EP FAQ 2015-001

Background

The Boiling Water Reactor Owners Group (BWROG) identified generic Emergency Operating Procedure (EOP) concerns and enhancements following a review of the Operating Experience (OE) from the accident at Fukushima Daiichi. As a result of this review, the BWROG Emergency Procedure/Severe Accident Guidelines (EPGs/SAGs) were updated to address the OE lessons learned and improve generic emergency procedure guidance. The updated guidance was issued as EPG/SAG Revision 3, published in February 2013.

Question – Revision 3 of the BWROG EPG allows for limiting Reactor Pressure Vessel (RPV) depressurization by reclosing the Safety Relief Valves (SRVs). This strategy change is intended to prolong operation of steam-driven water injection required for adequate core cooling (e.g., Reactor Core Isolation Cooling [RCIC] System, High Pressure Coolant Injection [HPCI] System, etc.) following an extended loss of AC power, and thus maintain the core cooling safety function. [S*team-driven water injection systems require RPV pressure to be above a certain value to sustain operation.*] Operators will determine if RPV depressurization will result in a loss of RCIC/HPCI, and, if so, terminate depressurization while maintaining RPV pressure as low as practicable. How should this change be addressed vis-à-vis the NEI 99-01, BWR Fission Product Barrier Table, RCS Barrier Loss threshold, #3 RCS Leak Rate?

Answer – There is no effect on the fission product barrier threshold intent. The relationship between the operationally significant action and the RCS barrier status is unchanged, i.e., performing an Emergency RPV Depressurization per site-specific EOPs is indicative of a loss of the RCS barrier. Even though the SRVs may be reclosed, RCS mass has been lost to the wetwell and subsequent depressurizations may be required (i.e., the ability of the RCS pressure boundary to serve as an effective barrier to a release of fission products has been diminished). For clarity, the threshold basis should be revised to indicate that plant operators may reclose the SRVs following an Emergency RPV Depressurization. To address this change, licensees should consider updating their emergency classification system procedure and/or basis document as indicated below.

NUMARC/NESP-007: Term/threshold not used; no impact from this change

NEI 99-01, Revision 4: Term/threshold not used; no impact from this change

NEI 99-01, Revision 5

Refer to the BWR EAL Fission Product Barrier Table, Thresholds for LOSS or POTENTIAL LOSS of Barriers. Using the generic wording as an example, the basis for RCS Barrier LOSS #3, RCS Leak Rate, threshold B, “Emergency RPV Depressurization is required” should be revised as follows:

> Plant symptoms requiring Emergency RPV Depressurization per the site specific EOPs are indicative of a loss of the RCS barrier. If Emergency RPV depressurization is required, the plant operators are directed to open safety relief valves (SRVs) ~~and keep them open~~. Even though the RCS is being vented into the suppression pool, a loss of the RCS should be considered to exist due to the diminished effectiveness of the RCS pressure barrier to a release of fission products beyond its boundary.

NEI 99-01, Revision 6

Refer to the BWR EAL Fission Product Barrier Table, Thresholds for LOSS or POTENTIAL LOSS of Barriers. Using the generic wording as an example, the basis for RCS Barrier LOSS #3, RCS Leak Rate, threshold B, “Emergency RPV Depressurization” should be revised as follows:

> Emergency RPV Depressurization in accordance with the EOPs is indicative of a loss of the RCS

barrier. If Emergency RPV Depressurization is performed, the plant operators are directed to open safety relief valves (SRVs) ~~and keep them open~~. Even though the RCS is being vented into the suppression pool, a Loss of the RCS barrier exists due to the diminished effectiveness of the RCS to retain fission products within its boundary.

Consistent with the guidance in Regulatory Issue Summary (RIS) 2003-18, Supplement 2, *Use of Nuclear Energy Institute (NEI) 99-01, Methodology for Development of Emergency Action Levels, Revision 4, Dated January 2003*, it is reasonable to conclude that the change proposed above would be considered as a "difference."

EP FAQ 2015-002

Background

The Boiling Water Reactor Owners Group (BWROG) identified generic Emergency Operating Procedure (EOP) concerns and enhancements following a review of the Operating Experience (OE) from the accident at Fukushima Daiichi. As a result of this review, the BWROG Emergency Procedure/Severe Accident Guidelines (EPGs/SAGs) were updated to address the OE lessons learned and improve generic emergency procedure guidance. The updated guidance was issued as EPG/SAG Revision 3, published in February 2013.

