Non-LOCA Release Fractions Feedback

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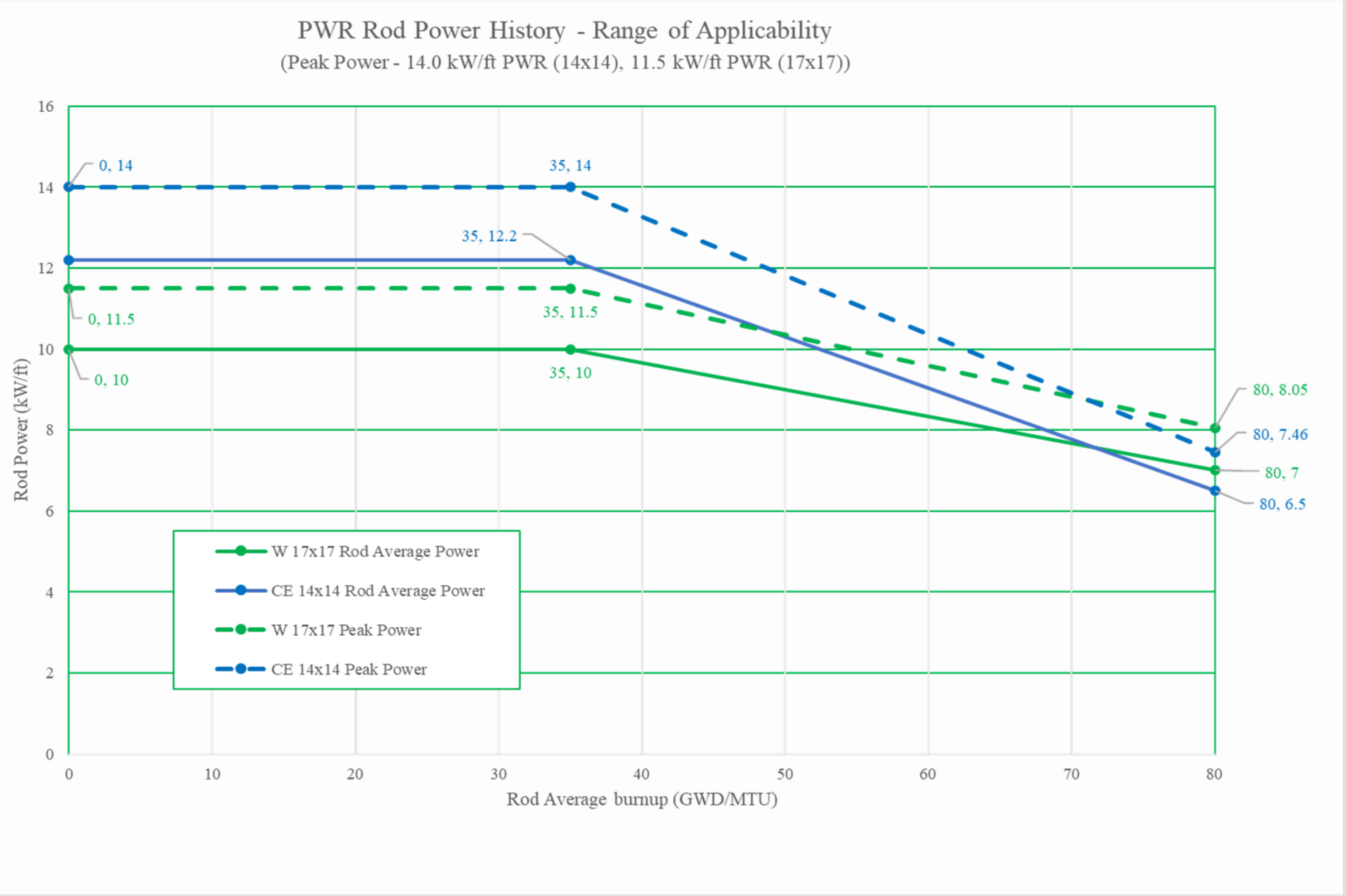
Feedback on Non-LOCA Release Fractions - Proposed PWR Non-LOCA Power Envelope



