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Sent: Friday, June 15, 2012 6:10 PM
To: Jacobs, Christian
Cc: Waldrop, Keith; King, Christine; Machiels, Albert; Rubenstone, James
Subject: EPRI comments on NRC's draft extended storage and transportation R&D gap prioritization report
Attachments: EPRI comments on the NRC extended storage RD gap prioritization May 2012 draft report - final sent to NRC.pdf

Dear Christian:

EPRI is pleased to provide the attached comments on the draft NRC report. If you or other NRC staff wish to discuss our comments in more detail, I am available at the coordinates below.

Thank you for the opportunity to provide comments.

Sincerely,

John Kessler

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Christian Jacobs, Project Manager
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Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: EPRI comments on the NRC draft report "Identification and Prioritization of the Technical Information Needs Affecting Potential Regulation of Extended Storage and Transportation of Spent Nuclear Fuel" dated May 2012

Dear Mr. Jacobs:

EPRI is pleased to have the opportunity to provide comments on the subject NRC document.

Of primary concern to EPRI is the major difference in NRC's R&D needs ranking criteria compared to those used in other extended storage R&D gap assessments. Regarding NRC's "low priority" ranking criterion, NRC states: "A low priority ranking by staff only indicates that enough information is available *for regulatory considerations*" [emphasis added]. For example, additional R&D on high burnup cladding hydride reorientation and ductile-to-brittle transition temperatures is not on NRC's high priority list.

Hence, EPRI requests the following:

- NRC should provide additional clarification on what NRC's prioritization based on "regulatory considerations" means. At present, EPRI is assuming NRC simply means NRC does not have sufficient information to determine if a particular degradation mechanism is active enough to warrant consideration in regulatory actions – *not* that the degradation mechanism is of actual importance to the long-term behavior of the systems, structures, and components (SSCs). If EPRI's assumption of NRC's meaning is correct, then NRC's prioritization exercise is significantly different than those prioritization exercises preceding it. It is imperative, therefore, that users of the final report be keenly aware of this significant difference in prioritization criteria.
- EPRI also requests NRC review the draft report to assure the current prioritizations are restricted to consideration of the sufficiency of information simply to determine if a particular degradation mechanism is active enough to warrant regulatory consideration in future licensing actions. There seem to be instances where NRC's prioritization considers other factors, such as the ability to monitor and mitigate particular degradation mechanisms[1] . If NRC means to

[1] From page 3-6 of the draft report: "The overall assessment is also influenced by the potential ability to monitor or inspect the dry storage system and components while in service, with minimal intrusion or manipulation."

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> include these considerations, EPRI therefore infers the following: if the ability to monitor or mitigate a particular degradation mechanism is available, then NRC would not include such degradation mechanisms in its consideration of future licensing requests.[2]

Additional EPRI's comments are found in the attachment to this letter.

I would be happy to clarify these comments or provide additional information. I can be reached by e-mail (jkessler@epri.com) or phone (704-595-2737).

Sincerely,

John H. Kessler
Manager, Used Fuel and HLW Management Program

Attachment

c: C. King
A. Machiels
K. Waldrop

[2] An example of such degradation mechanisms that might be successfully monitored would be essentially all of the degradation mechanisms leading to loss of bolted cask lid seals as the pressure between the inner and outer O-rings are continuously monitored.

<u>Attachment</u>

Detailed EPRI comments on the NRC document entitled "Identification and Prioritization of the Technical Information Needs Affecting Potential Regulation of Extended Storage and Transportation of Spent Nuclear Fuel" dated May 2012

General comments:

Prioritization criteria:
EPRI agrees that two important criteria for NRC's review should be those stated on page iv:

- "Regulatory significance for safety performance" and
- "The level of knowledge about the process or issue".

In the body of this letter, EPRI requests clarification of what NRC means with respect to "regulatory significance".

Regarding the assumptions on page v of the Executive Summary, EPRI agrees assuming existing technology and regulatory policies stay in effect is reasonable. Making assumptions about future technology deployment of evolution in regulations would not be justified at this time. EPRI has no opinion, however, on the appropriateness of assuming a 300-year period of assessment as NRC, itself, recognizes this time period is purely arbitrary.

EPRI also agrees that NRC's regulatory significance assessment should be focused on criticality, confinement, shielding, thermal performance, and retrievability. NRC also specifically assesses "structural integrity". EPRI feels this last issue is actually a part of the others, so need not be a focus of assessment in and of itself.

