

10 CFR 50.46c Proposed Rule and Associated Draft Regulatory Guides Westinghouse Electric Power Company Recommendations

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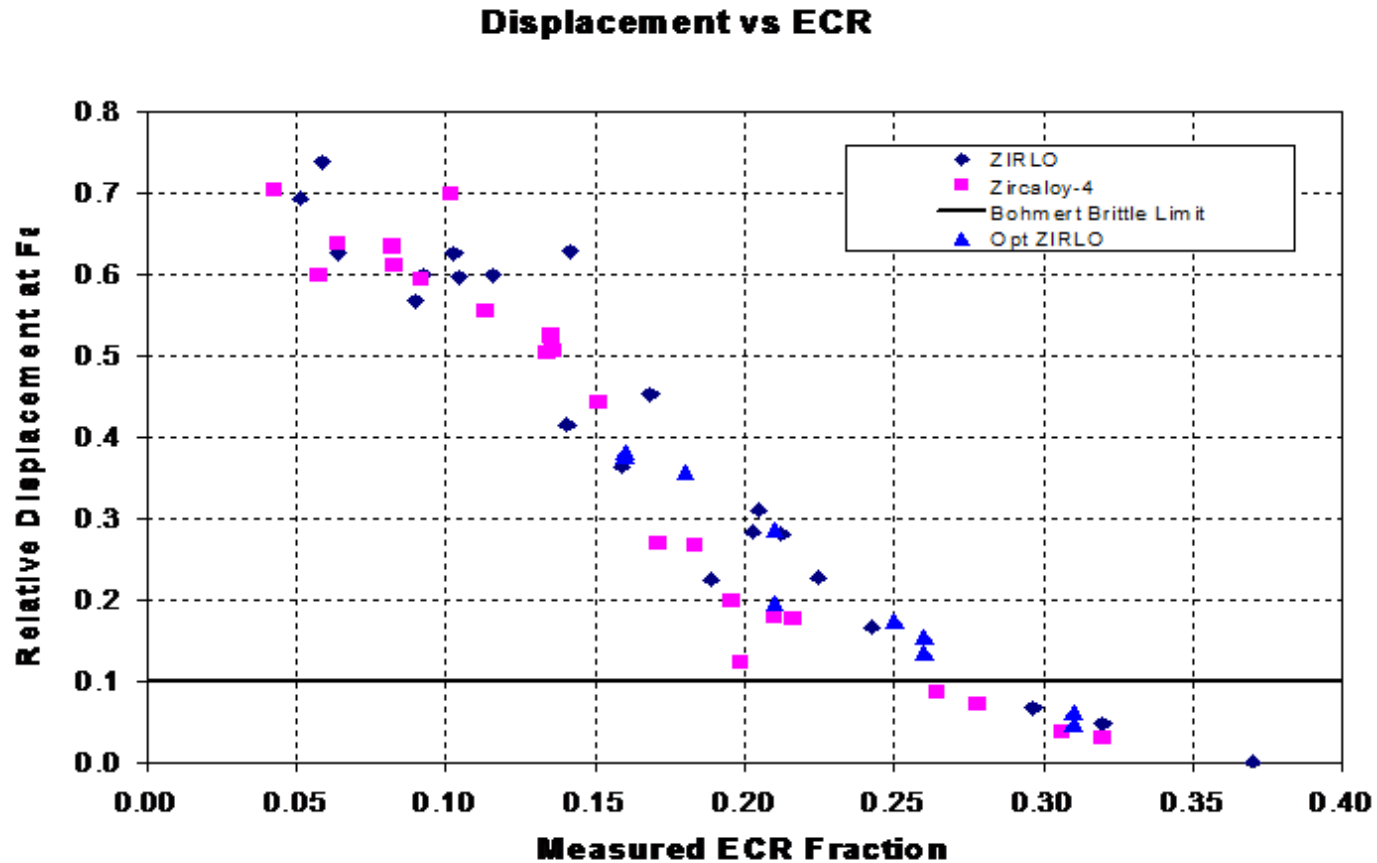
Outline

- Previous and ongoing Westinghouse LOCA Basis Testing
- Issues Associated with DG-1262 and DG-1263
- ANL Data Analysis
- Recommendations for DG-1262 and DG-1263
- Conclusions and Summary on DG-1262 and 1263
- Questions.

