MRP

Coordinated PWR Reactor Vessel Surveillance Program (RVSP)

PWROG MSC and MRP Joint Effort

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PWR Owners Group
Industry and NRC Coordination Meeting
on PWR and BWR Materials Issues
Coordinated PWR RVSP
Background

- **Feasibility Study under PWROG MSC (PA-MSC-0324) - 2008**
  - Joint project between Westinghouse and AREVA
  - *Recommendations for Management of Reactor Vessel Surveillance Program Resources for the Extended Operating Period* (WCAP-16944-NP)
    - Recommended establishing and implementing a plan to obtain high-fluence long-time irradiation data in place of test reactor data to resolve embrittlement trend curve (ETC) prediction accuracy above 3E19 n/cm^2
- **Surveillance Capsule Pull Recommendations under MRP project 17.4 - 2009**
  - Created draft coordinated PWR RVSP capsule management plan
  - Support by PWROG MSC provided through PA-MSC-0421

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Coordinated PWR RVSP Objectives and Parameters

1. Obtain vessel embrittlement data with high fluence and long times to provide objective evidence for 60 to 80 year operation.
2. Maintain plant-specific surveillance program compliance with 10 CFR 50 Appendix H and ASTM E185 for a 60-year license, while minimizing the burden on plant owners.
3. Contribute to industry goal to produce one embrittlement trend curve applicable to all vessel integrity applications.

Parameters:

- Target Fluence Range: 3×10^{19} to 10×10^{19} n/cm^2
- Assume all PWRs will receive a 60-year license renewal and plan to operate for 60 years or beyond.
- Minimize burden to utilities (e.g., capsule move, capsule reinsertion, additional testing , exemption requests)

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Status

ASTM E10.02 Workshop

- 1/26/10 workshop on Obtainment and Use of High Fluence Surveillance Data to Improve Existing Embrittlement Correlations
- Goals
  - To determine what needs to be considered and done to inform power reactor embrittlement models above $3x10^{19}$ n/cm^2
  - To identify steps necessary to resolve issues specific to the formulation of a single industry consensus embrittlement trend curve.
- 13 presentations by plant owners, PWR vendors, NRC (Kirk) and international researchers bridging PWR and test reactors; considered existing and planned programs intended to evaluate embrittlement after exposure to a high fluence.

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Coordinated PWR RVSP Status (Continued)

Draft Coordinated PWR RVSP

- AREVA draft report 51-9107111-000 issued for comment in January 2010
- Majority of utilities have provided input to draft plan
- Utility feedback is in process of being addressed

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Next Steps

Next Steps

- Optimization of coordinated plan
- Agreement in principal of the individual withdrawal and test schedules by the affected PWR utilities
- Review plan status with the NRC (Fall 2010)
- Plan implementation by the owners - ongoing effort under PWROG PA-MSC-0553 (2009 through 2011)
  - Working with owners to implement industry coordinated PWR reactor vessel surveillance plan

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Optimization

Optimization

- Evaluate material groups which may need to be subdivided (possibly 2)
- Identify material groups where significant divergence is seen between test and power reactor based correlations at high fluence
- Rate capsule importance for producing data needed for filling industry high fluence data needs
- Evaluate plan relative to objectives to address all limiting RPV materials to at least 60 year fluence and to encompass representative range of Cu, Ni, and irradiation temperature (T-cold)

