

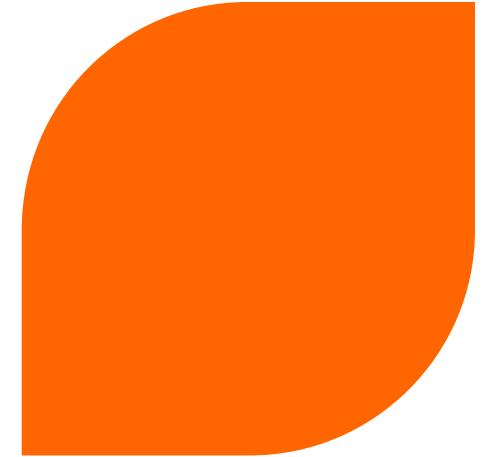


Additional Considerations:

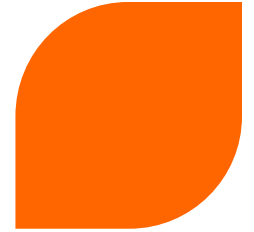
Application of Proposed PQD Criteria

Appendix K

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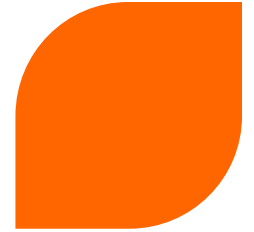


Applicability of DG-1263 Post Quench Ductility Criteria



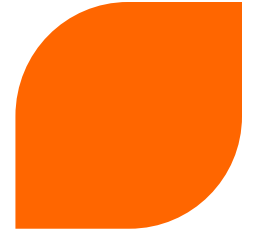
- ▶ **Draft Regulatory Guide (DG)-1263, Figure 2:**
 - ◆ Presents an acceptable analytical limit based on the defined ductile-to-brittle threshold
 - ◆ Acceptable for the zirconium-alloy cladding materials tested in the NRC's LOCA research program (Zr-2, Zr-4, ZIRLO, and M5)
- ▶ **Regulatory Position:**
 - ◆ Demonstrate comparable behavior of cladding alloys not tested in the NRC's LOCA research program, with the database established in the NRC's LOCA research program, in order to apply the limit defined in Figure 2 of this regulatory guide.
- ▶ **Irradiated testing requirements would discourage development of improved alloys**

Applicability of DG-1263 Post Quench Ductility Criteria



- ▶ **The range of alloying elements and concentrations used in developing Figure 2 is relatively wide**
- ▶ **The embrittlement process is well understood**
 - ◆ **The cladding is annealed early in LOCA**
 - ◆ **Hydrogen increases oxygen diffusivity through zirconium**
 - ◆ **Hydrogen increases oxygen solubility in zirconium at high temperature**
- ▶ **Some pre-hydrated testing is appropriate for new lightly alloyed zirconium claddings, however**
- ▶ **Irradiation effects should not be tested for zirconium alloys with alloying elements belonging to tested alloys in Figure 2 of DG-1263**

Appendix K



- ▶ **The deterministic analytical requirements of Appendix K do not belong in a rule:**
 - ◆ Does not fit with the concept of a performance based rule
 - ◆ Alternative best estimate approach is in a regulatory guide
- ▶ **Some of the requirements of Appendix K were establish based on the Large Break LOCA scenario and are not well suited to Small Break LOCA analysis**
- ▶ **Consider allowing Cathcart-Pawel for oxidation and energy generation. No large change in heat generation and direct correspondence to PQD criteria**
- ▶ **Moving the technical requirements of Appendix K to a Regulatory Guide and removing the reporting requirements would be appropriate for the new rule**
 - ◆ Upgrades would be easier to implement