Previous Westinghouse LOCA Basis Testing

- Previously Westinghouse tested **ZIRLO**[®] and Zircaloy-4 cladding using post oxidation ductility (POD – Hobson protocol) testing to demonstrate similarity of ZIRLO and Zircaloy-4 cladding and then later performed similar tests on **Optimized ZIRLO**[™] high performance cladding.
- AREVA performed and published LOCA basis tests on M5 cladding
- Westinghouse sent detailed information on breakaway testing of ZIRLO and Zircaloy-4 cladding to NRC in five (5) separate letters.
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POD Results



Ongoing Westinghouse LOCA Basis Testing

- Westinghouse is now performing both post quench ductility (PQD) and breakaway testing at our research facility conforming as closely to the draft reg guides as possible.

Issues Associated with DG-1262 and DG-1263

- Initial Observations.
 - Proposed acceptance test/analysis requirements for new zirconium cladding alloys appear to be significantly more demanding than the testing/analysis performed to develop the proposed rule.
- The ANL ductile to brittle transition (DBT) appears to have been developed using curve fits to determine when the strain as a function of ECR or of hydrogen content intersects the brittle criteria.
- A review of both ANL and the ASTM round robin PQD results indicate considerable variation in strain, especially as the DBT is approached.

Issues Associated with DG-1262 and DG-1263 (Cont'd)

- Given the ECR that accumulates during heat up and/or cool down, it is difficult to test using the DG protocol at 1,200°C cladding sample with 400 ppm hydrogen given the expected DBT [6% ECR, 400 ppm]
- DG-1263 Irradiated testing protocol represent a significant hurdle to the introduction of new alloys.

Recommendations for DG-1262 and DG-1263

- For performing PQD testing when the cladding is tested in bins there should be provision for the hydrogen level in each bin to vary from the target.
- There should be a provision to use curve fitting of the test data to determine ductile to brittle transition (DBT) within each bin.

**Proposal follows method what ANL
appeared to use.**

Recommendations for DG-1262 and DG-1263 (Cont'd)

- Since the measured hydrogen in each bin may vary from the target, the resulting DBT should not be required to be at a whole number ECR but could be a fraction, i.e.
 - Bin Target: 200 ppm.
 - Actual bin average: 223 ppm.
 - Resulting curve fit DBT: 12.7% ECR.

Recommendations for DG-1262 and DG-1263 (Cont'd)

- For purposes of modeling the final DBT can be done by fitting the DBT points from the individual bins.
- There should be a provision to perform a fit of the DBT as a function of both the hydrogen and ECR using the same bins as above.
- There should be a provision to test both a new alloy and an existing approved alloy and if similar PQD performance is achieved for both, then the proposed 50.46c DBT limits would be applicable to the new alloy.

Recommendations for DG-1262 and DG-1263 (Cont'd) - Irradiated Cladding

- Sufficient test results from a variety of zirconium alloys exist to demonstrate the equivalence of irradiated and non-irradiated cladding.
- Westinghouse recommends:
 - Remove the requirement in DG-1263 for irradiated testing.
 - or
 - The requirement for testing of irradiated cladding should be modified to require that the testing of irradiated cladding show similarity in terms of PQD behavior to the pre-hydrided cladding at only one hydrogen level which is at or above 66% of the maximum best estimate hydrogen.

Conclusions and Summary on DG-1262 and 1263

- Overall the requirements used to qualify new claddings should be similar to the work done for the currently qualified claddings.
- An alloy with only small changes from an approved alloy specification should only require demonstration of similar performance and not require a complete new qualification.
- The recommendations that Westinghouse has supplied for changes in the Draft Reg Guides are aimed at providing a practical means of demonstrating compliance and are based on extensive testing experience.

Questions

10 CFR 50.46c Proposed Rule and Draft Regulatory Guide DG-1261 Westinghouse Electric Power Company Recommendations

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June 26, 2014

Outline

- Issues Associated with DG-1261
- Recommendations for DG-1261 – Breakaway
- Conclusions and summary on DG-1261
- Questions.

Issues Observed with DG-1261 breakaway testing.

