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Name: Patricia Campbell

General Comment

17

See attached file.

Attachments

MFN 14-054

HITACHI

GE Hitachi Nuclear Energy

James F. Harrison

GE-Hitachi Nuclear Energy Americas LLC
Vice President, Fuel Licensing, Regulatory Affairs
P.O. Box 780
Wilmington, NC 28401 USA

T 910.620.1826
james.harrison@ge.com

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Secretary
U.S. Nuclear Regulatory Commission
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ATTN: Rulemakings and Adjudications Staff

Cindy Bladey, Chief
Rules, Announcements, and Directives Branch
Office of Administration
Mail Stop: 3WFN-06-44M
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Subject: Comments: Proposed Rule, Performance-Based Emergency Core Cooling Systems Cladding Acceptance Criteria, and Draft Regulatory Guides; 79 Fed. Reg. 16106 (March 24, 2014) and 79 Fed. Reg. 22456 (April 22, 2014)

GE Hitachi Nuclear Energy (GEH), including Global Nuclear Fuel (GNF) representatives, appreciates the opportunity to comment on the subject proposed rule and the associated draft regulatory guides. Specific comments are provided in Enclosure 1. In addition, GEH participated in the industry efforts through the Nuclear Energy Institute (NEI) to prepare and submit comments on this subject. GEH endorses the NEI comments.

If you have any questions regarding the enclosed comments, please contact me or Kurshad Muftuoglu (kurshad.muftuoglu@ge.com; 412-480-2067).

Sincerely,

James F. Harrison
Vice President, Fuel Licensing
Regulatory Affairs
GE Hitachi Nuclear Energy

Enclosure:

1. GEH/GNF Comments on Proposed Rule; Performance-Based Emergency Core Cooling Systems Cladding Acceptance Criteria

cc: P. Clifford (NRC)
J. Golla (NRC)
T. Inverso (NRC)
B.R. Moore (GNF)
J.G. Head (GEH)
P.L. Campbell (GEH)

ENCLOSURE 1

MFN 14-054

GEH/GNF Comments on Proposed Rule; Performance-Based Emergency Core Cooling Systems Cladding Acceptance Criteria

Non-Proprietary Information – Class I (Public)

ENCLOSURE 1

MFN 14-054

GEH/GNF Comments on Proposed Rule; Performance-Based Emergency Core Cooling Systems Cladding Acceptance Criteria

Non-Proprietary Information – Class I (Public)

GEH and GNF (GEH/GNF) support the industry comments that were developed by EPRI Regulatory Technical Advisory Committee (Reg-TAC) and coordinated by NEI to the 10 CFR 50.46c draft rule. This enclosure contains specific comments/responses that are generated by GEH/GNF.

GEH/GNF appreciates the opportunity to comment on the proposed 10 CFR 50.46c rule. The term GEH or GEH/GNF is used to represent the comments for both GEH and GNF. This comment package has 3 parts: (1) Specific responses to NRC questions, (2) comments on the rule and rule language, and (3) comments on the associated draft regulatory guides.

Summary:

The proposed rule and associated draft regulatory guides represent significant changes for the U.S. nuclear industry, with risk-informed and performance-based approaches. GEH requests that the NRC consider the specific comments provided below in the final rule. Of particular concern is the imposition of new requirements regarding breakaway oxidation and the additional burden which may not be justified for incremental safety benefit. GEH proposes an alternative approach that provides adequate monitoring and testing for ensuring safety and timely reporting.

Part 1 – Responses to Specific NRC Questions

Question	GEH/GNF Position
NRC Question 1. *Performance-Based Peak Cladding Temperature Limit.* The NRC is proposing, in § 50.46c(g)(1)(i), to maintain the existing prescriptive criterion on PCT for zirconium alloy cladding. Limits on cladding temperature are necessary to protect against a loss of coolable geometry resulting from brittle failure upon quench, to protect against high-temperature ductile failure, and to prevent reaching the point at which the zirconium-water reaction would become autocatalytic. In the original § 50.46 rulemaking, the 2200 °F limit on PCT was based on cladding embrittlement (i.e., protection against brittle failure upon quench), which was determined to be more limiting than either high temperature ductile failure or autocatalytic oxidation. The NRC's LOCA research program did not investigate cladding degradation mechanisms or develop the technical basis for performance-based requirements beyond the existing 2200 °F PCT criterion. Since the cladding embrittlement mechanism, oxygen diffusion, is strongly dependent on temperature, there exists an upper temperature at which the allowable time duration to nil ductility approaches zero (i.e., PCT °limit). As described in Section V.B.1 of this document, recent research has confirmed that 2200 °F remains an appropriate upper limit to protect against cladding embrittlement since nil ductility is achieved rapidly at higher temperature. As such, the proposed § 50.46c maintains the 2200 °F prescriptive PCT criterion. The NRC requests comment on the proposed rule's retention of the prescriptive PCT criterion, specifically:	**GEH/GNF Position/Response/Comment 1:** a. Yes. In line with the performance-based nature of the new rule, the PCT criterion should be allowed to be determined based on fuel performance. In the new rule, provisions should exist if a PCT limit higher than 2200°F is supported by data and applied for specific fuel materials including the protection against post-quench embrittlement. In the absence of additional testing and justification, 2200°F should remain as the default criterion that protects for all known failure mechanisms, including post-quench embrittlement. b. No, established testing procedures *per se* do not already exist. If a PCT limit higher than 2200 °F is sought, such testing requirements can then be developed. GEH/GNF does not believe this should be considered as a high-priority because the current criterion provides adequate assurance for safety in case of a postulated LOCA.

