to review the final version of JLD-ISG-2015-01 and its supporting documents.

We look forward to our continuing interactions with the staff on all important matters related to the Fukushima efforts, including successful implementation of reliable severe accident capable venting systems for BWR Mark I and II reactors.

Sincerely,

/RA/

John W. Stetkar
Chairman

REFERENCES

1. NRC, Interim Staff Guidance JLD-ISG-2015-01, Revision 0, Draft and Draft-2, “Compliance with Phase 2 of Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions,” March and April 2015 (ML15051A143 and ML15091A116)

2. NEI 13-02, Revisions 0E2 and 0F4, “Industry Guidance for Compliance with Order EA-13-109 BWR Mark I & II Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions,” March 2015 (ML14345B045 and ML15084A454)

3. NRC, Order EA-13-109, “Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accidents,” June 6, 2013 (ML13143A321)

4. NRC, “Recommendations for Enhancing Reactor Safety in the 21st Century, the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident,” July 12, 2011 (ML112510271)

5. NRC, SRM- SECY-12-0025, “Staff Requirements–SECY-12-0025 - Proposed Orders and Requests for Information in Response to Lessons Learned from Japan’s March 11, 2011, Great Tohoku Earthquake and Tsunami,” March 9, 2012 (ML120690347)

6. NRC, Order EA-12-050, “Order Modifying Licenses with Regard to Reliable Hardened Containment Vents,” March 9, 2012 (ML12054A696)

7. NRC, Interim Staff Guidance JLD-ISG-2012-02, Revision 0, “Compliance with Order EA-12-050, Reliable Hardened Containment Vents,” August 29, 2012 (ML12229A475)

8. NRC, SRM-12-0157, “Staff Requirements - SECY-12-0157, Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I And Mark II Containments”, March 19, 2013 (ML13078A017)

9. NRC, SECY-12-0157, “Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I And Mark II Containments”, November 2012 (ML12333A294)

10. NRC, Order EA-12-049, “Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,” March 12, 2012 (ML12054A735)

11. NRC, Interim Staff Guidance JLD-ISG-2013-02, “Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions,” November 14, 2013 (ML13304B836)

12. ACRS Letter, “Interim Staff Guidance JLD-ISG-2013-02, ‘Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions’,” October 18, 2013 (ML13280A246)

13. NRC, Interim Draft Report, “MELCOR Accident Analysis in Support of Containment Venting Systems for BWRs with Mark I and Mark II Containments,” March 2015 (ML15117A580)

14. NEI, White Paper, Revision 0, “HCVS-WP-01, Dedicated and Permanently Installed Motive Force,” April 14, 2014 (ML14120A295)

15. NEI, White paper, Revision 0, “HCVS-WP-02, Sequences for HCVS Design and Method for Determining Radiological Dose from HCVS Piping,” October 23, 2014 (ML14358A038)

16. NEI, White Paper, Revision 1, “HCVS-WP-03, Hydrogen/Carbon Monoxide Control Measures,” October 22, 2014 (ML14302A066)

17. NEI/BWROG, White Paper, Revision 1, “BWR Containment Venting,” October 29, 2013, (ML13352A057)

18. ACRS letter, "Draft SECY Paper, 'Proposed Rulemaking: Mitigation of Beyond-Design-Basis Events (RIN 3150-AJ49)'.", April 22, 2015 (ML15111A271)

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