ENCLOSURE 2

M210006

ACRS Subcommittee Presentation Slides for NEDC-33911P, BWRX-300 Containment Performance Licensing Topical Report

Non-Proprietary Information

IMPORTANT NOTICE

This is a non-proprietary version of the ACRS Subcommittee Presentation Slides for NEDC-33911P, BWRX-300 Containment Performance Licensing Topical Report, from which the proprietary information has been removed. The header of each page in this enclosure carries the notation "Non-Proprietary Information." Portions of the enclosure that have been removed are indicated by an open and closed bracket as shown here [[ ]].

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ACRS Subcommittee Presentation

GE-Hitachi (GEH)
Licensing Topical Report (LTR) NEDC-33911P
BWRX-300 Containment Performance
(Open and Closed Sessions)

January 13, 2021

Agenda

Open Session

A. Licensing Topical Report Purpose and Scope
B. Design Requirements for Containment and Passive Containment Cooling System to Meet Regulatory Requirements
C. Design Requirements for Containment Isolation Valves to Meet Regulatory Requirements
D. Analytical Methods Used for Evaluating Containment Performance
E. Acceptance Criteria for Containment Performance
F. Regulatory Compliance for Containment Performance

Closed Session

Compliance with 10 CFR 50, Appendix A, GDC 55 For Other Defined Basis

Licensing Topical Report Purpose and Scope

Licensing Topical Report Purpose and Scope

Provides the design requirements, analytical methods, acceptance criteria, and regulatory basis for the BWRX-300 containment design functions:

- Specifies design requirements for containment and the Passive Containment Cooling System (PCCS) that meet the regulatory requirements of 10 CFR 50, Appendix A, General Design Criteria (GDC) 1, 2, 4, 16, 38, 41, 42, 50, 51, 52, 53 and 54 (LTR Sections 2.2.2, 2.2.8, and Section 5.1)
- Specifies design requirements for the containment isolation valves (CIVs) that meet the regulatory requirements of GDCs 1, 2, 4, 54, 55, 56, and 57 (LTR Sections 2.2.7, 5.1.5-5.1.7, 5.1.21-5.1.24)
- Specifies analytical methods TRACG and GOTHIC with accompanying acceptance criteria that will be used for evaluating containment performance to demonstrate compliance with GDCs 38 and 50 (LTR Section 3). Evaluation methodology that will be used to demonstrate compliance is in NEDC-33922P
- Specifies BWRX-300 acceptance criteria for containment performance in accordance with the design requirements for containment, PCCS and CIVs (LTR Section 4.0)

Licensing Topical Report Purpose and Scope

LTR NEDC-33911P Containment Evaluation scope is supported by:

- Technical description of BWRX-300 containment, PCCS, and CIV design features and functions based upon proven design concepts from previous BWRs (LTR Section 2.2)
- Technical description of the BWRX-300 analytical methods utilizing the applicable parts of the ESBWR TRACG model to calculate the mass and energy release from the reactor pressure vessel, with input to GOTHIC for evaluating containment response from the mass and energy release. These models are used to demonstrate compliance for the containment, PCCS, and CIV acceptance criteria (LTR Sections 3.2-3.4)
- Regulatory evaluation of applicable regulations and guidance for the BWRX-300 containment, PCCS and CIV design features and functions to be used to demonstrate compliance with the acceptance criteria (LTR Section 5.0)

Design Requirements for Containment and PCCS to Meet Regulatory Requirements

Containment and PCCS Design Requirements

BWRX-300 primary containment vessel (PCV) is Safety Class 1, safety-related and seismic Category I with ASME Code requirements specified for:

- either metal or concrete containment structure
- piping systems passing through PCV mechanical penetrations and CIVs
- reactor pressure vessel (RPV) isolation valves
- structural supports for piping systems and components inside the PCV
- additional structures of the PCV internals

Postulated pipe rupture locations and configurations inside containment are specified per BTP 3-4, Part B, Item 1(iii)(2) and identification of leakage cracks per BTP 3-4, Part B, Item 1(v)(2) for piping connected to the RPV isolation valve assemblies extending to the containment wall

ASME Code Section III, Division 1, Subarticle NE-1120 and BTP 3-4, Part B, Items 1(ii)(1)(d) and (e), and Items 1(ii)(2) through (7) are applied to eliminate postulated breaks/cracks in those portions of piping from the containment wall to the outboard CIV

