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Comment On: NRC-2018-0066-0001
Dry Storage and Transportation of High Burnup Spent Nuclear Fuel

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Submitter Information

Name: Jeremy Renshaw
Address:
1300 West WT Harris Blvd
Charlotte, NC, 28262
Email: jrenshaw@epri.com

General Comment

Please see attached files for EPRI comment letter and the compiled list of comments on draft NUREG-2224.

Attachments

EPRI Comment Letter to NRC on NUREG-2224

EPRI Compiled Comment Form for NUREG-2224

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

September 24, 2018

Ms. May Ma
Office of Administration
Mail Stop: TWFN-7-A60M
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Submittal of Electric Power Research Institute (EPRI) Comments related to NRC Draft NUREG-2224, "Dry Storage and Transportation of High Burnup Spent Nuclear Fuel" (NRC Docket ID NRC-2018-0066)

Project Number: 689

Dear Ms. Ma,

The NRC recently published a Federal Register Notice (83 Fed. Reg. 39,476) in combination with the Draft version of NUREG-2224 and sought detailed comments related to the document as well as six fundamental questions.

The Electric Power Research Institute (EPRI) is pleased to provide the attached comments and information related to NRC's Draft NUREG-2224, "Dry Storage and Transportation of High Burnup Spent Nuclear Fuel" in support of NRC's desire to publish a document containing results and discussions related to R&D efforts to better understand the properties of used fuel cladding during periods of storage and transportation. The comments provided in the attached sheet are provided based on comments received from EPRI staff as well as other comments received from EPRI members.

Draft NUREG-2224 provides significant valuable information related to used fuel storage and transportation that largely confirms previous EPRI work in this technical area and results in similar conclusions, adding further credibility to the work of both institutions.

While this NUREG by and large achieves its stated goal of furthering the understanding of used fuel cladding properties during both storage and transportation, there are a number of areas that can be clarified or improved upon to fully meet these objectives. The purpose of EPRI's comments on this NUREG are aimed at further clarifying or identifying issues with the information contained in this Draft NUREG.

In order to be most efficient, comments have been filtered in two ways. First, duplicate comments have been combined into a single comment to reduce the overall effort of NRC staff to address comments and second, comments have been organized into two sets of comments: the first set is related to technical issues that have been identified and the second set is related

to minor comments such as grammar, formatting, and clarifications suggested to enhance the readability and clarity of the document. We hope that this will facilitate the NRC's review process for this document.

If you have any questions or comments related to this matter, please do not hesitate to contact me (704-595-2501).

Sincerely,

Jeremy Renshaw
Program Manager, Used Fuel and High-Level Waste
Electric Power Research Institute
704-595-2501

cc: Lisa Edwards, EPRI
Randy Stark, EPRI
Hatice Akkurt, EPRI
Shannon Chu, EPRI
Aladar Csontos, EPRI
Keith Waldrop, EPRI

Technical Issues Identified

NRC Page	Line Number	Person	Comment
1-1	25	Jeremy Renshaw	Per ISG-2, Rev. 2, the definition of retrievability was expanded to also include on a cask or canister basis. This new information needs to be reflected here and include all three options.
1-3	18	Jeremy Renshaw	EPRI Report NP-4524 states that “Breached PWR fuel rods will not split open from fuel oxidation during 100 years if the rod is not exposed to air until temperature drops below 230°C.” This report indicates a lower temperature, but provides no supporting reference or information.
1-7	18	Jeremy Renshaw	"infiltrates" is not an appropriate or objective word here. How about "is picked up by" or another word with a more neutral connotation
1-12	4	Jeremy Renshaw	Suggest that NRC include the latest set of rod puncture test data from ORNL and PNNL in this report. This would already add about another 10 data points to this graph.
1-13	1	Jeremy Renshaw	Haven't these modeled FRAPCON results in Figure 1-4 been demonstrated to be significantly higher than actual internal pressures for the IFBA rods? Suggest removing this figure and previous paragraph unless accurate data or modeling can be included (PNNL can supply this information to NRC).
1-18	20	Jeremy Renshaw	5 deg C/hour should not be considered "slow cooling." This is orders of magnitude faster than in dry storage. If anything, this should be considered rapid cooling. It is well known that annealing of the cladding can and does happen at elevated temperatures in zirconium alloys, but keeping temperatures at 400 deg C for 1-24 hours with subsequent rapid cooling (5 deg C/hr) does not allow for sufficient time at temperature for appreciable annealing to occur - that would occur if actual fuel rods in dry storage reached these temperatures.
2-3	5	Jeremy Renshaw	Riccardo Torres mentioned on the phone call that the burnups of these rods was in the 60 GWd/MTU range - this would be very important information to include in this report.
2-4	All	Jeremy Renshaw	This page contains lots of useful data, but it would be much more useful to recreate the graphs that are referred to, such that the reader can better understand that referenced data and conclusions