Question – Revision 3 of the BWROG SAG changes the conditions under which the primary containment flooding strategy would be employed. The objectives of this strategy are to remove heat from the RPV, retain core debris in the RPV, maintain primary containment integrity, scrub fission products from the containment atmosphere, and minimize radioactivity releases. In earlier SAG revisions, this strategy was implemented shortly after SAG entry in response to the inadequate core cooling condition. As changed, primary containment flooding is a discretionary strategy that must be coordinated with other accident management objectives. The appropriate timing and extent of primary containment flooding considers:

- Whether a primary system break exists (i.e., whether primary containment flooding will submerge fuel and core debris inside the RPV).
- The potential benefits of ex-vessel cooling.
- The optimal timing of venting to control primary containment pressure as the containment is filled.
- The availability and need for pressure suppression and vacuum relief capabilities.
- The effect of higher injection rates on hydrogen production and combustible gas control strategies.
- The likelihood and effect of increased seismic loads.
- Capabilities for containing of any water leakage from the primary containment.
- The availability of required resources, including personnel, electrical power, pneumatic supplies, and water sources.

How should this change be addressed vis-à-vis NEI 99-01, BWR Fission Product Barrier Table, Primary Containment Potential Loss threshold, #2 Reactor Vessel (or RPV) Water Level?

Answer - This SAG change affects the associated fission product barrier threshold and basis and may change the point at which a Potential Loss of the Containment Barrier is determined to have occurred. In the current threshold basis, the potential for core damage and a possible core melt sequence is evident in the BWROG EPG/SAG requirement to exit all EOPs and enter the SAGs because adequate core cooling cannot be restored and maintained (i.e., assured). In earlier EPG revisions, this condition was signaled by the phrase “PRIMARY CONTAINMENT FLOODING IS REQUIRED.” In EPG/SAG Revision 3, the condition “primary containment flooding is required” is only reached after SAG entry and the decision to flood the primary containment has been thoroughly evaluated based on the set of considerations listed above. Under some conditions, fuel melting is occurring and core debris has breached the RPV before a containment flooding strategy begins. The migration of corium to a location outside the RPV can be expected to present a significant challenge to primary containment integrity.

To address this SAG Revision 3 strategy change, the Containment Barrier Potential Loss threshold should also be changed such that it remains functionally equivalent to the current threshold wording which reflects the prior revisions of the SAGs; the Containment barrier should be considered potentially lost when adequate core cooling can no longer be assured and core damage is imminent. Within the context of EPGs, this point is best defined when, as a result of all core cooling methods being lost (i.e., unavailable or incapable of assuring adequate core cooling), operators are directed to enter a SAG (i.e., “SAG entry is required”). When preparing to implement Revision 3 of the SAGs, licensees should consider updating their emergency classification system procedure and/or basis document as indicated below.

NUMARC/NESP-007: Term/threshold not used; no impact from this change

NEI 99-01, Revision 4

Refer to the BWR Emergency Action Level Fission Product Barrier Reference Table, Thresholds for LOSS or POTENTIAL LOSS of Barriers. Using the generic wording as an example, the threshold for Containment Barrier POTENTIAL LOSS #2, Reactor Vessel Water Level, "Primary containment flooding required" should be revised as follows:

~~Primary containment flooding~~ SAG entry is required

The associated basis should be revised as follows:

2. Reactor Vessel Water Level

The entry into ~~the Primary Containment Flooding emergency procedure~~ Severe Accident Guidelines indicate ~~reactor vessel water level can not be restored and~~ that a core melt sequence is in progress. EOPs direct the operators to enter ~~Containment Flooding when Reactor Vessel Level cannot be restored to greater than a Site Specific value (generally 2/3 core height) or is unknown~~ the Severe Accident Guidelines when adequate core cooling cannot be assured. Entry into ~~Containment Flooding procedures~~ the Severe Accident Guidelines is a logical escalation in response to the inability to ~~maintain reactor vessel level~~ assure adequate core cooling.

The conditions in this potential loss EAL represent imminent core melt sequences which, if not corrected, could lead to vessel failure and increased potential for containment failure. In conjunction with and an escalation of the level EALs in the Fuel and RCS barrier columns, this EAL will result in the declaration of a General Emergency -- loss of two barriers and the potential loss of a third. If the emergency operating procedures have been ineffective in restoring reactor vessel level above the RCS and Fuel Clad Barrier Threshold Values, there is not a "success" path and a core melt sequence is in progress. Entry into ~~Containment flooding procedures~~ the Severe Accident Guidelines is a logical escalation in response to the inability to ~~maintain reactor vessel level~~ assure adequate core cooling.