PCV, penetration piping systems and associated support materials are designed in accordance with ASME Section II, Material Specifications with exception to nonconductive portions of electrical penetrations

Design Requirements For CIVs to Meet Regulatory Requirements

CIV Design Requirements – LTR Section 2.2.7

- CIVs, associated piping and penetrations meet seismic Cat. I and ASME Section III, Division 1, Subsection NE, Class MC Components and Subsection NC, Class 2 Components
- Isolation limits leakage within permissible limits
- CIV closure timing is commensurate with timing of fission product releases
- Instrument isolation valves that penetrate containment conform to RG 1.11
- Isolation valves, actuators and controls are protected against missiles and postulated high and moderate energy line ruptures
- Resetting automatic CIVs does not result in automatic reopening
- Penetrations with trapped liquid volume between the isolation valves have adequate relief for thermally induced pressurization
- Control diversity for penetrations with RPV isolation valves
- CIVs for main steam, feedwater, shutdown cooling and reactor water cleanup fail closed
- RPV isolation valves for IC steam supply and condensate return fail as-is with valve actuators maintaining the valve as-is by positive mechanical means

CIV Design Requirements – LTR Section 2.2.7

- All other CIV penetration configurations are maintained in the required post-accident position
- Valve qualification with ASME Standard QME-1-2007 (or later edition)
- Outside containment automatic CIV closure time established to assure isolation prior to first fission product release
- Excess flow check valves (EFCVs) are used in small piping with level instruments
- Piping in the area between the outermost RPV isolation valve and the containment boundaries, as well as the piping through the seismic Category I reactor building where the isolation condenser system (ICS) steam supply and condensate return piping connects to the ICS heat exchanger are ASME Section III, Class 1, NB piping, limiting the possibility of breaks
- Scram insert piping from the hydraulic control unit (HCU) room to the fine motion control rod drives (FMCRDs) are ASME Articles NB-2150 and NB-3120
- Primary pressure boundary components of the FMCRD lower housing of the spool piece and the flange of the outer tube assembly are made with ASME Code Section III 300 series stainless steel materials
- CIVs connected to the RPV boundary comply with the “other defined basis” definition of GDC 55 (discussed in the Compliance with 10 CFR 50, Appendix A, GDC 55 closed session)

Analytical Methods Used for Evaluating Containment Performance

Analytical Methods Used for Evaluating Containment Performance

NEDC-33911P sets the requirements for the evaluation method where approval of these requirements is requested

- LTR Section 3.0 outlines the evaluation method requirements used in demonstrating containment performance
- LTR Section 3.1 lists accidents and events that form the basis of the containment thermal-hydraulic performance requirements that demonstrate compliance with GDCs 38 and 50
- The remaining sub-sections of Section 3 introduce computer codes used in the evaluation method and sets the requirements following the guidance in RG 1.203

NEDC-33922P BWRX-300 Containment Evaluation Method (submitted separately):

- Use of TRACG for mass and energy release calculations developed and approved for ESBWR with justification of same method use for BWRX-300, and any application differences
- Identification of phenomena important to containment analysis and evaluation of uncertainties
- Correlations and inputs used to bound the uncertainties
- Nodalization studies
- Benchmarking to an integral effect test to demonstrate conservatisms

Acceptance Criteria for Containment Performance

Containment Performance Acceptance Criteria

- Containment pressure boundary and penetrations are designed for pressure and temperature for design base accidents (DBAs) in accordance with GDCs 2, 4, 16, 38, 41, 50 and 51
- Containment design pressure will bound the peak accident pressure resulting from the most limiting large break LOCA with margin (no less than 10% margin in PSAR) in order to conform with the requirements of GDCs 4, 16, 38, 41, 50 and 51, and the guidance of SRP 6.2.1.1.A
- Containment design features provide an essentially leak-tight barrier where containment pressure and temperature can be reduced rapidly and maintained at acceptably low levels following a LOCA to meet the requirements of GDCs 16, 38, 50
- Containment structure and internal compartments can accommodate without exceeding the design leakage rate with sufficient margin, the calculated pressure and temperature conditions resulting from a LOCA to meet the requirements of GDCs 16, 38, 50

Regulatory Compliance for Containment Performance

Regulatory Compliance

The BWRX-300 containment, PCCS, and CIV design complies with the following regulations:

