Boiling Water Reactor Vessel and Internals Project (BWRVIP) Report

Industry/NRC Materials Technical Exchange Meeting

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BWRVIP Overview

BWRVIP Background and Objectives

- Background
  - Intergranular Stress Corrosion Cracking (IGSCC) in austenitic piping was a major issue for Boiling Water Reactors (BWRs) in the 1980s – susceptibility of reactor internals to IGSCC was also recognized
  - Shroud cracking in 1993-1994 confirmed that IGSCC of internals is a significant issue for BWRs
  - BWR utility executives formed the BWRVIP in mid-1994
- Objectives
  - Lead industry toward proactive generic resolution of vessel and internals material condition issues with generic, cost-effective strategies
  - Identify or develop generic, cost-effective strategies
  - Serve as a focal point for the regulatory interface with the industry in BWR vessel and internals material condition issues
  - Share information among members to obtain useful data from many sources

2026 BWRVIP Members

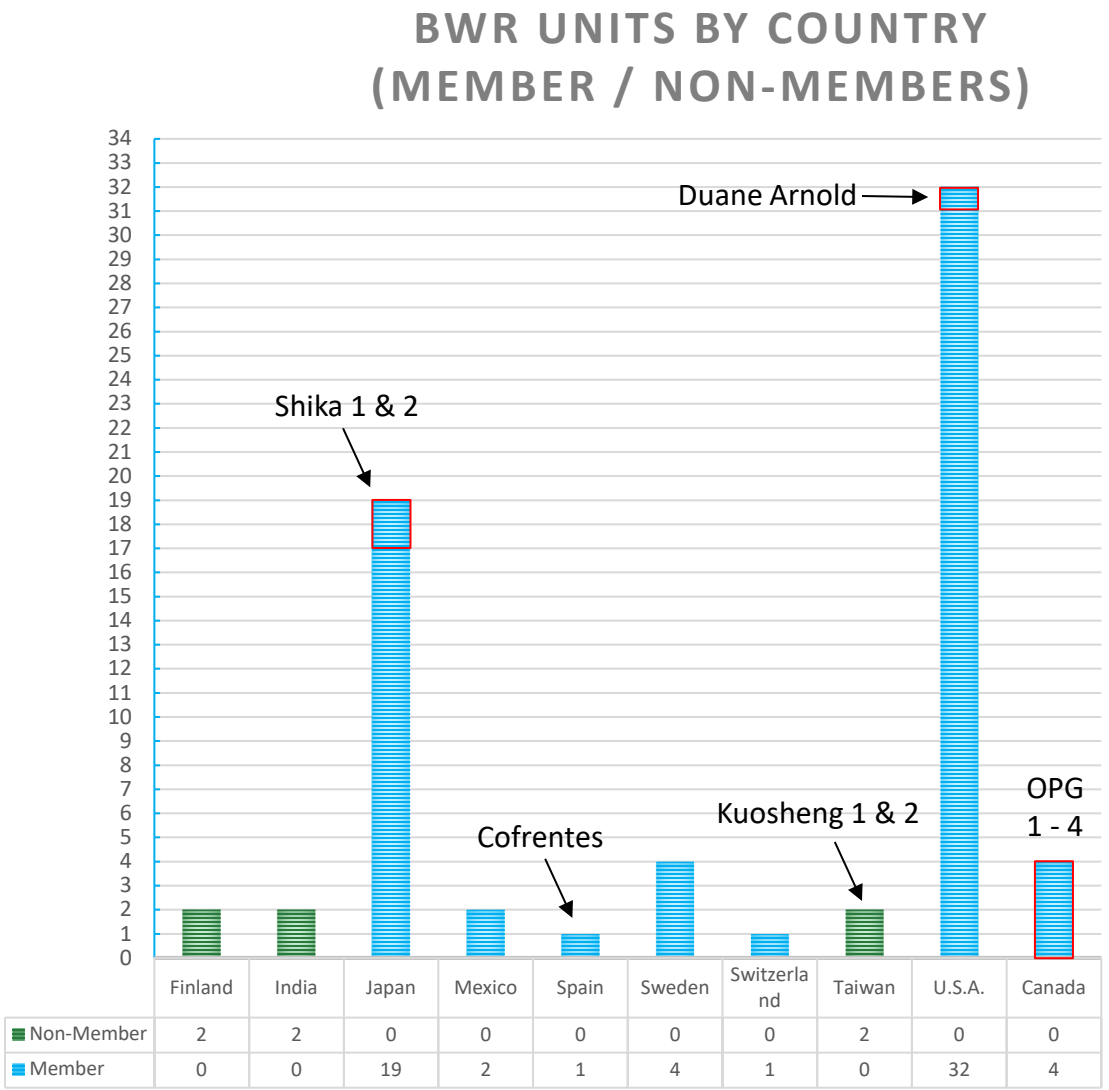
Comision Federal de Electricidad
Constellation
DTE Energy
Duke Energy
Energy Northwest
Entergy
NextEra Energy
NPPD
OPG
PSEG Nuclear
Southern Nuclear Company
Talen Energy
Tennessee Valley Authority
Vistra
Xcel Energy