NEI 99-01, Revision 5

Refer to the BWR EAL Fission Product Barrier Reference Table, Thresholds for LOSS or POTENTIAL LOSS of Barriers. Using the generic wording as an example, the threshold for Containment Barrier POTENTIAL LOSS #2, Reactor Vessel Water Level, "Primary containment flooding required" should be revised as follows:

~~Primary containment flooding~~ SAG entry is required

The associated basis should be revised as follows:

The potential loss requirement for ~~Primary Containment Flooding~~ entry into the Severe Accident Guidelines indicates adequate core cooling cannot be ~~established and maintained~~ assured and that core melt is possible. Entry into ~~Primary Containment Flooding procedures~~ the Severe Accident Guidelines is a logical escalation in response to the inability to ~~maintain~~ assure adequate core cooling.

[*Severe Accident Guidelines (SAGs) direct the operators to perform ~~Containment Flooding~~ actions when ~~Reactor Vessel Level cannot be restored and maintained greater than a site specific value or RPV level cannot be determined with indication that core damage is occurring~~ adequate core cooling cannot be assured.*]

Reflecting the above change, a site should determine if a corresponding change is also needed for the Fuel Clad Barrier LOSS #2.A threshold, Reactor Vessel Water Level. For example, if the site specified parameter values associated with inadequate core cooling conditions (e.g., an RPV water level), and did not refer to primary containment flooding, then no change may be needed. If, on the other hand, the threshold references primary containment flooding then it should be changed to "SAG entry is required," and provided with a basis similar to that above for the containment potential loss.

NEI 99-01, Revision 6

Refer to the BWR EAL Fission Product Barrier Reference Table, Thresholds for LOSS or POTENTIAL LOSS of Barriers. Using the generic wording as an example, the threshold for Containment Barrier POTENTIAL LOSS #2, RPV Water Level, "Primary containment flooding required" should be revised as follows:

> ~~Primary containment flooding~~ SAG entry is required

The associated basis should be revised as follows:

> The Potential Loss threshold is identical to the Fuel Clad Loss RPV Water Level threshold 2.A. The Potential Loss requirement for ~~Primary Containment Flooding~~ entry into the Severe Accident Guidelines indicates adequate core cooling cannot be ~~restored and maintained~~ assured and that core damage is possible. BWR EPGs/SAGs specify the conditions ~~that require primary containment flooding. When primary containment flooding is required,~~ when the EPGs are exited and SAGs are entered. Entry into SAGs is a logical escalation in response to the inability to ~~restore and maintain~~ assure adequate core cooling.
>
> PRA studies indicate that the condition of this Potential Loss threshold could be a core melt sequence which, if not corrected, could lead to RPV failure and increased potential for primary containment failure. In conjunction with the RPV water level Loss thresholds in the Fuel Clad and RCS barrier columns, this threshold results in the declaration of a General Emergency.
>
> Developer Notes:
>
> ~~The phrase, "Primary containment flooding required," should be modified to agree with the site-specific EOP phrase indicating exit from all EOPs and entry to the SAGs (e.g., drywell flooding required, etc.).~~ None.

Reflecting the above change and rationale, the following additional change should be made to Fuel Clad Barrier LOSS #2, RPV Water Level, "Primary containment flooding required."

> ~~Primary containment flooding~~ SAG entry is required

The associated basis should be revised as follows:

> Loss 2.A
>
> The Loss threshold represents ~~the~~ any EOP requirement for ~~primary containment flooding~~ entry into the Severe Accident Guidelines. This is identified in the BWROG EPGs/SAGs when ~~the phrase, "Primary Containment Flooding Is Required," appears~~ adequate core cooling cannot be assured. ~~Since a site-specific RPV water level is not specified here, the Loss threshold phrase, "Primary containment flooding required," also accommodates the EOP need to flood the primary containment when RPV water level cannot be determined and core damage due to inadequate core cooling is believed to be occurring~~.
>
> Developer Notes:

Loss 2.A

~~The phrase, "Primary containment flooding required," should be modified to agree with the site-specific EOP phrase indicating exit from all EOPs and entry to the SAGs (e.g., drywell flooding required, etc.)~~ None.