- 10 CFR 50.34(f)(2)(xiv), (f)(2)xv), (f)(2(xvii) – all non-essential systems isolate with two isolation barriers in series except for non-essential instrument lines
- 10 CFR 50.34(f)(3)(A)(1) – containment structure integrity is maintained for an accident that releases hydrogen generated from a 100% fuel clad metal-water reaction
- 10 CFR 50.44(c)(1), (c)(2), (c)(3), (c)(4), (c)(5) – the BWRX-300 containment is dry and nitrogen-inerted where no subcompartments may accumulate combustible gas mixtures
- 10 CFR 50.55a – containment, PCCS, and CIV design features use standards approved in 10 CFR 50.55a(a) in effect within 6 months of license application
- 10 CFR 50.63 – design includes Class 1E battery-backed DC power for safety-related components for coping with station blackout
- GDCs 1, 2, 4, 5, 13, 16, 38, 39, 40, 41, 42, 43, 50, 51, 52, 53, 54, 55 (separate slide provided in closed session for CIVs complying with “other defined basis”), 56, 57, 64 are met for the BWRX-300 containment, PCCS and CIVs
- 10 CFR 50, Appendix J – periodic integrated leakage rate testing conducted with guidance from RG 1.163

Regulatory Guidance

The guidance from the following regulatory guides is met for the BWRX-300 containment, PCCS and CIVs:

- RG 1.11 Instrument Lines Penetrating the Primary Reactor Containment
- RG 1.84 Design, Fabrication and Materials Code Case Acceptability
- RG 1.141 Containment Isolation Provisions for Fluid Systems
- RG 1.147 Inservice Inspection Code Case Acceptability
- RG 1.155 Station Blackout
- RG 1.163 Performance-Based Containment Leak Rate Test
- RG 1.192 Operation and Maintenance Code Case Acceptability
- RG 1.203 Transient and Accident Analysis Methods

Regulatory Guidance Contd.

The guidance from the following standard review plans (SRP) are met for the BWRX-300 containment, PCCS and CIVs:

- SRP 3.6.2 Determination of Rupture Locations and Dynamic Effects – complete description and associated branch technical positions compliance utilizing many of the assumptions from ESBWR Design Control Document (DCD) Section 3.6.1.1 will be provided in future licensing activities
- SRP 3.9.6 Functional Design, Qualification and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints – CIV design will use standards approved in 10 CFR 50.55a(a) effective within six months of any license application
- SRP 6.2.1 Containment Functional Design – BWRX-300 containment design is affected by the guidance in SRPs 6.2.1.1.A, 6.2.1.3; SRPs that are not applicable for the BWRX-300 design include: 6.2.1.1.C no pressure-suppression pool; 6.2.1.2 no subcompartments with large bore high energy lines; 6.2.1.4 no secondary system piping; 6.2.1.5 no emergency core cooling system (ECCS) to maintain pressure following design base events
- SRP 6.2.1.1.A PWR Dry Containments, Including Subatmospheric Containments – excluding Sections: (1) no ECCS, (2) no subcompartments with large bore high energy lines and (3) no secondary systems

Regulatory Guidance Contd.

The guidance from the following SRPs is met for the BWRX-300 containment, PCCS and CIVs:

- SRP 6.2.1.3 Mass and Energy Release for Postulated Loss-of-Coolant Accidents – calculated neutronics and thermal-hydraulics using previous TRACG Containment/LOCA submittals that are applicable to BWRX-300 design (see LTR Section 3.1)
- SRP 6.2.2 Containment Heat Removal Systems – BWRX-300 does not employ use of spray water, ECCS or sumps in the design to actively remove heat or pressure within containment and long-term core cooling is addressed in LTR NEDC-33910P BWRX-300 Reactor Pressure Vessel Isolation and Overpressure Protection
- SRP 6.2.3 Secondary Containment Functional Design – Not applicable to BWRX-300 containment design
- SRP 6.2.4 Containment Isolation System – design of the CIVs and associated piping and penetrations will meet the requirements of seismic Category I components and ASME Section III, Class 1 or 2 according to their quality group classification
- SRP 6.2.5 Combustible Gas Control in Containment - BWRX-300 containment is dry, nitrogen-inerted that does not rely upon gas control to maintain hydrogen and oxygen concentrations below combustible levels and maintain structural integrity following a DBA; for beyond design basis events and severe accidents, a separate evaluation and analysis will be provided in future licensing activities
- SRP 6.2.6 Containment Leakage Testing – conforms similarly to ESBWR
- SRP 6.2.7 Fracture Prevention of Containment Pressure Boundary – conforms similarly to ESBWR

Closed Session
Compliance With 10 CFR 50
Appendix A, GDC 55 For Other Defined Basis

10 CFR 50, Appendix A, GDC 55 Compliance

The BWRX-300 CIVs connected to the RPV boundary comply with the “other defined basis” alternative.