Question	GEH/GNF Position
a. In place of the prescriptive PCT criterion, should the NRC adopt performance-based requirements for zirconium alloy cladding to protect against high temperature ductile failure and autocatalytic oxidation? b. Do established testing procedures already exist for demonstrating acceptable high temperature cladding performance and defining acceptance criteria to meet these new performance-based requirements?	
NRC Question 2. *Periodic Breakaway Testing.* To address the breakaway oxidation phenomenon, the NRC proposes to add a performance-based requirement in § 50.46c(m)(3) that the licensee measure the onset of breakaway oxidation periodically on manufactured cladding material and report any changes in the onset of breakaway oxidation at least annually. This requirement, along with a periodic test requirement (defined as each reload batch in the proposed rule language), would confirm that slight composition changes or manufacturing changes have not inadvertently altered the cladding's susceptibility to breakaway oxidation. The NRC is considering adopting, as a final rule, a requirement that each licensee measure breakaway oxidation behavior for each re-load batch. The NRC requests specific comment on the type of data reported and the proposed frequency of required testing. The objective of periodic testing is to prevent affected fuel from being loaded into a reactor. At the same time, the objective is to do so without adding ineffective requirements and unnecessary burden. Other sampling approaches may be more effective. For example, should the licensee be required to report data relevant solely to their	**GEH/GNF Position/Response/Comment 2:** GEH/GNF expects testing for breakaway oxidation to be addressed as part of the fuel vendor quality assurance program. The type of data generated from each test is expected to be a pass or fail relative to an NRC-approved time, as opposed to a numeric value for breakaway onset time. GEH/GNF also recommends that the test frequency be set as part of the quality assurance program built on statistical confidence level based on test data, rather than as part of the rule. Breakaway oxidation of Zr-alloy cladding, as a concern in postulated LOCA scenario, was raised by some test results on the Zr-1wt% Nb alloy, E110, manufactured using the Russian electrolytic process for extracting Zr. NUREG/CR-6976, together with reports referenced therein, summarizes test data obtained on E110 and other Zr-alloys used for fuel cladding. As summarized in a presentation made at the June 2014 Public Meeting, ML14175A116, two key contributing factors that can result in a short time for breakaway oxidation are: 1) use of electrolytic process for extracting Zr and 2) use of HF-based (define HF process) pickling process as the last surface finish step in cladding manufacture. Another factor is related to the cladding surface roughness, in particular, presence of scratches. The surface scratches, however, have a relative small effect, about 200 seconds, on the timing for onset of breakaway oxidation. The source Zr for Zr-alloy cladding used currently in the US nuclear power plants for reload applications is produced using the Kroll process, which, unlike the electrolytic process, has not resulted in short time to breakaway oxidation. The Kroll process is used to manufacture Zr-alloy cladding for GEH/GNF and for other fuel suppliers in the US. Similarly, the finish on the cladding outer surface is belt-polished, which does not exhibit short times to breakaway oxidation, unlike pickled finish used for the E110

Question	GEH/GNF Position
reload fuel batch or should the licensee be able to report representative data based on periodic testing (e.g., test every 10,000 rods, tubing lot, or ingot) of the same zirconium-based alloy cladding compiled during the period from the last report?	cladding material. The two most significant factors that can result in early onset of breakaway oxidation are therefore not applicable to the manufacturing process used by fuel vendors in the US. GEH/GNF therefore considers the likelihood of affected fuel being loaded into a reactor to be very low. Although surface scratches can have a small effect on breakaway oxidation onset, the presence or extent of surface scratches can be readily controlled using the normal manufacture quality control and assurance processes, without a specific need for periodic testing for breakaway oxidation. GEH/GNF understands NRC's desire to have test data to confirm breakaway oxidation behavior of the cladding. The proposed rule and associated regulatory guides discuss test frequency on a batch reload basis. GEH/GNF considers having the test frequency specified in the rule or regulatory guides will evolve over time into an undue burden, particularly in light of the low likelihood of short time to breakaway oxidation occurring in cladding with a belt-polished surface finish and produced from Kroll-processed Zr. Instead, GEH/GNF proposes that the test frequency be defined as part of the fuel vendor quality assurance program. The program, which complies with 10 CFR Part 50 Appendix B requirements, will provide the necessary measures that will prevent 1) the use of Zr alloys produced using electrolytic process, and 2) having a pickled final surface finish. The program in effect eliminates the two most significant factors that induce early onset of breakaway oxidation, and therefore is well suited to provide the basic assurance that affected cladding is not loaded into reactors. The program will include some testing on the final finished cladding. The assurance of not loading affected cladding would be further bolstered by the statistical confidence provided by the test data. Under the quality assurance program, the test frequency will depend on the prior test data. With time, test data on the cladding breakaway oxidation response will be accumulated, and the test frequency can be adjusted accordingly without degrading the statistical confidence and without having to involve additional reviews by the NRC. GEH/GNF can implement necessary internal procedures that will ensure tests for breakaway oxidation are done during the cladding manufacturing process. It is important to recognize that the tests conducted likely will be on a pass/fail basis for a test period relevant to design basis LOCA considerations. For example, if the 5000 seconds is the time frame, cladding would be tested at sufficient frequency to provide assurance that only cladding which does not develop breakaway oxidation at 5000 s is