Consistent with the guidance in Regulatory Issue Summary (RIS) 2003-18, Supplement 2, *Use of Nuclear Energy Institute (NEI) 99-01, Methodology for Development of Emergency Action Levels, Revision 4, Dated January 2003*, it is reasonable to conclude that the change proposed above would be considered as a "deviation."

EP FAQ 2015-003

Background

The Boiling Water Reactor Owners Group (BWROG) identified generic Emergency Operating Procedure (EOP) concerns and enhancements following a review of the Operating Experience (OE) from the accident at Fukushima Daiichi. As a result of this review, the BWROG Emergency Procedure/Severe Accident Guidelines (EPGs/SAGs) were updated to address the OE lessons learned and improve generic emergency procedure guidance. The updated guidance was issued as EPG/SAG Revision 3, published in February 2013.

Question – Revision 3 of the BWROG EPGs allows for anticipatory venting to address conditions other than those associated with an immediate challenge to primary containment integrity resulting from high pressure (i.e., before suppression chamber pressure reaches the Primary Containment Pressure Limit) or combustible gas concentrations have reached a deflagration concentration. For example, venting may be performed early to address an adverse trend in suppression pool temperature that threatens the operation of systems required for adequate core cooling. How should this change be addressed vis-à-vis the NEI 99-01, BWR Fission Product Barrier Table thresholds dealing with a loss of containment due to primary containment isolation failure or bypass?

Answer – The NEI EAL development documents address BWR containment venting as follows.

NUMARC/NESP-007

> Threshold: Not used; however, the basis for Containment Loss threshold #2, Containment Isolation Valve Status After Containment Isolation Signal, states, "Also, an intentional venting of primary containment per EOPs to the secondary containment and/or the environment to considered a loss of containment."

NEI 99-01, Revision 4

> Threshold: Containment Loss threshold #3, CNMT Isolation Failure or Bypass, Intentional venting per EOPs. [*The venting threshold is one of three thresholds under this heading.*]
> Basis: "Also, an intentional venting of primary containment for pressure control per EOPs to the secondary containment and/or the environment is considered a loss of containment. Containment venting for temperature or pressure when not in an accident situation should not be considered."

NEI 99-01, Revision 5

> Threshold: Containment Loss threshold #3, CNMT Isolation Failure or Bypass, Intentional primary containment venting per EOPs. [*The venting threshold is one of three thresholds under this heading.*]
> Basis: "Intentional venting of primary containment for primary containment pressure or combustible gas control per EOPs to the secondary containment and/or the environment is considered a loss of containment. Containment venting for pressure when not in an accident situation should not be considered."

NEI 99-01, Revision 6

> Threshold: Containment Loss threshold #3, Primary Containment Isolation Failure, Intentional primary containment venting per EOPs. [*The venting threshold is one of three thresholds under this heading.*]
> Basis: "Intentional venting of primary containment for primary containment pressure or combustible gas control to the secondary containment and/or the environment is a Loss of the Containment. Venting for primary containment pressure control when not in an accident situation (e.g., to control pressure below the drywell high pressure scram setpoint) does not meet the

threshold condition."

There is no impact to the fission product barrier threshold or basis intent, and no change is recommended. The relationship between the operationally significant action and the Containment barrier status is unchanged, i.e., conditions and trends are such that the Control Room staff has made a decision to perform an intentional controlled venting of the containment. This intentional venting action results in a bypass of the primary containment, whether it is anticipatory or otherwise.

EP FAQ 2015-004

Question – Should the path of a radiological release that goes through a BWR wetwell be considered a "direct release path" for purposes of assessing the status of the containment fission product barrier (i.e., a loss or potential loss threshold)?

Background Note – In the event of a pipe break in the reactor coolant system inside a BWR drywell, pressurized coolant escaping from inside the reactor coolant system will flash to steam and begin to pressurize and heat the drywell atmosphere. As the pressure rises in the drywell, the downcomer vent system (or horizontal vents in Mk III containments) will also pressurize, eventually forcing the steam into the wetwell below the water level. The steam contacting the water condenses in the wetwell. This reduces (suppresses) the pressure in the primary containment following the loss of coolant accident by condensing the steam. In some designs and other usage contexts, a BWR wetwell may also be referred to as the torus or suppression pool.

Answer – Yes. A release path is "direct" if it allows for the migration of radioactive material from the containment to the environment in a generally uninterrupted manner (e.g., little or no holdup time); therefore, within the context of a Containment barrier Loss or Potential Loss threshold, a release path through the wetwell is a direct release path. This answer reflects the fact that, although the water in the wetwell would cause some "scrubbing" of the release by reducing the amount of iodines and particulates, it would not affect the amount of noble gases released to the environment. Noble gases (Kr, Xe) contribute to whole body submersion or immersion dose from cloud shine.