2-7	13	Jeremy Renshaw	This example is technically correct, but not applicable to the current situation since previous tests ignored the presence of the fuel (hence it would be like removing one of the two boards in the NRC example, not changing the arrangement or bonding between them). This does have a very significant effect on the overall flexural rigidity, so NRC is presenting a correct argument here, but in such a way that ignores the history of performing these calculations as if the fuel did not exist or provided zero structural support. Without this background information, this section does not seem to add value to the report. This section could be easily clarified to explain the impetus for performing such calculations in the context of the history of performing cladding-only material property testing.
2-12	11	Jeremy Renshaw	The table should include the information referred to in the previous paragraph (i.e. comparison of flexural rigidity) and include the two comparisons with extra rows (or transpose the table and add columns). This would make the paragraph and table more clear and useful. Similarly, the paragraph compares the EI2 cases with the numbers from the EI1 case. If this is applicable, then the bottom row of the current table should probably span the EI1 and EI2 region (not just one with a dash in the EI2 column insinuating no data).
2-12 to 2-13	15-22 and 1-7	Jeremy Renshaw	This methodology is not at all risk-informed. Instead, it continues the archaic practice of building conservatism upon conservatism to the point of the actual data having little to no relationship to the regulatory numbers used.
2-23	32	Jeremy Renshaw	Based on a previous comment, the 100 MPa number will need to be corrected based on the improved accuracy rod internal pressure information
5-1 and 5-2	All	Jeremy Renshaw	The conclusions section is somewhat vague in nature and could use some work to more clearly state the conclusions. It is possible to catch them after reading the entire report and conclusions sections carefully, but absent that, the conclusions section is too vague and doesn't provide a clear path forward on how to use the information in this report.
1-1	25	Waldrop	Clarify in the last sentence of this paragraph that the condition of the cladding may play a role in meeting the retrievability requirement. As written it just says the cladding condition may impact the safety analysis, but the point here was related to retrievability.
1-2	26	Waldrop	Suggest adding rod void (plenum) volume to the list of factors affecting RIP
1-2	29	Waldrop	Clarify this sentence. It's not clear what you are referring to by "it" (2nd word line 29). Do you mean it is critical to control the PCT to within values that preserve cladding integrity, or do you mean the avg gas temperature within the rods (i.e. "it") is critical to controlling the PCT?
1-3	30	Waldrop	Should you delete "and transportation"? ISG-11 Rev 3 is not applicable to transportation.

1-4	10	Waldrop	Suggest changing “results from the fission and decay gases released to the gap between the fuel and cladding” to “results primarily from the rod pre-pressure with some small contribution from the fission and decay gases released to the gap between the fuel and cladding”. Fission gas release contributes very little to the EOL RIP.
1-4	24-25	Waldrop	As written it sounds like the gas temperature is increasing because the volume increased. The volume change would not change the temperature, but the pressure.
1-7	36-37	Waldrop	Comment – While determining a threshold temperature and hoop stress for hydride reorientation may be difficult, research is ongoing to understand hydride reorientation. From this research a better metric for ensuring HRO will not impact cladding performance can be determined. It may be found that for even a higher PCT than 400 C, HRO will not occur due to being below a threshold hoop stress for HRO.
1-10	37-40	Waldrop	RXA claddings are more susceptible to HRO due to a larger fraction of grain boundaries in the radial direction. However RXA claddings have lower hydrogen content making the HRO less impactful.
1-11	12	Waldrop	You say pressure increases due to increase in fission gases, but fission gas release contributes little to EOL RIP.
1-12	4	Waldrop	An observation – The Oconee-1 data in Figure 1-3 gives a wide range of RIP for a very small range of burnup. Not very conducive to developing a Bu vs. RIP correlation.
1-13	1	Waldrop	There is a problem with the IFBA data in Fig 1-4.
1-14	12-14	Waldrop	There is a problem with the IFBA data in Fig 1-4 which would explain the discrepancy you are seeing.
1-25	17	Waldrop	You say that there is no gap, however this is not the case for all rods, and even in HBU rods the ends would likely not have pellet-cladding bonding with no gap. However, there would be some pellet swelling which would reduce the original gap and this would leave minimal deflection of the cladding in the pinch loading mode before the pellet began to provide significant resistance.
2-13	24-26	Waldrop	Pg 2-13, a safety factor of 1.4 is developed to account for hydride reorientation. This factor is further reduced to 1.25 to account for additional uncertainty. Then this is effectively reduced to a factor of 1.0 by suggesting to use cladding only properties and not allow any credit for the flexural rigidity provided by the cladding-fuel system which was clearly demonstrated by the CIRFT testing. I understand some reduction is prudent due to the limited data and the lack of data on all cladding types at this time, but to completely ignore any rigidity provided by the pellet is extremely conservative, unnecessary and not risk informed.