Question	GEH/GNF Position
	used for fuel manufacture. Test data in a summary report or a certifying document with the assurance of the supplied fuel cladding meeting the requirement assumed in LOCA analyses could be provided to reactor licensee for each reload batch. A summary of the test data can be provided to the NRC either at annual technology update meetings or in separate reports, showing that only cladding with breakaway oxidation behavior consistent with LOCA analyses are used for fuel manufacture.
NRC Question 3. *Analytical Long-Term Peak Cladding Temperature Limit.* Section 50.46c(g)(1)(v) of the proposed rule would require that a specified and NRC-approved limit on long-term peak cladding temperature be established which preserves a measure of cladding ductility throughout the period of long- term demonstration (e.g., 30 days). The current regulation at § 50.46(b)(5) stipulates that long-term temperature be maintained "at an acceptably low value." The proposed rule would define the performance-based metric to judge an acceptably low temperature. The overall goal of preserving ductility would provide reasonable assurance that the fuel rods will maintain their coolable bundle array. The NRC is requesting input regarding this performance objective to determine if this is the most suitable performance- based metric to demonstrate long-term cladding performance. Alternatively, the proposed rule could establish an analytical limit of long-term fuel rod cladding temperature related to observed corrosion behavior. For example, the Pressurized Water Reactor Owners Group (PWROG) has applied as a long-term core cooling acceptance criterion that the cladding temperature be maintained below 800 °F (see Topical Report (TR) Westinghouse Commercial Atomic Power (WCAP)-16793–NP, Revision 2, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the	**GEH/GNF Position/Response/Comment 3:** GEH/GNF concurs with the objective of preserving ductility; however, a single metric of peak cladding temperature is not considered to be a useful way to achieve the goal of preserving cladding ductility for the purpose of long-term cooling up to 30 days. During the short transient, in contrast to long-term cooling period, a limit on PCT is effective as a way of precluding oxidation. For the purpose of long-term cooling, the overall temperature-time profile and the potential failure mechanisms need to be considered. Although the criterion of 800 °F developed for PWRs (ML11292A021) is a useful reference with regard to additional corrosion and hydrogen pickup over a 30-day period, exceeding the 800 °F temperature for a time that is short relative to the 30-day period need not necessarily result in cladding ductility degradation, especially if a significant length of time is spent at temperatures much less than 800 °F.

Question	GEH/GNF Position
Recirculating Fluid,'' Appendix A (ADAMS Accession No. ML11292A021)). Doing so will ensure that additional corrosion and hydrogen pickup over a 30-day period will not significantly affect cladding properties. The NRC seeks comment on the acceptance criterion for long-term cooling and whether there is justification for a different temperature limit (other than the 800 °F provided in the WCAP).	
NRC Question 4. *Acceptance Criteria for Risk-Informed Alternative.* Section 50.46c(e) of the proposed rule contains the high-level acceptance criteria for an alternative that would allow entities to use, on a case-by-case basis, a risk- informed approach to address the effects of debris on long-term core cooling. In addition, the NRC will develop draft regulatory guidance for this provision concurrent with the staff's review of the STPNOC's pilot application for a risk- informed approach to address the closely related topic of GSI–191. The NRC seeks comment on whether the detailed acceptance criteria should be set forth in § 50.46c, or in the associated regulatory guidance.	**GEN/GNF Position/Response/Comment 4:** The detailed acceptance criteria for risk-informed alternative should <u>not</u> be set forth in 50.46c. In fact, the provisions in 50.46 allowing a risk-informed alternative to address debris-related concerns can be added in the rule as a high-level statement. This could provide a clarifying statement that a licensee adapting the voluntary risk-informed alternative would not need exemption requests. The acceptance criteria that would apply to the risk-informed approach, its required content, and reporting requirements that pertain to the risk-informed approach should not be included in the proposed rule. A regulatory guide for risk-informed alternative would be the most efficient way to handle the requirements.
NRC Question 5. *Regulatory Approach for Risk-Informed Regulation.* The NRC seeks comment on whether the risk-informed alternative offered by this regulation should require meeting numeric-risk acceptance criteria as a matter of compliance (similar to § 50.48c) or whether other risk-informed approaches that use risk-importance insights to establish measurable criteria or performance objectives, such as those in use by §§ 50.62, 50.63, and 50.65, or approaches using both risk importance and numeric-risk acceptance criteria, such as those in use by § 50.69, would be preferable.	**GEH/GNF Position/Response/Comment 5:** The rule should only include the high-level performance objective and acceptance criteria. An associated regulatory guide should provide acceptable measures for both risk importance and numeric-risk acceptance criteria, providing the applicable flexibility to the risk-informed approach. The §50.48(c)(4) risk-informed alternative to comply with the NFPA-805 fire protection requirements can be used as a model for the level of detail that the acceptance criteria are needed in the §50.46c rule.