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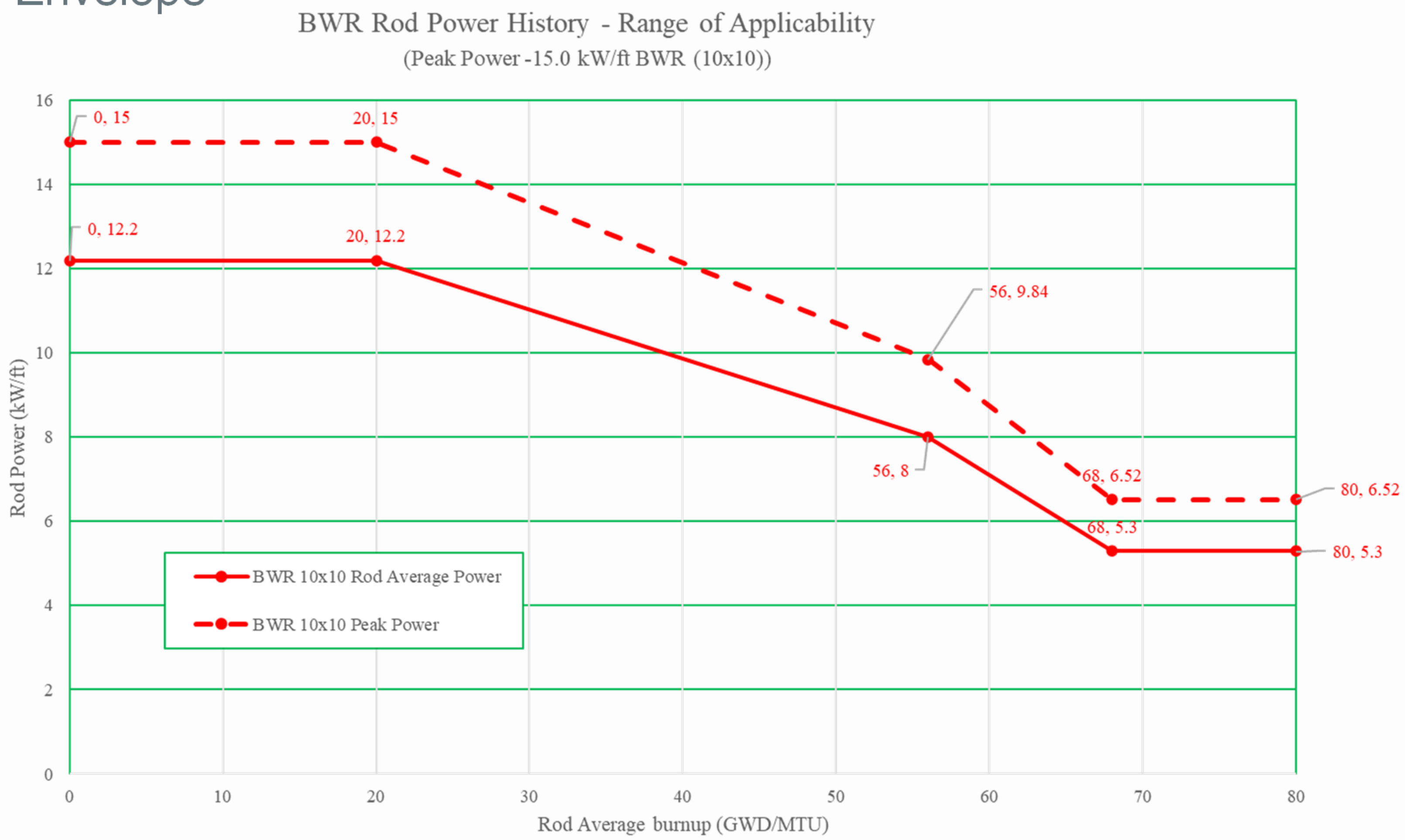

Proposed changes to Section C, RG 1.183 R1

- Modify Section C (page 9 RG 1.183 R1) to allow 10wt% U-235 and 80 GWd/MTU
  - The three IFA experiments used as the basis in NUREG/CR-7003 had enrichments of 7, 8 and 10wt% U-235
  - Enrichment by itself does not influence the isotopics / gap release

- Modify the second paragraph in Section C (page 9 RG 1.183 R1) using more generic verbiage such as, “for currently approved fuels,” since multiple vendors have NRC approved variations of UO2 fuel dopants (e.g., GNF’s aluminosilicate and WEC’s ADOPT) and that this would be addressed explicitly when new fuel products are licensed
  - There is nothing in the basis experiments that involves the testing of Cr-doped fuel
  - Also, the applicability of the RG explicitly includes chromium-coated cladding and chromia-doped fuel when discussing MHA LOCA models in the second paragraph but does not repeat this inclusion in the discussion on non-LOCA models in the third paragraph
  - This becomes a PWR coating only statement leaving coated claddings for BWRs outside of the RG applicability
  - Note, if incorporated, this change in verbiage would also be needed in the first paragraph on Page 20 of RG 1.183 R1.