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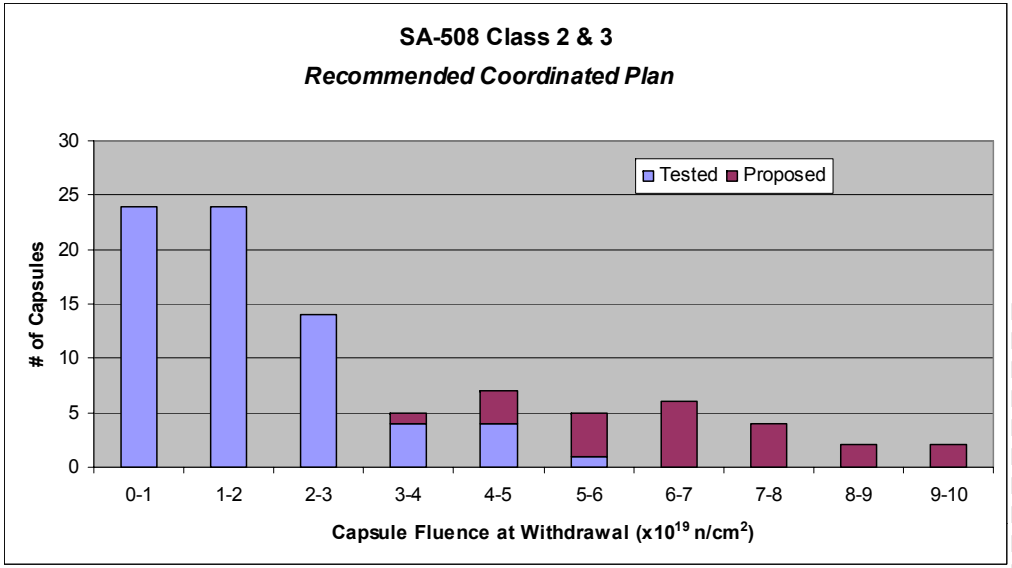
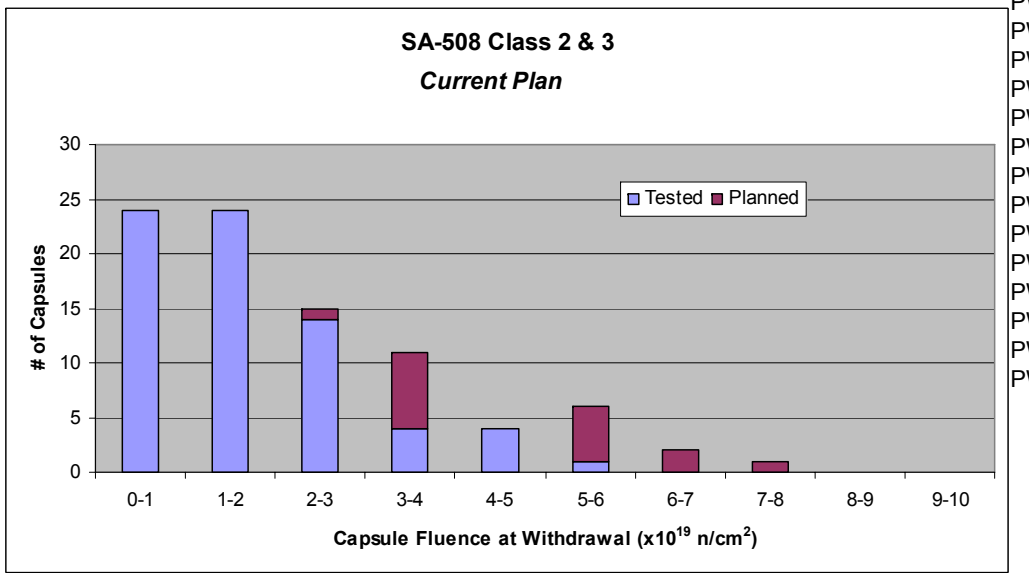
Materials Groupings

- Forgings:
  - SA-508 Class 2 and Class 3
- Plates:
  - SA-302 Grade B (all contain more than 0.10 wt% Cu),
  - SA-533 Grade B Class 1, Cu ≤ 0.10 wt%
  - SA-533 Grade B Class 1 and SA-302 Grade B Modified, Cu > 0.10 wt%
- Welds:
  - Linde 124, Cu < 0.10 wt%
  - Linde 0091, Cu ≤ 0.10 wt%
  - Linde 0091, Cu > 0.10 wt%
  - Linde 1092, Cu > 0.10 wt%
  - Linde 80, Cu ≤ 0.10 wt%
  - Linde 80, Cu > 0.10 wt%
  - SMIT 89, Grau Lo LW320 and BOLA