EPRI notes one of NRC's assumptions about cladding integrity requires additional clarification. EPRI agrees cladding provides "defense-in-depth, as a barrier for fission products, and may be important to the safe handling of SNF [spent nuclear fuel] …" Providing defense-in-depth is not the same as relying on cladding as the "confinement" barrier. This should affect the regulatory importance of this cladding function for maintaining "confinement".

Prioritization conclusions:
EPRI also agrees that there are several cross-cutting issues "that can aid in understanding conditions affecting several SSCs and degradation processes." NRC names three of these:

- Thermal modeling;
- Monitoring needs; and
- Effects of residual moisture after drying.

EPRI agrees that "best estimate" thermal model development is important for estimating peak cladding temperatures (including the spatial distribution of temperatures) during drying, as well as estimating SS canister surface temperature temporal and spatial distributions. The former will provide a better estimate of how much of the cladding may experience conditions to support hydride redistribution sufficient to degrade the cladding mechanical properties during subsequent storage and transportation. The latter will provide an estimate of the times when and locations on the surface of SS canisters where SCC may become an issue.

EPRI also agrees that in-service monitoring of the SS canister surface will provide additional information on whether conditions to support SCC may be present. While significant R&D will be needed to develop accurate and reliable monitoring of the conditions inside the cask/ canister during storage and transportation, it is nevertheless worthwhile to begin such R&D. The challenges to develop an accurate and reliable internal set of monitors are many. Hence, neither industry nor NRC should depend on the availability of such systems.

EPRI also agrees that some additional, confirmatory R&D would be valuable to assess the amount of water remaining inside the cask/ canister after drying. However, there is no current technical basis for departing from current drying practices.

Regarding NRC's "Priority 1" potential degradation mechanisms:

- Stress corrosion cracking (SCC) of stainless steel (SS) canister body and welds: EPRI agrees this is of high priority. In a recent EPRI assessment of extended storage R&D gaps, EPRI found SCC of SS canisters to be the only "high" priority R&D gap issue.[3]
- It is unclear why NRC determined that cask bolt corrosion, SCC, embrittlement, and mechanical degradation R&D data rose to NRC's highest priority. On page A6-15, NRC correctly notes that bolt degradation requires the protective bolt covers to degrade first. Assuming the protective covers function properly, which can be included in an aging management plan, the bolts would be less likely to degrade via corrosion. Even if the covers do lose their seal, it is likely they can still prevent a large amount of airborne particulates – particularly marine salts – from depositing on the bolts. It may also be possible to replace degrading bolts if needed. Finally, if bolt degradation leads to failure of the seals, then the existing inter-seal pressuring monitoring system will be able to detect this.
- NRC's placement of fuel pellet swelling due to helium in-growth as a high priority R&D need is, to EPRI's knowledge, unique among the various gap analyses that NRC, itself, cites. EPRI agrees that expansion of the fuel pellet during extended storage deserves some evaluation. It is highly unlikely however, that pellet expansion will be significant during extended storage for slightly enriched (<5%) uranium fuel.

[3] *Extended Used Fuel and High-level Waste Storage Collaboration Program – Progress Report and Review of Gap Analyses*, EPRI, Palo Alto, CA: 2011. 1022149.

Hence, EPRI would not consider these potential degradation mechanisms (bolt degradation and pellet swelling) to a "Priority 1" level.

Regarding NRC's "Priority 2" types of degradation requiring additional R&D:

- Determining – on an industry-wide basis – if and how many cladding flaws of sufficient initial depth to support delayed hydride cracking (DHC) exist is not only impractical, but unwarranted. Such data are collected at very high cost *only* for those handful of rods that have or could impact reactor operation. Large enough defects are unlikely to survive reactor operations; and when they occasionally do, they would lead to DHC during initial pool storage assuming the stress intensity factor would be greater than the critical stress intensity factor for initiation of DHC.
- Metal fatigue of *any* of the SSCs is unlikely – even under centuries of extended storage conditions. There are not enough fatigue cycles to make this an issue. Hence, EPRI would lower the priority of collecting R&D on this issue even further.
- Low temperature creep – if it occurs – is likely to be so small that this mechanism will not significantly degrade cladding even over prolonged storage periods. In EPRI's view, study of this mechanism is only of academic interest.
- A more appropriate topic for high-burnup fuel would be to assess the relevance of experimental creep data obtained on empty tubes versus the actual fuel element configuration that involves tight bonding between the cladding and the fuel.