2-14	12-13	Waldrop	The option to use cladding only properties with a factor to account for the flexural rigidity should be the primary option. The first alternative to use cladding only properties (pg 2-13, line 32) is extremely conservative as it totally ignores the rigidity provided by the fuel. The 1.25 factor suggested for Zr-4 seems reasonable – a roughly 10% reduction in the value determined to allow for other uncertainties. Also, the factors that will be developed for Zirlo and M5 from the HBU sister rod testing should employ a similar method to determine a factor for these materials.
2-17	9-11	Waldrop	The intent of this paragraph seems to be that a bounding hoop stress of 140 MPa is a good bounding number. It also says the future testing (from HBU demo sister rods) will hopefully confirm this for Zirlo and M5. However, the determination of 140 MPa as a bounding hoop stress is based on erroneous RIP data for IFBA, so we should look at lowering this 140 MPa bounding number based on correct RIP data from acutal fuel rods.
2-18	10	Waldrop	Fuel density of 0.34 lb/cu.in. is low. Is this because this has been reduced to account for dish and chamfer? If so, is that appropriate?
2-18	20	Waldrop	BWR 7 x 7 rods seems to be a typo. Shouldn't this be 15 x 15 PWR for the HB Robinson rods?
2-21	6-8	Waldrop	The equivalent strain is reduced by 90% to account for uncertainty and the influence of higher test temperature. Samples are normally tested at room temperature, which I thought was conservative. Applying a conservative factor to account for a higher temperature is not necessary if room temperature testing is conservative.
2-23	29	Waldrop	This sentence says the fatigue test results cannot be applied to thermal fatigue in storage. Thermal fatigue is not an issue for storage, is it? Suggest adding a clarifying statement to that effect.
2-23	32	Waldrop	As written the 100 MPa hoop stress is a nominal value based on the use of "on the order of." 100 MPa is very high based on RIP of typical HBU rods. Suggest a lower value more representative of a nominal value.
2-24	11-12	Waldrop	This concludes that seismic events aren't expected to compromise the fuel. However, in the linear damage rule for cumulative damage, should any impact from seismic be included in the cumulative damage, or is seismic damage so small it is negligible compared to other damage. If so, a statement could be added to clarify that point.
3-4	19-20	Waldrop	Good qualifier about the design basis. Allows use of the revised ISG-2
3-6	7-9	Waldrop	Suggest changing "This numerical factor is obtained…" to "This numerical factor can be obtained…" Use of "is" implies a requirement. Use of "can be" allows flexibility for another method to determine this factor. Understood that another method would need to be qualified.