- BWRX-300 incorporates isolation valves [[ ]] for large and medium pipe break LOCAs [[ ]]
- RPV isolation valves are single failure proof, contained in seismic Category I containment, and meet ASME Code Section III, Class 1; associated piping is ASME Section III, Class 1 NB piping that limits the probability of breaks in these piping segments
- Breaks between the RPV isolation valves and containment would be isolated to stop the leak and would be contained by the closed system outside containment that is designed to withstand full reactor pressure

10 CFR 50, Appendix A, GDC 55 Compliance

The BWRX-300 CIVs connected to the RPV boundary comply with the “other defined basis” alternative.

Automatic CIVs outside containment are also included for GDC 55 compliance with the following exceptions:

- RPV isolation valves for the ICS steam supply and condensate return piping with the closed loop IC located outside containment serve as a “passive” substitute for an open “active” outside containment automatic CIV; [[
  ]] to allow the ICS to function as a part of ECCS
- HCUs of the FMCRDs also serve as a closed system outside containment similarly to what was approved for the ESBWR; adding additional isolation valves in this piping for containment isolation is not in the direction of highest safety because it could become a new potential failure mode in a safety critical system and will not improve the integrity because the small diameter high pressure hydraulic lines are attached to a closed system outside containment and therefore do not cause a risk of containment leakage

LTR Figure 2-5: Main Steam and Feedwater CIVs Connected to RPV Boundary

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LTR Figure 2-7: Isolation Condenser CIVs Connected to the RPV Boundary

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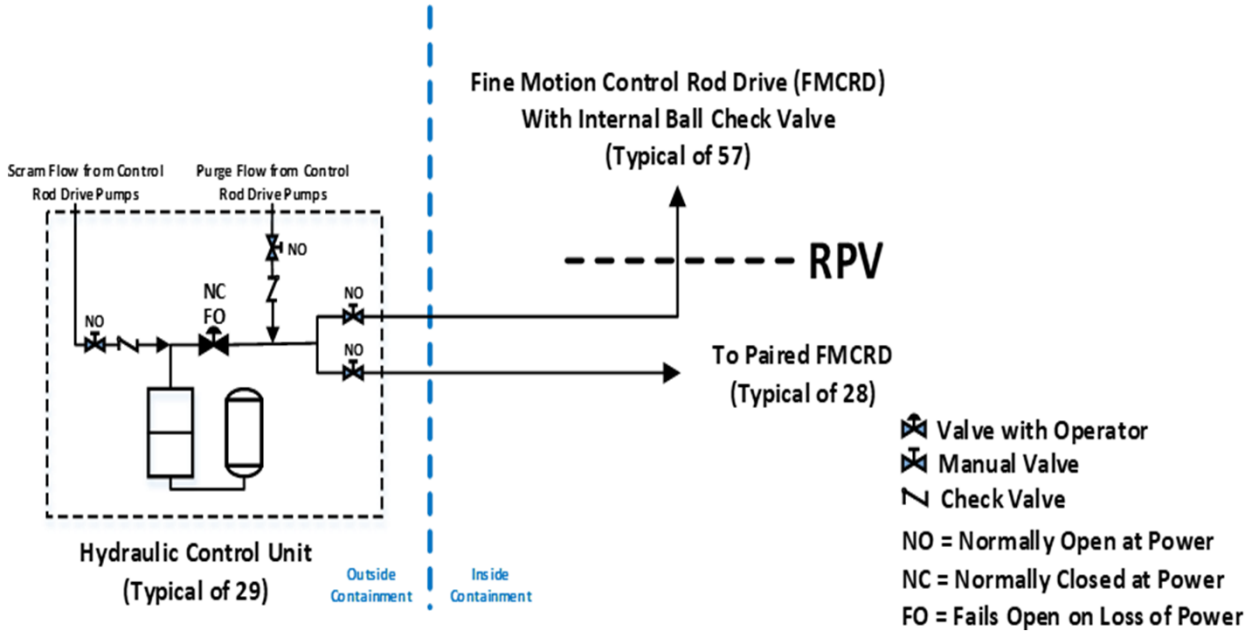
LTR Figure 2-8: FMCRD CIVs Connected to RPV Boundary



Questions or Comments