Question	GEH/GNF Position
NRC Question 6. *Operational Modes Considered in Risk-Informed Alternative.* Deterministic evaluations of GSI–191 are currently required only for those modes of operation where both recirculation from the sump is relied upon and the plant accident can cause high pressure jets that can result in generation and transport of debris to the sump. By contrast, probabilistic evaluations generally consider all modes of operation. The NRC seeks comment on whether the risk-informed approach provided in § 50.46(e) could generically exclude any plant operational modes (e.g., low power or shutdown) from consideration. If so, what are the bases for excluding these operational modes from consideration?	**GEH/GNF Position/Response/Comment 6:** The risk-informed approach could exclude the plant operational modes as appropriate. A potential debris concern is only applicable to modes of operation where both recirculation from the sump is relied upon and the plant accident can cause high pressure jets that can result in generation and transport of debris to the sump. The risk-informed approach as an alternative to address debris-related concerns would represent a subset of probabilistic evaluations that generally consider all modes of operation. Therefore, it is not necessary to expand the scope of the risk-informed approach to other modes where no high pressure jets are possible.
NRC Question 7. *Reporting Criteria for the Risk-Informed Alternative.* The NRC is proposing in § 50.46c(m) corrective actions and reporting criteria specific to the risk-informed approach for addressing the effects of debris on long-term cooling. These criteria are performance-based and similar in concept to the reporting criteria in § 50.69. Per proposed § 50.46c(m), the NRC's approval of the entity's risk- informed application would specify the circumstances under which the licensee or design certification applicant shall notify the NRC of changes or errors in the risk evaluation approach. In addition, the proposed rule would require entities to review the analyses, evaluations, and modeling for changes and errors and incorporate changes to the design, plant, operational practices, and operation experience. The entity would then be required to update the debris evaluation model and the PRA and its supporting analyses, and re- perform the evaluations of risk, defense- in-depth, and safety	**GEH/GNF Position/Response/Comment 7:** The corrective actions and reporting criteria specific to the risk-informed approach for addressing the effects of debris on long-term cooling should not be any different than current requirements that are applicable to probabilistic evaluations that are acceptable today. The details of risk-informed alternative, including the reporting requirements, should not be part of the LOCA rule. The rule should only be changed to allow the alternative approach without the exemption requests. But, a very prescriptive language that is present in the currently proposed (i.e. 50.46c(m)(4)) rule is counterproductive, especially, while the regulatory effort between stakeholders is still in progress.

Question	GEH/GNF Position
margins to confirm the acceptance criteria for the risk-informed approach continue to be met. The NRC seeks specific comment on the reporting criteria for the risk-informed approach. Alternatively, the NRC seeks comment on whether the reporting criteria for the risk-informed approach should be more prescriptive and establish requirements similar to those for the ECCS model (i.e., § 50.46c(m)(1) through (m)(3)). For instance, should the rule establish values for changes in D CDF, Δ LERF, defense-in-depth, and safety margins that would trigger specific reporting actions? If so, what values should reporting criteria establish as reporting triggers and what are the bases for selecting those values?	
NRC Question 8. *Exemptions Needed to Implement the Risk-Informed Alternative.* One objective of the proposed rule is to allow entities to submit a risk-informed alternative to address the effects of debris on long- term core cooling without the need to submit an exemption request. The NRC identified that, in order to eliminate the need for an exemption, changes may be necessary in GDCs 35, 38, and 41, as provided in the proposed rule. The NRC seeks input on whether conforming changes to other regulations would be necessary or desirable. Such conforming changes may avoid the need for entities wishing to use the risk-informed alternative to request exemptions from those regulations in order to effectively implement the risk-informed alternative. If you believe it is necessary or desirable to provide a conforming change to a regulation in order to avoid an exemption from that regulation, then please identify the specific regulation (and specific regulatory provisions, if applicable) for which a conforming	**GEH/GNF Position/Response/Comment 8:** GEH/GNF did not identify other regulations which should have allowable exemption for the risk-informed alternative. It should be also noted that, the BWROG voluntarily continues responding to NRC's debris related questions. The envisioned testing and evaluation programs extend beyond the dates proposed for the final rule. Therefore, it would be premature to shape the 50.46c rule with a specific language prior to a path for resolution is finalized. However, if the rule contains only language related to elimination of the need for an exemption without the implementation and reporting details, it would be possible to adapt future regulatory decisions. In the light of on-going discussions on debris-related issues for BWRs and the absence of finality on the matter, GEH/GNF has no further comment.