3-6	7-9	Waldrop	Suggest deleting the sentence beginning “However”. As written it is prescribing when to use the second alternative. Deleting the sentence would allow an applicant to use this second alternative as the primary approach if desired.
3-7	6	Waldrop	Suggest deleting “per ANSI N14.5 (2014)”. I do not believe all systems are fully meet N14.5 and deleting this does not lose the meaning conveyed.
3-7	8	Waldrop	Might want to use an alternative to “leaktight” as some systems may not fully meet the ANSI N14.5 leaktight definition.
3-7	23	Waldrop	Suggest deleting “per ANSI N14.5 (2014)”. I do not believe all systems are fully meet N14.5 and deleting this does not lose the meaning conveyed.
3-7		Waldrop	Section 3.2.1 discusses leaktight for storage. For storage, most welded canister based systems are designed and tested to be leaktight, and NUREG-2224 suggests that dose calculations for release are not needed if the storage system remains leaktight. That is rather straightforward for a storage canister inside an overpack.
3-9	42-43	Waldrop	The release fraction of 3E-5 was developed for transportation accident scenarios. I could see applying that same factor to storage for accident conditions of a tipover, but a smaller value is justified for fire and off-normal conditions, and even less for normal conditions. It does not make sense to use the same release fraction developed from a transportation drop accident as for normal conditions of storage.
3-10	32	Waldrop	Some of the international work on release fractions is already publicly available. e.g. Rondinelli presented some results at IHLRWM in 2017.
3-13	25-30	Waldrop	This paragraph as written suggest no renewals are possible until data from the HBU demo is available, yet several licenses were renewed before the cask was even loaded. This is because learning aging management allowed renewals based on the fact the data would be available when needed.
3-13	31	Waldrop	Paragraph beginning on line 31 is not very clear. The point should be that if the confinement boundary is maintained, then supplemental safety analyses for reconfiguration are not necessary.
3-14	5-6	Waldrop	#1 suggests that release of fission gases into the canister will impact the heat transfer. Given the relatively small volume in comparison, I would think this would be negligible, especially since much of the rod fill gas is also helium. For lower pressure systems not relying on convection, it does not take much helium to get the full effect of heat removal. For convection based systems, the amount of fission gas would be very small compared to the overpressure of helium in these systems.

3-14	22-23	Waldrop	As written, this sounds like the rod fill gas release will cause a rise in temperature. I think you mean a release of fission gas inside the canister may have an effect on heat transfer, which could change the peak component temperatures. Suggest clarifying.
3-15	39	Waldrop	There seem to be some missing words at the end of line 39. Suggest "…shows that reactivity increases for longer decay times … *and the application* would need to use …"
3-16	6	Waldrop	Normal conditions of storage assume 1% fuel failure. The 3% is a typo. Line 32 on this page references 1% for normal conditions of storage.
3-17	19	Waldrop	Suggest adding "…using insights from NUREG/CR-7203 for reconfigured geometry" at the end of this sentence for additional clarity and direction.
3-17	41	Waldrop	Normal conditions of storage assume 1% fuel failure. The 3% is a typo.
3-18	9	Waldrop	Suggest changing to "dose far away from the cask and therefore …" for clarity
3-19	4	Waldrop	Scenario 2 is no cladding failure, so it does not seem to belong here.
4-6	3	Waldrop	Suggest changing "This numerical factor is obtained…" to "This numerical factor can be obtained…" Use of "is" implies a requirement. Use of "can be" allows flexibility for another method to determine this factor. Understood that another method would need to be qualified.
4-6	5-6	Waldrop	Suggest deleting the sentence beginning "However". As written it is prescribing when to use the second alternative. Deleting the sentence would allow an applicant to use this second alternative as the primary approach if desired.
4-8	27	Waldrop	Suggest adding "If the release fractions in Table 4-1 are not used …" to provide clarity. A justification would not be needed if using the values in Table 4-1.
4-11	17	Waldrop	Some of the international work on release fractions is already publicly available. e.g. Rondinelli presented some results at IHLRWM in 2017.
4-14	2	Waldrop	What data from the HBU demo are you referring to that is needed before shipment of fuel stored 20 years? The initial data from loading will be available, but the data from opening the cask will not be available until about 2027.
4-14	4	Waldrop	Change "confinement" to "containment" for transportation
4-7		Waldrop	Section 4.2.1 discusses leaktight containment for transportation. For transportation, you typically have a transport overpack with a bolted lid that will not be leaktight, but inside the non-leaktight transport overpack, you have a leaktight canister. Section 4.2.1 should be expanded to include a leaktight canister inside a non-leaktight transport overpack. Similar to the storage condition, if the canister inside the transport overpack remains leaktight, one should not need to perform dose calculations for releases, even though the transport overpack may not be leaktight. If the canister remained leaktight, there would be no material available for release.