Example of Data Being Evaluated for Optimization for the Forging Group





Plant-Capsule	Removal Year	Fluence E+19	Temp F	Cu	Ni	P	Mn
PWR X, Cap Y	2019	3.1	545	0.13	0.76	0.020	0.62
PWR X, Cap Y	2024	4.1	545	0.13	0.74	0.018	0.72
PWR X, Cap Y	2016	4.2	562	0.10	0.84	0.014	0.73
PWR X, Cap Y	2010	4.5	558	0.06	0.75	0.006	1.30
PWR X, Cap Y	2011	5.2	527	0.06	0.72	0.013	1.41
PWR X, Cap Y	2014	5.2	527	0.09	0.70	0.011	1.22
PWR X, Cap Y	2006	5.6	545	0.05	0.69	0.010	0.67
PWR X, Cap Y	2020	5.8	558	0.16	0.79	0.012	0.69
PWR X, Cap Y	2024	6.0	559	0.17	0.80	0.012	0.73
PWR X, Cap Y	2013	6.2	562	0.10	0.84	0.014	0.73
PWR X, Cap Y	2016	6.5	553	0.16	0.79	0.019	0.68
PWR X, Cap Y	2020	6.6	551	0.03	0.73	0.007	1.33
PWR X, Cap Y	2012	6.6	551	0.05	0.73	0.010	0.56
PWR X, Cap Y	2014	6.8	551	0.01	0.70	0.007	1.29
PWR X, Cap Y	2013	7.2	545	0.05	0.69	0.010	0.67
PWR X, Cap Y	2014	7.2	542	0.09	0.71	0.009	0.65
PWR X, Cap Y	2020	7.3	527	0.06	0.72	0.013	1.41
PWR X, Cap Y	2026	7.3	527	0.09	0.70	0.011	1.22
PWR X, Cap Y	2023	8.0	554	0.11	0.86	0.018	0.76
PWR X, Cap Y	2023	8.1	547	0.07	0.70	0.010	0.64
PWR X, Cap Y	2030	9.0	547	0.06	0.70	0.011	0.67
PWR X, Cap Y	2022	9.2	532	0.06	0.75	0.010	0.79