Question	GEH/GNF Position
change would be made, either the language of the change or a description of the conforming change's objective, and the reason(s) why an exemption would otherwise be needed if the NRC did not make a conforming change to that regulation.	
NRC Question 9. *Staged Implementation.* The NRC is proposing, in § 50.46c(o), a staged implementation plan for the proposed rule. As part of this plan, licensees have been divided among three implementation tracks based upon existing margin to the revised requirements and anticipated level of effort to demonstrate compliance. The NRC requests specific comment on the staged implementation plan, track assignments, or alternative means to implement the requirements of the proposed rule.	**GEH/GNF Position/Response/Comment 9:** A staged implementation of the proposed rule is an efficient approach. However, listing of the plant names in the track assignments could be problematic if the conditions that had resulted in particular assignment changes for a given plant. A better approach would be setting forth the criteria for compliance timetable in the rule. The criteria could be similar to the one used in the current proposed rule. The licensees then can provide their plan for compliance with the revised rule within a predetermined timeframe. The expectations of the content of the plan could be included in the rule. The plan should include the method (e.g. demonstration of existing analysis against new limits. a new analysis using existing EM, or a new analysis with a new methodology), and submittal date. The alternative means to implement the requirements of the proposed rule should not exclude so-called a 'hardware solution'. Implementation of fuel should be also allowed in lieu of analysis-only as It would introduce a greater safety margin. Such individual plans by the licensees would be reviewed and agreed by the NRC before implementation. Depending on the final rule, the licensees might need to do more analysis to comply with requirements associated with debris and crud. Compliance with the breakaway oxidation requirements will also take additional effort. Therefore, it is not clear from the rule and the proposed staged implementation plan how the Track 1 plants can comply with the new rule in 24 months. Given the variety of issues that need to be addressed, additional time in the rule might be needed to avoid exemptions.
NRC Question 10. *New Reactor Implementation.* The NRC is proposing, in § 50.46c(o)(5) through (9), an implementation approach that takes into account design certifications, standard design approvals, manufacturing licenses, and combined licenses and their status in relation to the effective date of the rule. The proposed	**GEH/GNF Position/Response/Comment 10:** It is logical to expect new applications to comply with the rule that is then current. However, there is no need to urge the new reactor designs to comply with all requirements of the rule faster than the current operating plants, especially when their LOCA response is typically more favorable compared to current technology. NRC should consider giving similar grace periods after the final rule date, since none of these issues

Question	GEH/GNF Position
implementation plan for new reactors would allow applicants for a design certification, standard design approval, and manufacturing license under review at the time of the effective date of the rule to come into compliance with the rule at time of renewal. The holder of a combined license issued prior to the effective date of the rule would be permitted to operate the plant for one fuel cycle before coming into compliance with the rule. Therefore, the NRC is proposing to recognize that new reactors may operate for the initial fuel cycle with fuel for which the burnup effects being accounted for in the rule would not be a consideration. Applications for design certifications, standard design approvals, manufacturing licenses and combined licenses submitted after the effective date of the rule would be expected to be in compliance with the rule at the time of approval. The NRC is requesting input regarding this implementation proposal, including suggestions for alternate approaches.	pose a safety concern.
NRC Question 11. *Re-structuring 10 CFR Chapter I with respect to ECCS Regulations.* The NRC is considering restructuring its ECCS regulations as part of the finalization of this rulemaking due to: (1) Commission direction to include in the proposed rule a provision allowing licensees to use a risk-informed submittal to address the effects of debris during the long- term recovery period; and (2) the potential benefit and efficiency of collocating all ECCS-related requirements within the CFR. As such, the NRC seeks comment on the following potential administrative changes: • Codify the performance-based ECCS and cladding requirements (as proposed in this	**GEH/GNF Position/Response/Comment 11:** GEH/GNF sees no particular benefit from the potential administrative changes. In contrast, the proposed changes will create confusion and unnecessary paperwork for compliance. As also acknowledged by NRC, such changes would have a large impact on licensees and fuel suppliers with regard to procedures, plans, programs, topical reports, and engineering calculations that reference Appendix K and the current ECCS regulations, without any significant benefit. GEH/GNF notes the commission direction to include in the proposed rule a provision allowing licensees to use an alternative risk-informed submittal to address the effects of debris during the long-term recovery period in the most simplified manner possible. This goal can be better accomplished with addition of a single paragraph stipulating that licensees opting for the alternate risk-informed solution for debris concerns in LTC would not need to submit requests for exemption from specified regulation. All the

Question	GEH/GNF Position
document) as a new section, § 50.181. • Reserve § 50.183 for the potential future risk-informed ECCS requirements rule (currently referred to as the draft final § 50.46a rule). • Codify the requirements for the risk-informed submittals (proposed as § 50.46c(e) in this proposed rule) to address the effects of debris in the long- term recovery period as a new section, § 50.185. • Duplicate the content of appendix K to 10 CFR part 50, ECCS evaluation models, and add the content as a new section, § 50.187. (The NRC notes that appendix K to 10 CFR part 50 will remain in place until all licensees have implemented the proposed requirements (i.e., until completion of the proposed staged implementation period).) • If this restructure is pursued, following the completion of the proposed staged implementation period, the NRC would make the following administrative changes: ○ Remove the current § 50.46, ECCS acceptance criteria, in its entirety. ○ Remove the current appendix K to 10 CFR part 50, in its entirety. (The content will exist as § 50.187.) ○ Redesignate the current § 50.46a, ''Acceptance criteria for reactor coolant system venting systems,'' as § 50.46. The tables that follow depict the described potential changes: *[... Table is omitted here for brevity...]* Should this restructure be pursued, the following table depicts the structure of 10 CFR part 50 after finalization of the § 50.46a Risk-Informed ECCS Requirements and after the proposed staged implementation of the § 50.46c Performance-based	other details for the risk-informed alternative, including the acceptance and reporting requirements, would be best handled if they are contained in a regulatory guide. As a simplification effort, GEH/GNF supports the industry idea of moving the content of Appendix K to 10 CFR Part 50 into a new regulatory guide while keeping Appendix K with a high-level of requirements and criteria for conservative evaluation methods.