Consistent with the guidance in Regulatory Issue Summary (RIS) 2003-18, Supplement 2, *Use of Nuclear Energy Institute (NEI) 99-01, Methodology for Development of Emergency Action Levels, Revision 4, Dated January 2003*, it is reasonable to conclude that the addition of this clarification would be considered as a "difference."

EP FAQ 2015-005

Question – Consistent with the guidance in the Boiling Water Reactor Owners Group (BWROG) Emergency Procedure Guidelines (EPG), many sites have Emergency Operating Procedures (EOPs) that rely upon Minimum Core Steam Flow (MCSF) as an optional strategy to achieve adequate core cooling during an Anticipated Transient Without Scram (ATWS) event. Use of MCSF in BWR EOPs is an optional strategy that may not benefit all BWR designs. This core cooling strategy is not reflected in the NEI EAL development guidance for:

- NUMARC/NESP-007, Initiating Condition SG2
- NEI 99-01, Revision 4, Initiating Condition SG2
- NEI 99-01, Revision 5, Initiating Condition SG2
- NEI 99-01, Revision 6, Initiating Condition SS5

For an ATWS event, each of the above guidance documents base an EAL determination of an extreme challenge to core cooling on a specified Reactor Pressure Vessel (RPV) water level. Should EALs or Basis information be revised to also address the optional use the MCSF strategy during an ATWS?

Background Note – During some high-power ATWS conditions, operators may be required to intentionally lower RPV water level below the top of active fuel as an event mitigation action (i.e., to reduce reactor power). During this condition, the core may be generating at least the minimum steam flow required to assure adequate core cooling (i.e., MCSF) even though RPV water level is below the Minimum Steam Cooling RPV Water Level (MSCRWL). This action will delay fuel heatup by cooling the uncovered upper regions of the core through steam flow; the source of steam is the remaining inventory of water in the RPV. The MCSF cooling maneuver is implemented as a delaying tactic to avoid the need for emergency RPV depressurization before sufficient boron has been injected into the RPV to assure reactor shutdown under hot conditions.

Answer – No; MCSF is an optional core cooling method, and its use and effectiveness is subject to a number of factors. During an ATWS, the fact that the MSCRWL cannot be restored and maintained is sufficient to meet the EAL criterion that core cooling is extremely challenged.

EP FAQ 2015-006

Question - NEI 99-01 R6 contains the following Developer Note guidance for ICs CU2, CA2, SA1 and SS1:

> "The EAL and/or Basis section may specify use of a non-safety-related power source provided that operation of this source is recognized in AOPs and EOPs, or beyond design basis accident response guidelines (e.g., FLEX support guidelines). Such power sources should generally meet the "Alternate ac source" definition provided in 10 CFR 50.2."

The earlier revisions of NEI 99-01 (R4 and R5) and NUMARC/NESP-007 predate the accident at Fukushima Daiichi and thus do not contain any reference to beyond design basis accident response guidelines.

Plants have added, or are in the process of adding, new FLEX capabilities in response to NRC Order EA-12-049. These capabilities will allow a plant to maintain or restore key safety functions for an indefinite period of time following an extended loss of AC power. Should EALs or Bases be revised to recognize/credit FLEX capabilities (e.g., a plant now has the ability to re-energize a bus from a FLEX generator)?

Answer – Consistent with the Developer Note guidance cited above, a FLEX power source may be reflected in an EAL and/or Basis if the source meets the "Alternate ac power source" definition criteria in 10 CFR 50.2. A licensee may propose to include within their EALs or EAL bases other equipment specified in beyond design basis accident response guidelines (e.g., FLEX or B.5.b/EDMG equipment). The rationale for such proposals should include a discussion how the equipment would be maintained (to ensure reliability), deployed (including estimated times), and operated.

Consistent with the guidance in Regulatory Issue Summary (RIS) 2003-18, Supplement 2, *Use of Nuclear Energy Institute (NEI) 99-01, Methodology for Development of Emergency Action Levels, Revision 4, Dated January 2003*, it is reasonable to conclude that a proposal to include beyond design basis event response equipment within EALs or EAL bases, outside of the guidance specifically allowed in NEI 99-01 R6, would be considered as a "deviation."