Section-by-section comments:

Table 4-1: Regulatory Significance for Normal and Off-Normal Storage and Transportation, Including ONLY Those Degradation Phenomena Judged to have Potentially Significant Impacts on Safety
EPRI's investigated NRC's assessment of regulatory significance for each potential degradation component listed in Table 4-1.

- In general, the "SR" (structural) safety function seems to be secondary to all the other safety functions. For example, the actual safety functions that require the concrete overpack for welded SS canister systems to maintain its structural integrity would be "thermal", "shielding", and "retrieval". Hence, it seems unnecessary to include structural integrity as its own safety function in this draft report.
- Cladding provides defense-in-depth for confinement rather than being the primary confinement barrier. Hence, it is unclear whether cladding or fuel-cladding interactions degradation mechanisms should be assigned a "confinement" safety function. Only the stainless steel canister or the metal cask and cask lid should be assigned the primary confinement function.
- No safety function is assigned to fuel basket creep causing strain of fuel basket structure. Is this intentional?

- It is unclear why concrete "inspection and repair" is considered a "degradation phenomenon".

Table 5-1: Overall Rankings for Further Research Based on Regulatory Significance, Level of Knowledge, and Use of Data

- "Level of Knowledge" and "Overall Ranking" values for pitting and crevice corrosion of SS canister body and welds are missing from the table.
- The EPRI reference in the "References" section should have a date of August 2011 rather than April 2012.

Appendix A: Evaluation of Technical Information Needs

A1.1: Cladding OD corrosion and oxidation-related phenomena:
NRC discusses whether MIC (presence of biofilms and microbes) "can occur from the limited residual water in a sealed cask environment". It seems unlikely that MIC will occur on the *inside* of a sealed canister due to the presence of both a high radiation and a helium-filled environment.

NRC concludes this subsection by stating "the capability to detect air ingress to the canister is an important monitoring need." It is unclear to EPRI whether this capability is a "need" or simply a desirable characteristic. At present, the only way to reliably monitor for air ingress for time periods on the order of decades or more is to install a gas sampling line on the canisters. Use of such an additional penetration may introduce additional confinement issues. Air monitoring systems that would be installed completely inside the cask or canister that would perform reliably over decades or more will require years of R&D before it is even possible to determine if such a system would work. Hence, EPRI requests NRC reconsider whether air ingress monitoring is a "need".

A1.2: Cladding ID corrosion and oxidation-related phenomena
NRC cites Sindelar et al. (2011) that recommends destructive examination of cladding should be performed with appropriate sampling to check for SCC. This is impractical.

NRC notes that pellet swelling after 100-300 years of operation due to fission gas expansion and helium gas generation has not been confirmed. NRC states that until this possibility can be evaluated, "the SCC phenomena would be an issue for EST [extended storage and transportation]". Clearly it will not be possible to confirm pellet swelling due to these phenomena if it takes over a century to perform such a test. Accelerated testing via doping of simulated fuel is being conducted at ITU in Germany and, to EPRI's knowledge, results to date have not found UOX susceptible to swelling.

A1.3: Hydrogen-related phenomena
In addition to EPRI's 2002 report to which NRC's draft report refers, EPRI has recently produced an updated report on the possibility of DHC.[4] In the updated report EPRI reviews more recent data and analyses – including those by Kim (2009) referred to in the draft NRC report. EPRI reiterates its conclusion that existence of initial flaw sizes large enough to initiate DHC are unlikely.

NRC also concludes the level of information on hydride reorientation and ductile-to-brittle transition temperature (DBTT) is "high". NRC concludes this for the cases for which cladding temperatures remain above the DBTT because "knowledge of the propagation rate and time to failure is not applicable for reorientation of hydrides." Yet NRC also states "efforts should be made to determine conditions under which [hydride reorientation] is benign." Furthermore, NRC also cites a report by Sindelar et al. (2011) that indicates the database on establishing the DBTTs are "insufficient". Given that NRC does not have hydride reorientation issues as either Priority 1 or Priority 2 R&D needs, EPRI concludes that NRC feels hydride reorientation is not of regulatory concern as long as cladding temperatures exceed the DBTTs. This should mean:

- If high burnup cladding is transported early (i.e., when temperatures are well above DBTTs), then NRC should feel confident granting high burnup used fuel transportation licenses because the cladding will remain sufficiently ductile.
- Given DBTTs data are lacking and it is not known whether high burnup used fuel transportation will occur before cladding temperatures descend below the DBTT range, it is unclear why NRC does not include R&D to better establish DBTTs on its Priority 1 list.