Forsmarks Kraftgrupp AB
Iberdrola Generation
Kernkraftwerk Leibstadt
OKG Aktiebolag

Chubu Electric Power Company
Chugoku Electric Power Company
Hitachi-GE Vernova
Hokuriku Electric Power Company
Japan Atomic Power Company
J-Power
Tohoku Electric Power Company
Tokyo Electric Power Company

BWRVIP Membership at a Glance

- 24* of 26 BWR operators are BWRVIP members
  - *Hokuriku Electric Power Company joined BWRVIP in 2026; plans to restart Shika 2 in 2026
  - *NextEra rejoined BWRVIP with Duane Arnold restart effort underway
    - *Unit retired in 2020*
  - *OPG joined BWRVIP
    - Constructing four BWRx-300s at Darlington
  - Cofrentes current operating license expires November 30, 2030; future remains uncertain
  - Taiwan's Ministry of Economic Affairs now considers it “feasible” for Taipower to restart Kuosheng 1 & 2
    - *Units retired in 2021 & 2023*
- Average age of a BWRVIP Member unit: 41 years
  - *15 BWRs are over 50 years old*
  - *32 BWRs are over 40 years old*
- BWRVIP Member units account for ~15% of the worldwide nuclear capacity



	Finland	India	Japan	Mexico	Spain	Sweden	Switzerland	Taiwan	U.S.A.	Canada
Non-Member	2	2	0	0	0	0	0	2	0	0
Member	0	0	19	2	1	4	1	0	32	4

2026 BWRVIP Organization

Red = Vacant

Green = New

Blue = Tentative

Executive Committee

Barry Davis, Entergy	(Chair)
Ron DiSabatino, Constellation	(Vice Chair)
Nathan Palm, EPRI	(Program Manager)

Executive Oversight Committee

Barry Davis, Entergy	(EC Chair)
Ron DiSabatino, Constellation	(EC Vice Chair)
TBD	(AC/IC Exec Sponsor)
Aaron Chladil, Xcel Energy	(MC Exec Sponsor)
Norimichi Yamashita, TEPCO	(International Sponsor)
Troy Barker, NPPD	(EOC at large)

Research Integration Committee

Carl Rosenwald, DTE Energy	(Chair)
Becky Nealis, Constellation	(Vice Chair)
Wynter McGruder, EPRI	(Task Manager)
Mitch Dior, PSEG	(BWROG Chair)

Assessment Committee

Michelle Alger, Southern	(Technical Chair)
Russ Lidberg, Xcel	(Co-Vice Chair)
Brice Babarsky, Constellation	(Co-Vice Chair)
Wayne Lunceford, EPRI	(Task Manager)

Inspection Committee

Eddie Goss, Energy Northwest	(Chair)
Mike Swartz, Constellation	(Vice Chair)
Bob Grizzi, EPRI	(Task Manager)

Mitigation Committee

Becky Nealis, Constellation	(Technical Chair)
Mike Shobe, Energy Northwest	(Vice Chair)
Michelle Mura, EPRI	(Task Manager)

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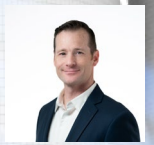

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Operating Experience

Operating Experience

- No operating experience (OE) has occurred since the 2025 technical exchange meeting that triggered the initiation of the emergent issues protocol
- Some OE trends exist that represent non-safety challenges (next slide)

General Trends By Component (1/2)

Core Shroud

Core shroud exams are showing some minor flaw growth in the length and depth direction for both standard and off-axis flaws

- Flaw growth still within crack growth rate assumptions based on reporting

Core Spray

Minor flaws are being identified in the core spray spargers and piping locations

- Not significant in size but have resulted in need to evaluate leakage impacts

Jet Pumps

Jet pump vibration, flaws, and wear continue to be reported and managed using existing evaluation guidance or repairs/replacement

- Flaw locations are in known susceptible areas (RS-1, wedges, rods, set screws, etc.)

Misc.

