NEI 13-02

Section 2, BOUNDARY CONDITIONS FOR VENT DESIGN AND OPERATION

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Section 2 Introduction

- Recognition that HCVS implementation may occur two phases (Phase 1 Wetwell; Phase 2 Drywell)
  - Primary containment conditions at initiation of venting from the wetwell and drywell flowpaths may be different
    - NEI 13-02 separates the boundary conditions for design and operation between wetwell and drywell
    - Boundary conditions used in design of HCVS shared components and piping is included in initial version of NEI 13-02
  - Phase 2 involves design and installation of a HCVS, using a vent path from the containment drywell, or demonstrate that it is unlikely that venting from the drywell would occur before alternate reliable containment heat removal (Appendix C will provide method/basis for evaluation; part of Phase 2)

Section 2 Introduction

- Beyond Design Basis Events (BDBE) and Severe Accidents
  - A unique aspect of Order EA-13-109 calls for very clear definition of the boundary conditions to be applied to the design and operational considerations required to implement the HCVS for both BDBE and severe accidents
- Key guiding principle for HCVS design
  - Define design conditions for the HCVS that match the capability of the containment to withstand severe accidents.
    - The HCVS is not required to be designed or have capability beyond those containment conditions (e.g. temperature, pressure, radionuclide, combustible gases) that have potential to challenge the containment boundary function.

Section 2.1 HCVS Use for DBE

- Use of the HCVS during design or licensing basis events (DBE) is not assumed nor required
  - The Emergency Procedure Guidelines (EPGs) provide direction on the use of the HCVS to support maintaining adequate core cooling and prevention of core damage in response to containment conditions that progress beyond plant design basis conditions.

Section 2.2 HCVS Use for BDBE

- BDBE are events that involve assumptions and failures that exceed those associated with DBEs
  - BDBE may not be considered severe accidents or result in severe accident conditions.
    - » For example, an extended loss of AC power (ELAP) is a BDBE, but not considered a severe accident since use of FLEX mitigates core damage

Section 2.2 HCVS Use for BDBE

- In the context of HCVS design, broad functional capability design considerations for the prevention of containment over-pressurization prior to core damage and mitigation of containment over-pressure conditions that may exist after core damage is used
- The primary design objective of the HCVS is to provide sufficient venting capacity to prevent a long-term overpressure failure of the containment by keeping the containment pressure below the primary containment design pressure and the primary containment pressure limit (PCPL).

Section 2.3 HCVS Use for Severe Accidents

- The primary severe accident use of the HCVS is to protect the containment from over-pressure failure caused by the increase in pressure from steam or non-condensable gases, or containment temperature within containment following severe core damage
- The performance of the HCVS in response to a severe accident is intended to minimize, as far as reasonably practicable, uncontrolled releases of radionuclides to the environment by preventing containment over-pressure

Section 2.3 HCVS Use for Severe Accidents

- The spectrum of severe accidents considered within the HCVS design are limited to those that do not compromise the containment integrity to reasonably retain radionuclides from being released to the environment given severe accident conditions.
  - Realistic assumptions may be used to determine the boundary conditions for design of the HCVS.
  - Maintaining containment pressure below PCPL minimizes leakage through drywell head seal.

Section 2.4 HCVS Design Boundary Conditions

- The unbounded nature of severe accidents requires a bounded design philosophy: the HCVS design should not exceed the current capability of the limiting containment components or the conditions under which the containment is required to remain functional
- Four primary parameters are selected for use in defining the HCVS component capability
  - Pressure
  - Temperature
  - Radiation
  - Hydrogen/CO Concentration

Section 2.4 HCVS Design Boundary Conditions

- The four primary parameters are used to determine the applicability to different flowpaths of the HCVS design
  - The portion that only supports wetwell venting
  - The portion that only supports drywell venting
  - The portion that is shared by both
- The drywell vent flowpath will generally experience the most limiting boundary conditions, so the drywell boundary condition parameters are recommended for the shared portions of the HCVS

Section 2.4 HCVS Design Boundary Conditions

- Within the context of a severe accident, the Severe Accident Guidelines (SAGs) define the containment pressure used for venting to control (restore and maintain) pressure
  - The plant-specific PCPL
  - The most bounding PCPL for design of components is PCPL-C, which is based on the pressure capability of containment
    - » PCPL-C is selected as the boundary condition for the design pressure of the HCVS components and piping. It is expected that the capability of HCVS components and piping will be greater than the design boundary conditions

Section 2.4 HCVS Design Boundary Conditions

- Within the context of a severe accident, the temperature of gases in the wetwell and drywell will differ due to the high temperatures induced by core damage
- The EPG/SAG guidance on determining the plant-specific PCPL provides a temperature range for the suppression pool of 70ºF to 350ºF and 100ºF to 545ºF for the drywell
  - The design temperature for the wetwell vent portions of the HCVS are recommended to use 350 ºF which is above the saturation temperature corresponding to typical PCPL values
  - 545ºF is recommended as the design temperature for the drywell and shared portions of the vent unless a lower number can be analytically justified.

Section 2.4 HCVS Design Boundary Conditions

Severe Accident Capable Vent Design Parameter Boundary Conditions

Boundary Parameter	**Wetwell Vent Path**	**Drywell Vent/ Shared Paths**
Containment Design Pressure	Containment Pressure at PCPL-C	
Containment Design Temperature	350 ºF	545ºF

Section 2.4 HCVS Design Boundary Conditions

- Essentially 3 options exist for the control of hydrogen deflagration or detonation
  - Design the vent pipe for detonation conditions (addressed in Appendix H)
  - Purging is an acceptable method to minimize flammable concentrations
  - Exclusion of oxygen within the vent pipe to limit potential combustion/detonation
- Control of hydrogen and oxygen concentrations are consistent with references.

Section 2.5 HCVS Operation Assumptions

- The HCVS must be capable of operation during an (ELAP) and under conditions that may exist during a severe accident
- Severe accident conditions within the containment require consideration of accessibility and stay time using the methodologies in Appendix F (Calculation of Operator Doses) and Appendix G (Calculation of Source Term for the HCVS)