A1.7 Propagation of existing flaws
NRC states the precursors to flaws cannot be predicted because "the initial distribution of flaws and the exact stress and temperature conditions that can assist flaw propagation are not known." EPRI determined the largest flaw size that would pre-exist is 73µm.[5]

A2.3 Pellet swelling
EPRI agrees that – in theory – further pellet swelling during storage would add some amount of stress to the cladding. The issue is whether pellet swelling during storage is sufficient to add enough stress to the cladding to cause cladding rupture during extended storage.

A factor that should be considered is the fact that pellet temperatures during reactor operation are significantly higher than post-operation. After reactor operation the pellet will shrink somewhat, thereby leaving room for subsequent pellet expansion due to long-term helium build-up during storage. Thus, there may be a significant amount of time before additional significant pellet-cladding mechanical interaction (PCMI) leading to increased cladding stress occurs.

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[4] *Delayed Hydride Cracking Considerations Relevant to Spent Nuclear Fuel Storage.* EPRI, Palo Alto, CA: 2011. 1022921.
[5] *Creep as the Limiting Mechanism for Spent Fuel Dry Storage,* EPRI, Palo Alto, CA: 2000. 1001207.

Again, NRC recommends the amount of pellet swelling due to helium production over a century or more be confirmed by experiment. An experiment over such time scales is not possible without using some sort of accelerated testing.

Finally, NRC implies in section A1.3 that as long as cladding temperatures exceed the DBTT there is likely to be adequate ductility for the cladding to survive a transportation accident. Hence, fuel pellet swelling during the time period when cladding temperatures exceed the DBTT will likely be managed by cladding plastic deformation due to sufficient cladding ductility.

NRC cites two reports that indicate pellet swelling due to helium buildup will likely not be an issue – if then – for at least a century or more. Hence, EPRI recommends that additional R&D to study this issue be given lower priority in the near- to intermediate-term so limited resources can be directed toward nearer-term R&D needs.

A2.4 Additional fuel fragmentation
[Note typo in second subsection title.]

NRC cites Hanson et al. (2011) regarding fuel fragmentation during reactor operation leading to "10 to 30 pieces with some additional powder creation". This introduces a relatively small amount of additional surface area from which fission gases may escape, thereby limiting the amount of additional fission gas in the cladding plenum. Furthermore, the cladding will easily accommodate this additional fission gas contribution as it occurs during reactor operation when cladding ductility is high. Hence, this issue seems irrelevant to fuel fragmentation causing additional particulate source term during normal storage or transportation for which there is a retrievability requirement.

If a transportation accident occurs that may cause additional fuel fragmentation and particulates, extreme care will already be taken when reopening the transportation cask such that any additional fuel fragmentation caused by helium buildup would not change the method of recovery. Hence, even if present knowledge is "low", EPRI argues additional R&D for this potential degradation mechanism be given low priority as its potential consequences would not change how transportation accident recovery would be managed.

A3.2 Fuel assembly hardware metal fatigue;
A4.3 Basket metal fatigue caused by temperature fluctuations; and
A5.2 Neutron absorber metal fatigue
NRC assigns a "high" R&D priority for metal fatigue caused by temperature fluctuations. The amount of fatigue caused by temperature fluctuations even over extended storage periods is low compared the number of fatigue cycles many similar systems can withstand.[6] The additional amount of metal fatigue during storage caused by temperature fluctuations – even over a century or more will be trivial. Hence, EPRI recommends additional R&D for these issues be given a very low priority.

[6] Data on the required number of cycles before metal fatigue becomes an issue are prevalent.

A3.3 Corrosion and SCC of fuel assembly hardware
Corrosion and SCC of fuel assembly hardware has occurred for a subset of fuel assemblies *during reactor operation* (i.e., aqueous corrosion rather than atmospheric corrosion from water vapor). NRC and industry have already addressed this issue by the use of assembly handling equipment that allows handling by normal means. Thus, this issue has already been addressed for subsequent storage and transportation.