Draft data; for illustration only

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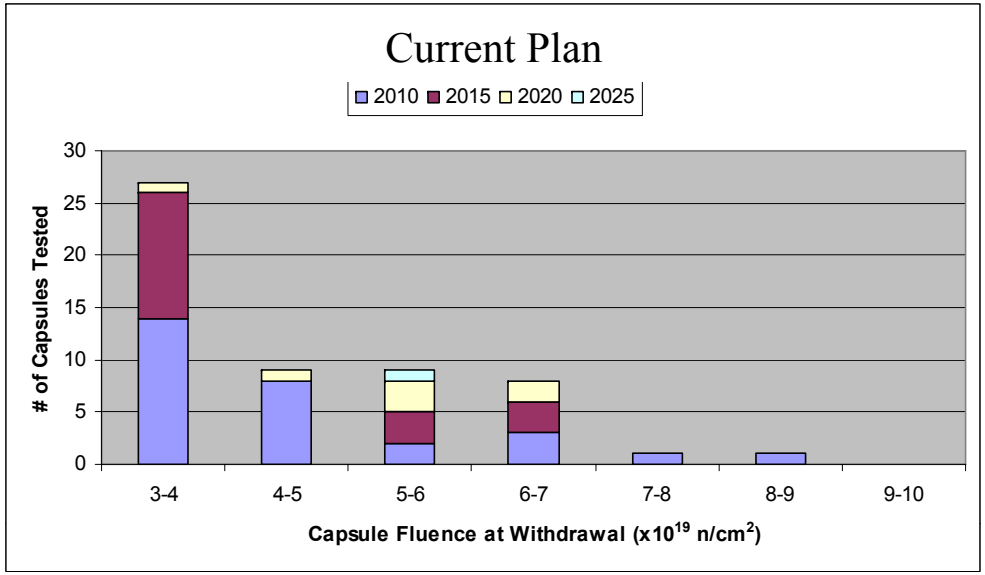
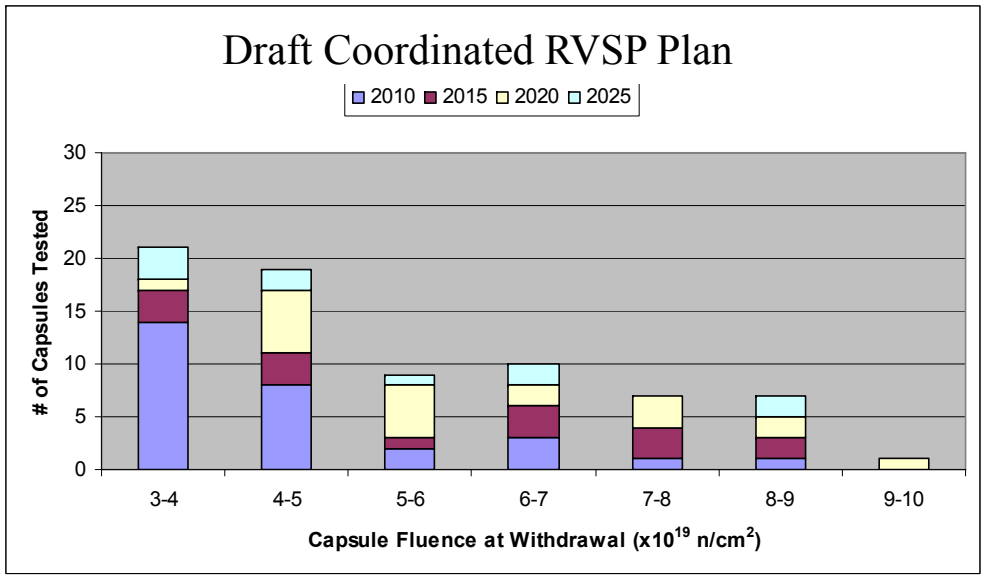
Coordinated PWR RVSP
Draft General Recommendations

- **For the 69 U.S. PWR plants, roughly 232 capsules have been tested.**
  - Current plan: 35 capsules are planned for testing in next 15 years
  - Recommended coordinated plan: 56 capsules are planned for testing in next 15 years
- **Twelve plants have already tested their 60-year capsule and should test another capsule.**
  - This additional capsule would satisfy 80-year license needs.
- **Three capsules from the 69 plants should be moved to a higher lead factor location.**
- **Five capsules currently stored in the spent fuel pool should be reinserted for further irradiation.**

Coordinated PWR RVSP
Draft Results Overview





- The current plan uses GALL report recommendations
  - 60 year capsule & remove other capsules
- The draft coordinated RVSP plan extends irradiations, but still within E185-02 max. of 2xEOL fluence (60 years)
- Draft coordinated plan provides better distribution of data
- Relative to the current plan, the draft coordinated plan will provide the following increases in high fluence ($>4x10^{19}$ n/cm^2) capsules:
  - 6 more in 5 years
  - 19 more in 10 years
  - 25 more in 15 years

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Coordinated PWR RVSP Conclusions

- The recommended coordinated U.S. PWR RVSP would add a significant amount of high fluence PWR Charpy data within the next 15 years.
- This plan is intended to provide input to the embrittlement trend curves with PWR data for use in 60 and 80 year RPV evaluations.
- Implementation of this plan will contribute to the industry goal to produce one embrittlement trend curve applicable to all vessel integrity applications.
- This coordinated plan is designed to produce surveillance data to support license renewal of each of the U.S. PWRs to 60 and 80 years of operation.