Question	GEH/GNF Position
ECCS and Cladding Requirements rulemaking is complete: *[... Table is omitted here for brevity...]* The NRC acknowledges that such changes could have a large impact on licensees and vendors with regard to procedures, plans, programs, topical reports, and engineering calculations that reference appendix K to 10 CFR part 50 and the current ECCS regulations. In your comments, please include the estimated cost for conforming changes to topical reports, licensing amendments, and other technical documents. Please also comment on whether the anticipated benefits and efficiencies would outweigh the administrative burden, costs, and complexities.	
NRC Question 12. *Cumulative Effects of Regulation.* The cumulative effects of regulation (CER) consist of the challenges licensees face in addressing the implementation of new regulatory positions, programs, and requirements (e.g., rulemaking, guidance, generic letters, backfits, inspections). The CER is manifested in several ways, including the total burden imposed on licensees by the NRC from simultaneous or consecutive regulatory actions that can adversely affect the licensee's capability to implement those requirements while continuing to operate or construct its facility in a safe and secure manner. Consistent with SECY–11–0032, "Consideration of the Cumulative Effects of Regulation in the Rulemaking Process," dated March 2, 2011 (ADAMS Accession No. ML110190027), the NRC is requesting comments on CER with respect to this proposed rulemaking. The NRC's consideration of CER will be based, in part, on the NRC's confirmation of the safe operation for each operating	**GEH/GNF Position/Response/Comment 12:** a. The rule's effective date, compliance date, and submittal dates do not provide sufficient time to implement the new proposed requirements, including changes to programs, procedures, in light of other CER challenges. As illustrated by the owners' group reports on margin assessment and the agency's own evaluation, the high-burnup fuel research findings do not pose a safety concern. b. To cope better with ongoing CER challenges, GEH/GNF would suggest having more implementation schedule flexibility. This can be accomplished by allowing licensees to develop their own plan for compliance based on the principles laid out in the regulation. NRC can then evaluate the proposed implementation plans on a case-by-case basis. c. The breakaway oxidation periodic testing requirement does not support the revised rule's goal of providing adequate protection to the health and safety of the public. After the initial testing, process control of fuel manufacturing would sufficiently ensure no early onset of breakaway oxidation. With the implementation of the rule in its currently proposed form, the periodic testing requirement will continue to be an unnecessary burden to the industry for years to come, without enhancing public health and safety, and will add to the

Question	GEH/GNF Position
reactor, as described in Section III, "Operating Plant Safety," of this document. During the development of this proposed rulemaking, the NRC engaged external stakeholders through multiple public meetings, an ANPR, and solicitation of public comments. Additionally, the proposed rule would establish a staged implementation plan, which would reduce the overall implementation burden on licensees. With regard to CER, the NRC requests specific comment on the proposed rule's implementation schedule in light of any existing CER challenges, specifically: a. Do the proposed rule's effective date, compliance date, and submittal dates provide sufficient time to implement the new proposed requirements, including changes to programs, procedures, and the facility, in light of any ongoing CER challenges? b. If there are ongoing CER challenges, what do you suggest as a means to address this situation (e.g., if more time is required for implementation of the new requirements, what time period is sufficient)? c. Are there unintended consequences (e.g., does the proposed rule create conditions that would be contrary to the proposed rule's purpose and objectives)? If so, what are the unintended consequences? d. Please comment on the NRC's cost and benefit estimates in the proposed rule regulatory analysis (ADAMS Accession No. ML12283A188). Specifically, please comment on the vendor hydrogen uptake and LOCA model costs, costs of PQD and breakaway testing, and licensee analysis costs.	existing and future CER challenges. The resources that will be potentially spent to address the breakaway oxidation concerns are not warranted. In particular, the periodic testing and reporting requirement would consume resources without providing any additional safety or contributing any new technical knowledge. The periodic testing requirement for breakaway oxidation in the rule is excessive and can potentially results in a situation that is contrary to the proposed rule's objectives by reducing or limiting valuable resources that would be otherwise used for enhancing safety. d. The manpower estimates provided in the regulatory analysis seem low. It is not possible to accurately estimate the necessary effort without a detailed project plan. Based on the recent examples of LOCA EM reviews, a 2 year calendar time to review the models appear to be unrealistically low.

Part 2 – Comments on the Proposed Rule and Its Language

Comments in this section refer to the proposed 10 CFR 50.46c rule language that is published in the Federal Register, Volume 79, Number 56 (March 24, 2014) pp. 16139-16146.

Proposed Rule § 50.46c	GEH/GNF Position/Comment
(d)(2)(iii) *Core geometry and coolant flow.* The ECCS evaluation model must address calculated changes in core geometry and must consider those factors, including debris, that may alter localized coolant flow in the core or inhibit delivery of coolant to the core. A licensee may evaluate effects of debris using a risk-informed approach to demonstrate long-term ECCS performance, as specified in paragraph (e) of this section.	**GEH/GNF Position/Response/Comment 13:** In paragraph (d)(2)(iii), the words "including debris" expands the scope of the rulemaking beyond the high-burnup research findings and the original goal stated in *Purpose of Regulatory Action*. Recommendation: The NRC should allow the industry to resolve the debris-related issues under the ongoing programs, such as GSI-191 resolution for PWRs and voluntary cooperation of BWROG. Once the concerns are addressed, there would be no need to permanently alter the LOCA methodologies for standard evaluations.
(d)(3)(vi) For operating licenses issued under this part as of [EFFECTIVE DATE OF RULE], required documentation of Table 1 in paragraph (o) of this section must be submitted to demonstrate compliance by the date specified in Table 1 in paragraph (o) of this section.	**GEH/GNF Position/Response/Comment 14:** There appears to be an editorial mistake in paragraph (d)(3)(vi): the words "of Table 1 in paragraph (o) of this section" from the end of 3rd line and in the 4th line of the paragraph seem mistakenly inserted. Recommendation: Remove the extra words.