What matters is whether additional, corrosion or SCC of fuel assembly hardware could occur during dry storage leading to difficulties retrieving the fuel by normal means. NRC notes "corrosion is only possible at relative humidity above 20-40 percent, which may not be present as a consequence of the limited amount of water and dissociation of water as a result of radiolysis." NRC did not state whether this relative humidity level is valid in a helium gas environment. Assuming this RH level is valid for such conditions, it is trivial to calculate the amount of residual water that would cause this RH level. Hence, no additional R&D on this subject is required – except to evaluate the possibility of sufficient residual water being left in the cask/ canister after drying.

There is evidence that in some cases, some residual water exists in the cask/ canister after drying. The difficulty of drying increases for cases for which the initial decay heat of the cask/ canister is relatively low. Low initial decay heat casks/ canisters also means assembly temperatures are always relatively low during both drying and subsequent storage and transportation. Lower assembly temperatures may limit the initiation and progress of assembly corrosion and SCC. For higher initial decay heat casks/ canisters, the amount of residual water is likely to be less. Hence, it is unlikely sufficient residual water will remain to cause such relatively high humidity levels during subsequent storage.

Thus, EPRI concludes the R&D priority for this potential degradation issue also be set to "low".

A4.1 Creep of fuel baskets
NRC notes that creep of fuel baskets may be exacerbated by neutron irradiation. There is a wealth of existing data on metal creep due to neutron irradiation. In general, neutron irradiation-induced creep is only significant for high levels of neutron fluence. The amount of neutron fluence even during long-term storage is orders of magnitude lower than that associated with creep. Hence, this creep mechanism is unimportant.

A4.2 Basket weld embrittlement
NRC states weld embrittlement for high BU and MOX fuel may be larger than for lower BU UOX fuel. EPRI assumes NRC means this is due to additional radiation damage caused by a larger neutron source term. The neutron fluence caused by used UOX, high burnup UOX, and MOX fuel is orders of magnitude lower than welds that have become embrittled due to neutron bombardment. EPRI therefore recommends the R&D priority for this issue be set to "low".

A4.4 Fuel basket corrosion
It is relatively straightforward to calculate the theoretical upper bound of cask/ canister internal corrosion caused by reaction with residual water. If one assumes all the water is consumed via water/ metal reactions over the available cask/ canister internal surface area, it is therefore possible to calculate the thickness of metal converted to corrosion products. It is likely a large amount of water would be required to significantly reduce metal thicknesses. Hence, additional R&D is not necessary.

A5.1 Neutron absorber creep
NRC states "significant creep of neutron absorbers could affect criticality considerations." Data already exist under similar situations in spent fuel pools where neutron absorber shrinkage has occurred. The amount of shrinkage required to significantly increase k_{eff} has been assessed for these situations. It is improbable that metal neutron absorber creep would occur to a similar extent.

Related to this topic, NRC cites Hanson et al. (2011) that reported a two-year creep test for Metamic at bounding temperature and mechanical loads that resulted in creep strains no larger than 0.24 percent. Such small creep strains are unlikely to significantly affect k_{eff} values.

NRC also correctly notes that creep is only significant during early storage times when temperatures are higher. Therefore, additional data collection related to long-term creep is not needed.

A5.3 Neutron absorber wet corrosion and blistering
NRC states for Boral® - an aluminum-based cermet – "the greater volume of the corrosion product Al_2O_3 will seal off pores, creating isolated regions that contain hydrogen (a by-product from the corrosion process), Al_2O_3, and water." EPRI assessed this particular mechanism and concluded not enough Al_2O_3 would be produced to clog the pores.[7] Rather, EPRI speculates capillary forces are likely sufficient to prevent hydrogen escape until hydrogen pressures high enough to cause blistering are generated. EPRI also notes that the blistering phenomenon has been observed only for a subset of Boral® in use. The subset of Boral® that is subject to blistering is related to the size of the pores, as NRC correctly points out. However, what matters is the connected porosity (rather than the total porosity), along with the pore size. Boral® with larger total porosity and Boral® with low total porosity are not subject to blistering; it is only that subset of Boral® with intermediate porosity that has been found to blister.

EPRI is also aware of anectodal evidence that drying times for casks/ canisters employing some types of Boral® are sometimes longer than those for other casks/ canisters. This is probably due to the additional time it takes for trapped water in this subset of Boral® to volatilize and escape from the Boral®.

[7] *Experimental Characterization of BORAL® Pore Size and Volume Distributions*. EPRI, Palo Alto, CA: 2010. 1021051.