4-19	5	Waldrop	The ORNL data assumed 10, 25 and 11 percent rod failure, but NCT is only 3% failure.
5-1	36	Waldrop	Include tipover in addition to drop accident scenarios
3-8	2	Shannon Chu	The language above Table 3-1 and Table 4-1 of NUREG-2224 which indicates "If the release fractions are not used, justification of the proposed release fractions of the source terms is expected to include an adequate description of burnup for the test specimen, number of tests, collection method for quantification of respirable release fractions, test specimen pressure at the time of fracture, and source collection system (sophisticated enough to gather the bounding respirable release fractions)." Appears to be more restrictive than the related language in NUREG-1536R1 which indicates "Other release fractions may be used in the analysis provided the applicant properly justifies the basis for their usage." Can the language be changed to be more consistent with NUREG-1536R1?
4-8	27	Shannon Chu	The disclaimers here and on Line 2 of Page 3-8 appear to be the only place where respirable fraction is mentioned in NUREG-2224. NUREG-1536R1 does not discuss respirable fraction, which implies that particle size and respirable fraction may not be accounted for in the release fractions provided. Please clarify whether it is acceptable for a user to apply a respirable fraction (with appropriate justification) to the release fractions in Table 5-2 of NUREG-1536R1 and/or the release fractions in Tables 3-1 and Table 4-1 of NUREG-2224 for analyses of inhalation dose. In NUREG/CR-6672 there are much lower values presented for a parameter identified as a "rod to cask release fraction for respirable fuel fines".
1-4	24-25	Albert Machiels	Delete the sentence on line 24 and continuing on line 25. (Note: Given the low amount of energy released by decay heat, the average gas temperature will increase by an infinitesimal amount).
1-7 to 1-8		Albert Machiels	Section 1.5 Hydride Reorientation is not very robust and a bit too simple. There is no distinction between CWSR and RXA cladding microstructures; this preferably needs to be improved for technical credibility purposes.
1-7 to 1-8		Albert Machiels	Finally, there is no mention of the impact of some fuel designs, which is a major topic for BWR claddings (but not for PWR claddings, at least in the USA).
1-11	2-14	Albert Machiels	Section 1.5.3 is weak for the following reason: There is no mention of the impact of an inner liner, which is present in most of the BWR rods; this should be a part of the discussion in the first paragraph of Section 1.5.3. (See attached ESCP presentation dated May 4, 2015) (see similar comment above).

1-13	1	Albert Machiels	Section 1.5.3 is weak for the following reason: The inclusion of Figure 1-4. The work behind this figure is flawed. The NRC was aware of it, as indicated on Lines 12-14, but still chose to include the figure in the draft document
1-11 to 1-18		Albert Machiels	The draft NUREG has a weak (faulty) section (Section 1.5.3 End-of-Life Rod Internal Pressures and Cladding Hoop Stresses), which heavily relies on a faulty DOE study. The NRC is aware of it. What they plan to do about it is less clear.
1-21		Albert Machiels	Data on M5 obtained at ANL are not really applicable to hypothetical dry storage conditions starting from 400 °C. This was addressed in an NFIR presentation (attached), in which the NRC did not participate, but Mike Billone is aware of my objections.
1-26	3	Albert Machiels	"... pellet imparts structural support ..." This is a conclusion that EPRI published in Report 1009929. The NRC should reference EPRI's prior work in this area to validate its position in this report.
General		Glenn Schwartz	What will the NRC expect of CoC holders and licensees once this NUREG is published with regards to implementation for HBU fuel currently residing in operating DCSSs, future CoC amendments, CoC renewal applications?
General		Glenn Schwartz	In term of application of the approach presented, it would be helpful to include a basic flowchart covering all the major actions and decision points.
1-1	22	Glenn Schwartz	With regard to ISG-2, Rev.2 the tie to this NUREG is when ready retrieval is demonstrated on an assembly basis (ISG-2 Option A). If an applicant can demonstrate ready retrieval via ISG -2 Options B or C (canister or cask basis), then is there a need to follow this entire NUREG?
1-25	29	Glenn Schwartz	There are a number of sections that refer to expectations from the HBU fuel rod testing (in this section noting DOE plans to perform tests). With the testing currently underway, it seems that it would be better to hold off publication of this NUREG until this testing is completed.
2-13	27	Glenn Schwartz	Same comment as above for the results of the CIRFT testing.
3-5	5	Glenn Schwartz	Based on the approach for drop accidents provided, what is stated to be two alternatives appears to be more a series (must go through cladding only approach before pellet contribution approach). Based on the discussion on Page 1-25, since the cladding only properties (RCT experiments) are overly conservative and not representative of actual fuel stress conditions during transportation and drop accidents, it is not clear why the Figure 3-2 needs to be considered.
3-7	26	Glenn Schwartz	With regards to non-leaktight confinement, the expectation is to use fixed fuel failure rates (and bounding release fractions in Table 3-1) in the event an applicant cannot provide and justify