Proposed Rule § 50.46c	GEH/GNF Position/Comment
(e) *Alternate risk-informed approach for addressing the effects of debris on long-term core cooling.*	**GEH/GNF Position/Response/Comment 15:** As indicated in the response to NRC Question 4, rule should only contain a high-level goal and acceptance criteria accompanied with any necessary wording to indicate no exemptions needed. Recommendation: Details given paragraphs (e)(1) through (e)(3) should be moved to an applicable regulatory guide.
(g)(1)(i) *Peak cladding temperature.* Except as provided in paragraph (g)(1)(ii) of this section, the calculated maximum fuel element cladding temperature shall not exceed 2200 °F.	**GEH/GNF Position/Response/Comment 16:** In paragraph (g)(1)(i), inconsistent with performance-based rule. It is recommended that PCT limit higher 2200 °F, if justified, should be allowed. Recommendation: Adopt a rule language that is consistent with performance-based aim of the regulation. For example: *The calculated cladding temperature shall not exceed an acceptable PCT analytical limit. Any analytical PCT limit higher than 2200 °F must be approved by NRC.*

Proposed Rule § 50.46c	GEH/GNF Position/Comment
(g)(1)(ii) *Cladding embrittlement.* Analytical limits on peak cladding temperature and integral time at temperature shall be established that correspond to the measured ductile-to brittle transition for the zirconium-alloy cladding material based on an NRC-approved experimental technique. The calculated maximum fuel element temperature and time at elevated temperature shall not exceed the established analytical limits. The analytical limits must be approved by the NRC. If the peak cladding temperature, in conjunction with the integral time at temperature analytical limit, established to preserve cladding ductility is lower than the 2200 °F limit specified in paragraph (g)(1)(i) of this section, then the lower temperature shall be used in place of the 2200 °F limit.	**GEH/GNF Position/Response/Comment 17:** In paragraph (g)(1)(ii), the wording describing a lower PCT applicable at higher hydrogen content can be improved to avoid misunderstanding. For example: ... If the peak cladding temperature resulting from the integral time at temperature analytical limit, established to preserve cladding ductility is lower than the 2200 °F limit specified in paragraph (g)(1)(i) of this section, then the lower temperature shall be the applicable limit corresponding to the integral time at temperature analytical limit.
(g)(1)(v) *Long-term cooling.* An analytical limit on long-term peak cladding temperature shall be established that corresponds to the ductile-to-brittle transition for the zirconium-alloy cladding material determined using an NRC-approved experimental technique. The analytical limit must be approved by the NRC.	**GEH/GNF Position/Response/Comment 18:** In paragraph (g)(1)(v), the rule should recognize that the performance-based metric does not necessarily require an analytical limit that corresponds to the ductile-to-brittle transition as long as the established temperature limit preserves ductility. In other words, the ductile-to-brittle transition might not be the sole criterion. Recommendation is to change to wording so that the limit is not restricted to actual transition. For example: An analytical limit on long-term peak cladding temperature shall be established that ensures ductility is preserved for the zirconium-alloy cladding material determined using an NRC-approved experimental technique. The analytical limit must be approved by the NRC.

Proposed Rule § 50.46c	GEH/GNF Position/Comment
(m)(1) *Categories of changes, errors, or operation inconsistent with the ECCS evaluation model.*	**GEH/GNF Position/Response/Comment 19:** (m)(1) "operation inconsistent" is a confusing term because the analysis is generally more bounding than the actual operation. Its broad meaning is likely to cause misinterpretation in the future. Recommendation: remove the words "operation inconsistent with" in this and subsequent paragraphs.
(m)(1)(i) If an entity identifies any change to, or error in, an ECCS evaluation model or the application of such a model, or any operation inconsistent with the ECCS evaluation model or resulting noncompliance with the acceptance criteria in this section, that does not result in any predicted response that exceeds any acceptance criteria specified in this section and is itself not significant, then a report describing each such change, error, or operation and a demonstration that the error, change, or operation is not significant must be submitted to the NRC no later than 12 months after the change or discovery of the error, or operation.	**GEH/GNF Position/Response/Comment 20:** In the current rule, an estimate for the impact of a change or an error in the EM is necessary. In the proposed rule, a demonstration that the error, change, or operation is not significant is required. Clarification is needed that, similar to impact estimate, the demonstration can be based on first principles, known sensitivities, code calculations, and/or engineering judgment.