Dry tube relaxation and disengagement continues to be identified and managed through replacement and agitation to reset the dry tube

Steam Separator, Dryer Support Lug, and shroud head bolt degradation and cracking continue to be reported

General Trends By Component (2/2) - Summary

- Flaws and wear continue to be successfully identified, tracked, evaluated, and even repaired/replaced using BWRVIP guidance.
  - Flaws and wear are largely occurring in expected locations and at the sizes/volumes that are bounded by assumptions in existing guidance.
  - Trends show minimal “new” degradation.
    - In many instances, “newly identified” indications can be shown to be existing by review of prior video
    - In other cases, improved examinations show that flaws identified in past examinations are actually non-relevant

2026 BWRVIP Technical Activities

2026 Key BWRVIP Technical Activities

- Updating of core shroud inspection and evaluation guidance
- Reevaluation of stainless steel and low alloy steel SCC growth rates
- Publication of consolidated flaw evaluation guidance for BWR reactor internals components
- Evaluation of effects of “water washing” on noble metal effectiveness
- Platinum deposition evaluation of a fuel channel fastener
- Evaluation of fatigue crack growth ΔK thresholds
- Research on flaw proximity criteria for reactor internals flaw evaluation
- Evaluation of fluoride effects on crack growth rates
- Modification of xLPR for BWRs to assess recirc. line break likelihood

Summary of BWRVIP Report Submittals

Submittals in the NRC Review Process

- No BWRVIP reports are currently within the NRC review process
- BWRVIP-100, Revision 2, Updated Assessment of the Fracture Toughness of Irradiated Stainless Steel for BWR Core Shrouds
  - Final SE received July 2025
  - “-A” published October 2025
  - NRC acceptance of “-A” received December 2025
- BWRVIP-138, Revision 2, Updated Jet Pump Beam Inspection and Evaluation Guidelines
  - Final SE received August 2025
  - “-A” published November 2025
  - NRC acceptance of “-A” received January 2026

Planned Submittals

- BWRVIP-368, Technical Basis for Optimization of the U.S. BWR Fleet Integrated Surveillance Program (ISP) Capsule Withdrawal Schedule
  - Initial public meeting with NRC held on April 23, 2024
  - Report published December 2025
  - Pre-submittal meeting held on May 4, 2026
  - NRC Submittal for Review and Approval planned for Q3 2026
  - Fee waiver will be requested
- BWRVIP-316, Reactor Pressure Vessel Aging Management Evaluation for Extended Operations
  - Publication planned for Q3 2026
  - NRC Submittal for Review and Approval planned for Q4 2026
  - Fee waiver will be requested

BWRVIP-76, Revision 3 – Core Shroud I&E Guidance

- Expected to be completed in Q3 2026
  - Contains significant changes as compared to Revision 1-A, which is currently being implemented by the fleet
  - Revision 2 was published but never NRC approved or implemented
- BWRVIP intends to submit Revision 3 for NRC approval given the extent of the changes
- There is significant interest from the BWRVIP members in being able to implement Revision 3 as soon as possible
  - BWRVIP is considering screening the report using the NEI-03-08 App. C or some other process to allow for immediate implementation
  - Screening would specifically address change in risk associated with implementation of guidance changes over duration of NRC review
- Pre-submittal meeting will be requested once report is completed

Use of the NEI 03-08 Appendix C Screening Process

- No reports screened in 2025 ➔ No NRC submittal letter in 2026
- Details of previously screened reports provided in the following letters:
  - BWRVIP Letter 2025-024 (NRC Notification Letter; May 15, 2025) - NRC Accession #: ML25134A291
    - BWRVIP-38, Revision 1: BWR Shroud Support Inspection and Flaw Evaluation Guidelines (Published 2024)
  - BWRVIP Letter 2025-022 (NRC Notification Letter; May 13, 2025) - NRC Accession #s: ML25133A212
    - BWRVIP-48, Revision 1: Vessel ID Attachment Weld Inspection and Flaw Evaluation Guidelines
    - BWRVIP-48, Revision 2: Vessel ID Attachment Weld Inspection and Flaw Evaluation Guidelines
    - BWRVIP-49, Revision 1: Instrument Penetration Inspection and Flaw Evaluation Guidelines
    - BWRVIP-57, Revision 1: Instrument Penetration Repair Design Criteria
    - BWRVIP-62, Revision 2, Volume 1: Implementation Criteria for Inspection Relief for BWR Internal Components with Hydrogen Injection
    - BWRVIP-84, Revision 3: Guidelines for Selection and Use of Materials for Repairs to BWR Internal Components
    - BWRVIP-303: Load Definitions and Combinations for Use in BWR Internals Repair/Replacement and Flaw Evaluations
    - This letter contains the report revisions details (where applicable) and the complete Appendix C screening for each of the above listed reports.
    - Utilities should reference the above submittals when implementing screened reports and referencing them in licensing submittals.

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