ENCLOSURE 1

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ACRS Subcommittee Open Session Presentation Slides for
NEDC-33922P,
BWRX-300 Containment Evaluation Method Licensing Topical Report

Non-Proprietary Information

ACRS Subcommittee Presentation

GE-Hitachi (GEH)
Licensing Topical Report (LTR) NEDC-33922P
BWRX-300 Containment Evaluation Method

(Open Session)

March 18, 2022

Agenda

- Licensing Topical Report Purpose and Scope
- Acceptance Criteria for Containment Evaluation Method
- RPV and Containment Features Pertinent to the Method
- LOCA Scenarios and Limiting Pipe Breaks
- Overview of the Evaluation Model
- TRACG Method for Mass and Energy Release
- Containment Analysis Method Using GOTHIC

Licensing Topical Report Purpose and Scope

LTR Purpose and Scope (LTR Section 1.1)

GEH is seeking NRC approval for application of an analysis method to be used for evaluating the BWRX-300 dry containment thermal hydraulic performance.

The LTR scope includes:

- Method description
- Method qualification
- Sensitivity studies
- Application of the method to the BWRX-300 for the events identified above
- Demonstration cases

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LTR Purpose and Scope (LTR Section 1.1)

The analysis method to be used for the BWRX-300 containment thermal hydraulics performance demonstrates that the containment design complies with the following acceptance criteria listed in Section 4.0 of Licensing Topical Report (LTR) NEDC-33911P, BWRX-300 Containment Performance:

- The containment pressure boundary and penetrations are designed for the design pressure and temperature to be established for design basis accidents (DBAs) during future licensing activities in accordance with 10 CFR 50, Appendix A, General Design Criteria (GDC) 2, 4, 16, 38, 41, 50, and 51.
- In accordance with 10 CFR 50, Appendix A, GDC 4, 16, 38, 41, 50, and 51, containment design pressure will be evaluated during future licensing activities to bound the peak accident containment pressure resulting from the most limiting large break loss-of-coolant accident (LOCA) with margin, with no less than 10% margin during the preliminary safety analysis report (PSAR) phase in order to conform to Standard Review Plan (SRP) 6.2.1.1.A Acceptance Criteria.
- In accordance with 10 CFR 50, Appendix A, GDC 16, 38, and 50, the BWRX-300 containment design features establish an essentially leak-tight barrier, and will be demonstrated during future licensing activities to reduce containment pressure and temperature rapidly, and maintains them at acceptably low levels following a LOCA; and the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from a LOCA.

LTR Purpose and Scope (LTR Section 1.1)

- The methodology described in the LTR complies with all applicable regulatory requirements as written.
- GEH is not requesting NRC approval for exemptions from any regulatory requirements.

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Technical Evaluation

Containment Design Acceptance Criteria (LTR Section 1.3)

- Accident pressure and temperature are less than design pressure and temperature with appropriate margin
- Containment pressure is reduced to less than 50% of the peak accident pressure for the most limiting LOCA within 24 hours
- Containment pressure responses after 24 hours for LOCAs that do not produce the peak accident pressure are maintained below 50% of the peak pressure for the most limiting LOCA
- Containment atmosphere remains sufficiently mixed such that deflagration or detonation does not occur inside containment

The containment evaluation method presented in the topical report is an acceptable method to demonstrate that the above performance design criteria are met.

Relevant RPV and Containment Design Features (LTR Section 2.0)

The RPV, including the isolation condenser, piping and RPV isolation valves, are described in NEDC-33910P, "RPV Isolation and Overpressure Protection"

Conceptual containment design, penetrations, isolation valves, and Passive Containment Cooling System (PCCS) are described in NEDC-33911P, "Containment Performance"

The following containment design features are relevant to the purposes of the LTR:

- Containment is a dry enclosure, near atmospheric pressure during normal operation
- Containment design pressure and temperature are within the experience base of conventional BWRs
- Containment is inerted with nitrogen during normal operation
- There are no subcompartments containing large bore high energy lines
- The subcompartments have sufficiently large openings such that the boundaries of the subcompartments do not experience large pressure differentials resulting from pipe breaks outside the subcompartments

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LOCA Scenarios and Limiting Pipe Breaks (LTR Section 3.0)

- All large bore piping attached to the RPV has 2 isolation valves. The RPV isolation valves, except for those on the IC piping, close on either of the following conditions:
  - High drywell pressure
  - Low-low RPV water level
- An assumed single failure rendering an ICS train inoperative is the most limiting single failure for small breaks because the small breaks rely on ICS to depressurize the RPV.
- The limiting large breaks are:
  - Main steam pipe
  - Feedwater pipe
- All design basis large breaks are rapidly isolated at the RPV nozzle.
- The limiting small breaks are unisolated instrument line breaks, either in the steam or liquid space.

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Overview of the Evaluation Model

Overview of the Evaluation Model (LTR Section 4.0)

TRACG is used to evaluate the mass and energy release from the BWRX-300 RPV

- Utilizes applicable parts of TRACG Application for ESBWR approved LTR, which is incorporated in the approved ESBWR Design Certification
- Section 5.0 of the LTR details application of the ESBWR TRACG method to the BWRX-300.