EPRI conducted initial, accelerated Boral® corrosion testing in 2009.[8] This initial testing program investigated the corrosion rates of aluminum. EPRI has initiated an additional, longer-term accelerated Boral® corrosion testing program to assess whether Boral™ could lead to loss of B_4C. EPRI anticipates this additional work to be completed in late 2013. Furthermore, EPRI is also engaging industry to develop an industry-wide Boral® aging management program with the goal of establishing such a program in 2013.

Hence, EPRI agrees with NRC that neutron absorber wet corrosion and blistering for a subset of Boral® is an issue that requires additional R&D.

A5.5 and A5.6 Neutron absorber depletion, embrittlement, and cracking
EPRI agrees that additional R&D for these potential degradation mechanisms should be assigned a low priority.

A6.1 Atmospheric SCC of SS canisters
EPRI agrees additional R&D on this potential degradation mechanism is very high. EPRI is initiating an in situ inspection program of SS canisters using visual exams coupled with surface contaminant collection and canister surface temperature measurements. The first of these in situ exams is scheduled for later this month. EPRI is also considering the applicability or adaptability of existing NDE techniques to further characterize potential indications of SS canister surface degradation observed during the visual examinations.

A6.3 MIC of SS canisters, steel canisters and casks, and cast iron casks
EPRI agrees that further study of this potential degradation mechanism is warrated – especially for extended storage times when decreased radiation fields, build-up of potential microbial nutrients, and higher surface relative humidity levels could support development of microbial colonies.

A6.6 through A6.8 Degradation of metal and elastomeric seals
EPRI and NRC are aware of longer-term degradation testing of these seals. Furthermore, NRC correctly points out that existing seal monitoring programs should detect seal failure. Hence, EPRI agrees additional R&D is low priority.

A6.9 Corrosion, SCC, and embrittlement of bolts;
A6.10 Cask bolt thermal fatigue
As briefly discussed in the body of this letter, if NRC intends to include the ability to monitor for potential degradation in its assessment, then all degradation mechanisms causing bolted cask seal failure should be assigned priorities lower than “high”. Furthermore, additional bolt degradation testing is well underway by several organizations (e.g., BAM in Germany and CRIEPI in Japan). Hence, EPRI would rank additional R&D needs for bolt corrosion and SCC as “medium” and thermal fatigue as “low”.

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[8] *Accelerated Corrosion Testing of BORAL®*. EPRI, Palo Alto, CA: 2009. 1018911.

A7 Neutron shielding degradation
EPRI agrees additional R&D for these degradation mechanisms is of low priority.

A8 Concrete overpack, vault, and pad degradation
As discussed in the EPRI (2011) report NRC cites, EPRI considers additional R&D on these mechanisms as low. This is because monitoring of many of these degradation mechanisms is relatively straightforward and replacement of degraded concrete structures is feasible. The main reason to somewhat increase the R&D priority for these degradation mechanisms is the worker dose involved with periodic inspection, and the cost and worker dose involved with concrete structure replacement. Given that concrete structure replacement – if needed at all – is not likely to be needed for many decades, nearer-term R&D priorities should be placed elsewhere.

Appendix B: Regulatory Prioritization of Component Degradation
EPRI briefly reviewed this appendix. Given Table B-1 is based partially on NRC staff professional opinion and the appendix does not provide a detailed explanation for the rational for each entry in the table, it is difficult for EPRI to assess the appropriateness of the contents of Table B-1. Hence, EPRI is only able to make some general comments along with a handful of specific comments on the table.

As discussed earlier, all structural changes should be considered with respect to their impacts on the primary safety functions (confinement, subcriticality, shielding, thermal, retrievability). Hence, those entries listed as "SR" should be replaced with one or more of the other safety function impacts – assuming the structural change results in an impact on one or more of these safety functions.

Fuel-cladding interactions: changes in the fuel state that result in a higher than expected fuel temperature: it is unclear why changes in *fuel* temperature would affect the functional requirements. Temperature gradients and temperature-versus-time trends for the SSCs important to maintaining functional requirements are a function of decay heat rather than the fuel temperature.

Fuel assembly hardware "material loss": it is unclear what material loss is being referred to.

Corrosion and loss of metallic seal material; bolt degradation: it is unclear why thermal impacts are included in the table. While EPRI suspects it is being included due to differences in heat rejection between pressurized helium and depressurized helium and/ or air, EPRI requests clarification.

Given NRC has assigned low priority to neutron absorber degradation, it is unclear why there are any entries in this part of the table.

"SH4": cracks in the concrete would have to be unrealistically large for shielding effectiveness to be significantly degraded.