- Modify the third paragraph in Section C (page 9 RG 1.183 R1) to provide the flexibility to use Appendix I in cases where peak exposures, powers or enrichments go outside of the applicability of Figure 1

Proposed changes to Section C, RG 1.183 R1

Examples of Section C modifications:

- This RG applies to MHA LOCA models for applicants and licensees ~~using zirconium-alloy cladded~~ ~~uranium dioxide (UO2) fuel rod designs~~ with reactor core burnups up to a maximum rod-average of ~~68~~80 gigawatt-days per metric ton uranium (GWd/MTU) (and fuel enrichments up to ~~8~~10 weight-percent uranium-235) for currently approved (as of the issuance of this RG) fuel and cladding materials, examples of which includes coated zirconium alloy claddings and doped fuels. ~~including chromium-coated cladding (thicknesses less than 50 microns (μm)) and chromia-doped (up to 0.16 weight-percent) fuel~~. It is not applicable for other fuel-clad combinations, including fuel with iron-chromium-aluminum (FeCrAl) alloy cladding.

- This RG applies to non-LOCA models for applicants and licensees with reactor core burnups up to a maximum rod-average burnup of ~~68~~80 GWd/MTU (and fuel enrichments up to ~~8~~10 weight-percent uranium-235) for currently approved (as of the issuance of this RG) zirconium-alloy cladded UO2 fuel rod designs at power levels below the burnup-dependent power envelopes depicted in figure 1 of this guide. For rod designs outside of these limits, Appendix I provides an acceptable analytical technique to calculating maximum steady-state release fractions.

Proposed changes to Appendix I, RG 1.183 R1

- Second paragraph in Appendix I discusses "…The analytical technique described in this appendix specifies the use of fuel rod power profiles based on core operating limits or limiting fuel rod power histories. In addition, this analytical technique produces a composite worst time-in-life (i.e., maximum gap fraction for each radioactive isotope). Therefore, the steady-state fission product gap inventories calculated using this analytical approach will be significantly larger than realistic fuel rod or core-average source terms. One means of capturing more realism in the calculation of the steady-state release fractions would be to calculate burnup-dependent release fractions for each radionuclide. The use of such means will be considered on a case-by-case basis."

The intent is to have the guidance acknowledge that more detailed, finite calculations are acceptable. The last sentence of the second paragraph states, "The use of such means will be considered on a case-by-case basis," and implies it is not acceptable and further justification is required.

- Recommendation:
  Replace the last sentence, "~~The use of such means will be considered on a case-by-case basis,"~~ with, "The resulting burnup-dependent source terms could then be used to calculate radiological consequences at different times in life."

Proposed changes to Appendix I, RG 1.183 R1

- Attribute I-3: High-confidence upper tolerance release fractions should be calculated using an NRC-approved fuel rod thermal-mechanical code, along with quantified model uncertainties.

The modification proposed below is because not all fuel vendor codes are licensed / apply uncertainties in the same way when showing compliance to steady-state criterion of fission gas release (for long-lived) or temperatures (for short-lived).

- Recommendation:
  ~~High-confidence upper tolerance r~~Release fractions should be calculated using an NRC-approved fuel rod thermal-mechanical code which has a NRC-approved methodology for calculating high-confidence stable fission gas release and fuel temperatures.~~, along with quantified model uncertainties~~.

Proposed changes to Appendix I, RG 1.183 R1

- Attribute I-3.1: For short-lived isotopes, the 2011 release model standard ANSI/ANS-5.4 recommends multiplying the best-estimate predictions by a factor of 5.0 to obtain upper tolerance release fractions.

1. The factor of 5.0 recommended in ANSI/ANS-5.4 is based on NUREG/CR-7003's calculations using FRAPCON and does not translate one to one to a fuel vendor's code and,
2. Whether or not we can use "best-estimate" values of fuel rod temperatures (calculated by using some bounding power history) which are then used to calculate the diffusion coefficient ($D_{i,m}$) that is used in the equation shown in I-2.1.2 and I-2.1.3

It should **not** be required to do both, i.e., applying a factor of 5 multiplier on an upper tolerance temperature prediction. The use of "best-estimate predictions" in the statement below refers to the use of Table I-1 which corresponds to the decay constants, alpha and fractal scaling factors; the temperatures used for calculating diffusion are separate.

- Recommendation:

  For short-lived isotopes, the 2011 release model standard ANSI/ANS-5.4 recommends multiplying the best-estimate predictions by a factor of 5.0 to obtain upper tolerance release fractions. When using an NRC approved fuel rod thermal-mechanical code which may produce different values for R/B of Kr85m, an alternative factor may be derived following the same procedure as described in Sections 4.4.1 and 4.4.2 of NUREG/CR-7003 with nominal predicted fuel rod temperatures.