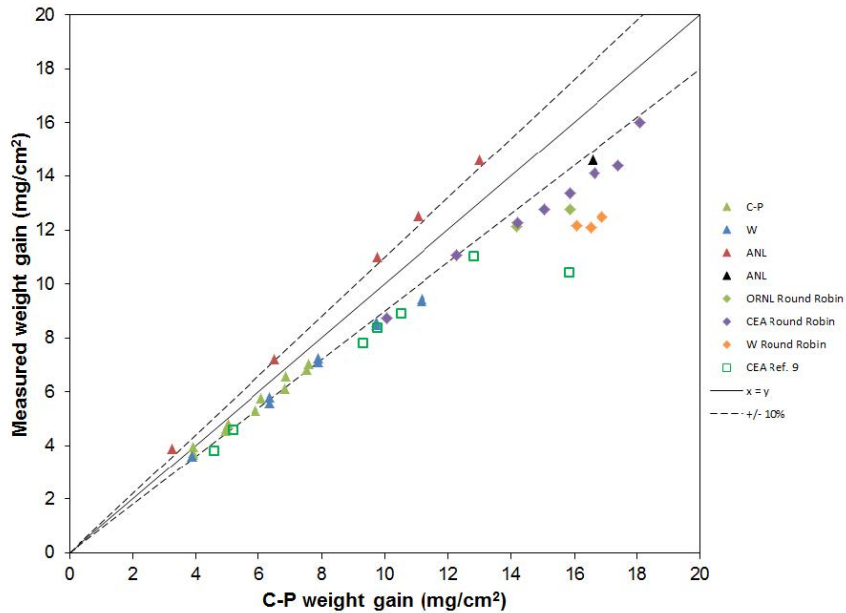
- Proposed breakaway corrosion testing and reporting is a disproportionate requirement to underlying phenomenon and the testing protocol is overly specific.
- Many cladding alloys including Zircaloy-4 and ZIRLO cladding do not follow $\pm 10\%$ of CP at 1,000°C at 2,000 sec and will not conform to DG-1261 assumptions.
- Doing breakaway in the range above 1,000°C can result in exceeding the ECR limit prior to the onset of breakaway.

Issues Observed with DG-1261 breakaway testing. (Cont'd)

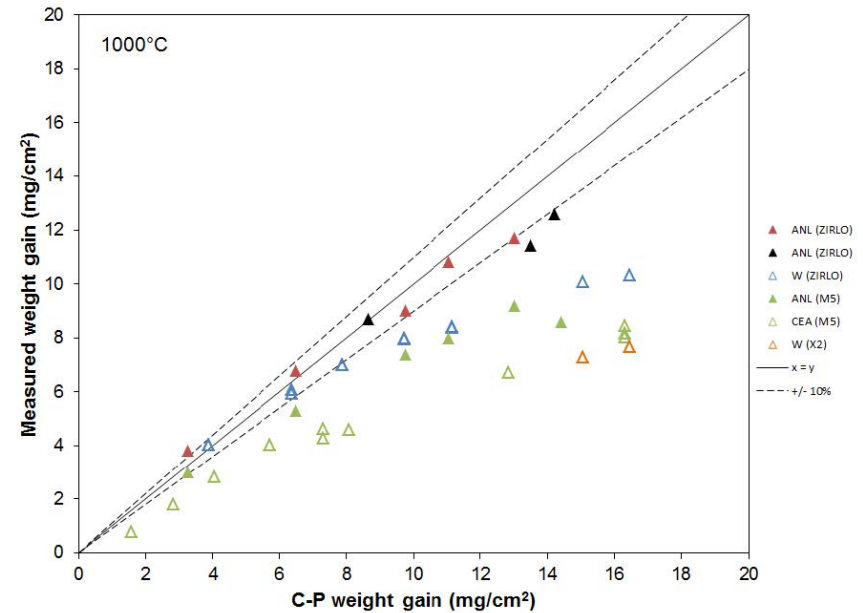
- The requirement that when using Grade A water that the O content be < 45 ppb appears to be taken from autoclave testing requirements in ASTM G2 which requires the use of Grade A water. The water is then deaerated to < 45 ppb O by steaming the autoclave. The regulatory guide provides no basis or rationale for imposing this requirement on the feed water supply.
- The tolerance of the design basis scratch of $\pm 5 \mu\text{m}$ is unrealistic when using a process which replicates the scratching due to spacer grids.

CP measured vs predicted weight gain

Zircaloy-4 Data



ZIRLO, M5 and X2 Data



Recommendations for DG-1261 - Breakaway

- Testing to determine the minimum time to breakaway in the temperature range above 1,000°C should not extend beyond the time where the weight gain exceeds the allowable ECR (18%).
- The tolerance on the scratch depth should be removed. A process which replicates scratching cannot meet the tolerance proposed.
- The requirement to demonstrate that weight gain is within $\pm 10\%$ of the CP prediction at 1,000 °C should be removed. Normal thermocouple calibration procedures should be sufficient.
- The requirement to use Grade A feed water with < 45 ppb O content should be changed to only require Grade A water.

Conclusion and summary on DG-1261

- Proposed breakaway corrosion testing and reporting is a disproportionate requirement to underlying phenomenon.
- The recommendations that Westinghouse has supplied for changes in the Draft Reg Guide are aimed at providing a practical means of demonstrating compliance and are based on extensive testing experience.

Questions