			other values (normal, off-normal, accident). Do the fixed/bounding values take into account the better cladding properties described in the prior report sections?
3-11	39	Glenn Schwartz	It is not clear what are the expected industry actions from the statement, "the staff considers it prudent to gather and review evidence that HBU fuel in dry storage beyond 20 years has maintained its analyzed condition", how this would be accomplished and at what schedule. The sentence also redundantly states "gathered and reviewed".
3-12	18	Glenn Schwartz	While this supplemental safety analysis section is considered an alternate approach, does this section imply that is it required to be performed until the completion of the HBU demo program?
3-19	25	Glenn Schwartz	During the 9/06/2018 public meeting, there was clearly confusion with regards for canning of fuel. The report should clearly specify that canning would be performed during the transfer from SFP to dry storage, based on fuel condition known at that time. It is unlikely that once loaded and placed into operation that these systems will need to be opened and fuel assemblies residing in the DCSS will need to be inspected and subsequently canned.
4-8	24	Glenn Schwartz	For non-leaktight containments, fuel release fractions for normal conditions of transport and accident are based on open literature search. Is this too conservative relative to the noted cladding properties covered in prior sections?
4-13	6	Glenn Schwartz	It is not apparent how the postulated fuel reconfigure scenarios are applicable to HBU fuel.
1-2	7	R. Ridder	Add the words "storage and transport" before "operations"
1-4	22	R. Ridder	Replace the word "fabrication" with "design"
1-6	Zr-4 Figure	R. Ridder	Same 640 wppm value is given for both average and inner 2/3 of cladding
1-19	19, 24	R. Ridder	What is meant by the term "figure of merit"? Is there a more common term?
1-20	21	R. Ridder	Why are we limited to 10 thermal cycles if results suggest no effect on radial hydrides from multiple cycles?
1-24	25-30	R. Ridder	What are the criteria that must be assumed in an analysis showing hypothetical reconfiguration?
2-15	35	R. Ridder	Why are 5 thermal cycles applied if SNF does not experience these cycles?
2-23	23	R. Ridder	Daily, and especially seasonal, fluctuations in temperature will be very slow and should not be considered a fluctuating or "cyclic" load
3-1	30-35	R. Ridder	What hypothetical mechanism is driving the reconfiguration of HBU fuel in storage, and what criteria must be used to determine what, if any, reconfiguration has taken place?

3-4	4	R. Ridder	"bowing that significantly opens up the lattice spacing" is too vague. What makes fuel with bowed rods Damaged?
3-4	7, 26	R. Ridder	"Missing rods" – lines 7 and 26 contradict each other
3-15	3-7	R. Ridder	If there is no significant impact, why might a thermal analysis be required?
3-17	41	R. Ridder	Why is 3% failed fuel used in lieu of 1%?
4-1	28	R. Ridder	Same comment on reconfiguration.
4-4	7, 24	R. Ridder	"Missing rods" – lines 7 and 24 contradict each other
4-4	5-6	R. Ridder	"bowing that significantly opens up the lattice spacing" is too vague. What makes fuel with bowed rods Damaged?
4-8	13	R. Ridder	What is the basis for the 3% failures under NCT?
4-12	29-31	R. Ridder	How is evidence of fuel condition beyond 20 years in storage supposed to be acquired? (the Demo storage duration is only 10 years).
4-12	44	R. Ridder	"hypothetical reconfiguration…into justified geometric forms" is too open-ended.