GOTHIC is used to evaluate the BWRX-300 containment response

- New containment model developed for BWRX-300
- Based on GOTHIC computer code – meets 10 CFR 50 Appendix B QA requirements
- The GOTHIC code has been benchmarked to separate effect and integral tests. Benchmarking to the test data of a similar size containment is included in the LTR.

Evaluation method for the BWRX-300 containment response to design basis events developed per the applicable elements of RG 1.203.

- Uses base and conservative cases
- Individual key inputs, assumptions and modeling parameters conservatively biased simultaneously in the conservative cases (same approach taken for the ESBWR containment method in NEDC-33903P-A Revision 1, “TRACG Application for ESBWR”)
- Evaluation method described in LTR Section 6.0.

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TRACG Method for Mass and Energy Release (LTR Section 5.0)

- TRACG Code and Qualification (LTR Section 5.1)
  - TRACG is the GE Hitachi Nuclear (GEH) proprietary version of the Transient Reactor Analysis Code (TRAC).
  - TRACG uses realistic 1D and 3D models and numerical methods to simulate phenomena that are experienced in the operation of boiling water reactors (BWRs)
  - TRACG ECCS-LOCA analysis method for BWR/2–6 and for ESBWR have been approved previously.
  - The uncertainties in the TRACG ECCS-LOCA analysis methods are quantified for the BWR/2-6 and for ESBWR
    - Only the uncertainties relating to RPV inventory and break flow are accounted for in the BWRX-300 application

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TRACG Method for Mass and Energy Release (LTR Section 5.0)

- Applies the ESBWR TRACG-LOCA method to the BWRX-300 mass and energy release calculations (LTR Section 5.2)
  - TRACG RPV Nodalization for BWRX-300 (LTR Section 5.2.1) – For RPV and ICS, more detailed than ESBWR
  - Evaluation of Large and Small Steam and Feedwater Pipe Breaks (LTR Section 5.2.2)
    - The main steam piping of both loops up to the turbine stop valves are included in the model, and a large steam pipe break flow includes the flow from both ends of the break conservatively assuming instantaneous separation of the pipes.
  - Channel Grouping, Decay Heat, and Power Shape (LTR Section 5.2.3)
  - Modeling of the Isolation Condenser and Radiolytic Gases (LTR Section 5.2.4)
  - Modeling Biases (PIRTs) (LTR Section 5.2.5)
    - Conservative biases (LTR Table 5-1) are used to bound uncertainties in key TRACG models
    - For conservative cases, the initial operating conditions are also conservatively biased (LTR Table 5-4)
  - Initial Conditions for Conservative Cases: Trips and Isolation Signals bound the time required to reach the analytical setpoint, signal development time, and the time required for valve stem travel until the area restriction starts to occur. (LTR Section 5.2.6)

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TRACG Method for Mass and Energy Release (LTR Section 5.0)

GEH performed both base and conservative demonstration cases:

- Demonstration Cases (Base and Conservative) for Main Steam and Feedwater Large Breaks (LTR Sections 5.3, 5.3.1, 5.3.2)
- Demonstration Cases (Base and Conservative) for Small Steam and Liquid Pipe Break Cases (LTR Section 5.4)

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Containment Analysis Method Using GOTHIC (LTR Section 6.0)

The GOTHIC application methodology includes base cases and conservative cases.

- Base Cases:
  - Nominal inputs, assumptions, and correlations

- Conservative Cases:
  - Individual key inputs, assumptions and modeling parameters are conservatively biased simultaneously
  - This method compounds conservatisms and provides reasonable assurance that the overall method results bound the uncertainties.

- This is the same approach that was taken for the ESBWR containment method.

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Details of Containment Analysis Method Using GOTHIC (LTR Section 6.0)

- Identification of the relevant inputs and phenomena relevant to the BWRX-300 containment response and the selection of the models and correlations used to develop the base GOTHIC containment model (LTR Sections 6.1 – 6.4)
- GOTHIC input model for the BWRX-300 containment (LTR Section 6.5)
- Base cases and the results obtained from those base cases (LTR Section 6.6)
- How nodalization impacts the calculated results (LTR Section 6.7)
- Which model uncertainties and biases of the GOTHIC methodology are most important for application of the GOTHIC model for analyses of the BWRX-300 containment (LTR Sections 6.5 through 6.7)
- Key model uncertainties and biases used in developing the conservative GOTHIC containment model (LTR Section 6.8)
- Benchmark predictions of test data (LTR Section 6.9)
- Demonstration analyses showing the BWRX-300 containment response for various break sizes and locations using the conservative GOTHIC containment model (LTR Section 6.10)
  - Large steam line break (LTR Section 6.10.1)
  - Small steam or liquid breaks (LTR Section 6.10.2)
- Summary of assumptions and inputs used in the GOTHIC conservative cases (LTR Section 6.11)

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Conclusion

In summary…

- The methodology described in the LTR complies with all applicable regulatory requirements as written.
- GEH is not requesting NRC approval for exemptions from any regulatory requirements.
- TRACG utilizes the applicable parts of the TRACG Application for ESBWR approved LTR, which is incorporated in the approved ESBWR Design Certification
- Utilizes GOTHIC, a standard code used for evaluating thermal-hydraulic containment response in the nuclear industry
- Individual key inputs, assumptions and modeling parameters conservatively biased simultaneously in the conservative cases (same approach taken for the ESBWR containment method)

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Questions or Comments