Grammar/Formatting/Clarification Issues

NRC Page	Line Number	Person	Comment
1-5	1	Jeremy Renshaw	Is this phrase intended to reference the EPRI-DOE HBU demo?
1-7	2	Jeremy Renshaw	Typo: Should be "These data include" … not "includes"
1-12	1-3	Jeremy Renshaw	This paragraph could easily be misread by a member of the public and recommend it be changed/clarified that the last sentence is eventually referring to Figure 1-5 and not M5 data - this is mainly an issue of the order of presenting information. The previous paragraph talks about rod internal pressures, then this one talks about M5 data and then goes back to discussing the figure with no transition or clarification, causing confusion on what is intended here.
2-9	23	Jeremy Renshaw	Minor grammar error: "Use" should be "Using" or should be deleted
2-10	6	Jeremy Renshaw	The labels in Figure 2-8 are not very clear at first glance for EI1, A, EI2, and B. NRC should include lines between the labels and the points on the graph referred to for clarity for Points A and B.
2-24	10	Jeremy Renshaw	Minor spelling error: "leve" should be "level"
3-5	12	Jeremy Renshaw	Minor spelling error: "becritical" should be two words
3-18	29	Jeremy Renshaw	Minor grammar error: "models is" should be "model is"
Many	Many	Jeremy Renshaw	Significant portions of this report are repeated in other sections. This would be more effectively managed by referring to the original section when the information is presented versus repeating all of the information.
4-14	17	Jeremy Renshaw	"orundamaged" should be "or undamaged" - side note: many other instances of extra spaces between words, extra commas [two in a row], spelling, or grammatical errors were identified, but not included herein - recommend a more thorough scrub by the NRC staff to result in a high-quality and easily readable report

iii	3	Waldrop	Editorial – Change “Performance” to “properties” or rephrase sentence. Overall we are interested in the performance of the cladding, but it is the time dependent change of the properties that affect the performance.
All		Waldrop	Overall there appear to be a lot of issues converting the Word file to PDF which created many extra spaces and missing spaces between words.
1-1	5	Waldrop	Delete comma and extra spaces at beginning of sentence
1-1	18	Waldrop	Change “dependent of” to “dependent on”
1-1	24	Waldrop	Change period to a comma after reference NRC 2016a
1-1	24	Waldrop	Add space between “demonstrated” and “on”
1-1	39	Waldrop	Missing a close parentheses after “(10 CFR 71.55(e)”
1-9	7	Waldrop	Correct “Corresponding Temperatures *on* the…”
2-4	3-4	Waldrop	Editorial – Change “calculate” to “calculated” line 3 and line 4
2-12	2	Waldrop	Editorial – “(.e.” should be “(i.e.”
2-23	14	Waldrop	Editorial – Two periods. Delete one.
3-1	10	Waldrop	Editorial – “high-level”
3-1	23	Waldrop	Editorial – double space before “and”
3-5	12	Waldrop	Editorial – Add space between “be” and “critical”
3-17	15	Waldrop	Editorial – delete the opening parentheses after NUREG/CR-7203
3-18	18	Waldrop	Editorial – add space between “HBU” and “failure”
3-18	29	Waldrop	Editorial – Change models to model, or is to are
3-18	31	Waldrop	Suggest changing “individual storage” to “individual DSS” or “individual storage system”
3-19	4	Waldrop	Change “on” to “at”
4-3		Waldrop	Footnote symbol for “Safety Analyses” should be the double plus, not an asterisk
4-4	14	Waldrop	Editorial – Delete the colon in the middle of the sentence
4-6	5-6	Waldrop	Delete last part of sentence “can be found in are described in”
4-11	4	Waldrop	Editorial – Change “Chapter” to “Section” to be consistent in terminology
4-14	17	Waldrop	Editorial – Add space between “or” and “undamaged”
4-15	10	Waldrop	Editorial – delete one comma
4-18	27-28	Waldrop	Editorial – Should be “Tables 9-12”
4-18	41	Waldrop	Editorial – Delete “due to” after 71.47(b)

1-3	18	Albert Machiels	A reference is needed for the "later research"
1-4	9-10	Albert Machiels	Delete "which" on line 9 and line 10 entirely. (Note: the rod internal pressure depends mostly on He pre-pressurization levels and internal void volume reduction, at least for PWRs for which the interest is greater).
1-7	26	Albert Machiels	Replace "and" by "or" at the end of the line.
5-1	16-17	Albert Machiels	Same comment as for page 1-26, Line 3
1-1	5	Matt Keene	End of line, “,” before word “Further”
1-24	29	Matt Keene	“regulations,then” missing space after comma
3-11	Section 3.2.4.1	Matt Keene	Should probably read more similar to 4.2.4.1 (page 4-12)
3-15	17	Matt Keene	“This study,” should probably delete comma.
3-17	15	Matt Keene	“NUREG/CR-7203 (“ did not see corresponding close parenthesis “)”
3-18	18	Matt Keene	“HBFfailure” missing space. Should be “HBF failure”