Proposed Rule § 50.46c	GEH/GNF Position/Comment
(m)(3) *Breakaway oxidation* Each holder of an operating license or combined license shall measure breakaway oxidation for each reload batch. The holder must report the results to the NRC annually (i.e., anytime within each calendar year), in accordance with § 50.4 or § 52.3 of this chapter, and evaluate the results to determine if there is a failure to conform or a defect that must be reported in accordance with the requirements of 10 CFR part 21.	**GEH/GNF Position/Response/Comment 21:** The requirement to measure and report breakaway oxidation for each reload batch is unnecessary when breakaway oxidation is addressed as part of fuel supplier's QA program and considering the margin to breakaway oxidation that exists for BWR LOCAs. A typical BWR will only experience time period less than hundred seconds following a LOCA at temperatures high enough to cause breakaway oxidation, while the time required for breakaway oxidation is several thousand seconds. This proposed requirement will therefor cause an undue burden to the holder of an operating license or combined license and provide no safety benefit. GEH/GNF recommends either of two options. First option is to delete paragraph (m)(3). Second, alternate option is to replace wording in paragraph (m)(3) with: Each holder of an operating license or combined license shall retain documentation demonstrating that cladding used for each reload batch has satisfied the fuel supplier's NRC-approved acceptance criteria that assures the cladding is not susceptible to breakaway oxidation within the approved timeframe. Discovery of a failure to conform or a defect must be reported in accordance with the requirements of 10 CFR part 21.

Proposed Rule § 50.46c	GEH/GNF Position/Comment
(m)(4) *Updates to risk-informed consideration of debris in long-term cooling.*	**GEH/GNF Position/Response/Comment 22:** Being a voluntary alternative, the risk-informed approach for the debris-related issues during LTC would be most efficiently managed is all of the associated requirements are maintained in a separate regulatory guide. Furthermore, the nature of risk-informed approach is about considering the relative contribution of debris to the overall risk calculated for the plant. Once the debris related issue is resolved for a given plant, maintaining and updating such calculation is an excessive burden that does not improve plant safety. Any significant change to such calculation would only be considered if there is a gross error in the calculation or a major change in the plant configuration. The former would be dealt with under existing corrective actions programs, including Part 21, and the latter would require additional regulatory actions. Therefore, it would not be necessary to have a separate corrective actions and reporting requirement for the risk-informed consideration of debris in long-term cooling. Recommendation: GEH/GNF recommends that Section (m)(4) be removed in its entirety.

Proposed Rule: Appendix A to Part 50	GEH/GNF Position/Comment
Criterion 35—Emergency core cooling. A system to provide abundant emergency core cooling shall be provided. The system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant at a rate such that 1) fuel and clad damage that could interfere with continued effective core cooling is prevented and 2) clad metal-water reaction is limited to negligible amounts. Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure. The effects of debris on system safety function with respect to long-term cooling may be evaluated in accordance with all requirements applicable to the risk-informed approach in § 50.46c.	**GEH/GNF Position/Response/Comment 23:** GDC-35 is related to the plant hardware. Analogous to that there is no mention of best-estimate alternative instead of Appendix K for evaluation of ECCS performance, there is no need to insert a provision for risk-informed alternative to avoid an exemption here. Such clarification made in 50.46c is sufficient. <u>Recommendation:</u> No change in GDC.

Proposed Rule: Appendix A to Part 50	GEH/GNF Position/Comment
Criterion 38—Containment heat removal system. A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss of-coolant accident and maintain them at acceptably low levels. Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure. The effects of debris on safety system function with respect to the maintenance of containment pressure and temperature may be evaluated in accordance with all requirements applicable to the risk-informed approach in § 50.46c.	**GEH/GNF Position/Response/Comment 24:** Similar to the comment above, no change in GDC-38 is necessary to insert a provision for the risk-informed approach.

Proposed Rule: Appendix A to Part 50	GEH/GNF Position/Comment
Criterion 41—Containment atmosphere cleanup. Systems to control fission products, hydrogen, oxygen, and other substances which may be released into the reactor containment shall be provided as necessary to reduce, consistent with the functioning of other associated systems, the concentration and quality of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents to assure that containment integrity is maintained. Each system shall have suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) its safety function can be accomplished, assuming a single failure. The effects of debris on system safety function following occurrence of the postulated accidents may be evaluated in accordance with all requirements applicable to the risk-informed approach in § 50.46c.	**GEH/GNF Position/Response/Comment 25:** Similar to comments above, no change in GDC-41 is necessary to insert a provision for the risk-informed approach.

Part 3 – Comments on the Draft Regulatory Guides

Comments – General	
DG-1261 and DG-1262 contain detailed requirements on thermocouple calibration and certification, and includes attachment of certificates to data reports.	**GEH/GNF Position/Response/Comment 26:** Much of such requirements duplicate routine activities undertaken under fuel vendor's quality assurance program. For GEH, the QA program is implemented in accordance with 10 CFR Part 50 Appendix B and NQA-1. The program contains specific requirements on calibration, certification and use of nationally recognized standards or international standards. Recommendation: The requirement in DG-1261 and DG-1262 to attach calibration certificates to data reports is therefore redundant and unnecessary, and should be removed.

Comments on DG-1261	
DG-1261 page 5 on Reporting Results of Periodic Testing states that "The objective of periodic testing is to confirm that a cladding's susceptibility to breakaway oxidation has not been altered. Therefore, it is acceptable to report only changes in the time to the onset of breakaway oxidation." In addition, A-2.3 and in other parts of DG-1261, it is	**GEH/GNF Position/Response/Comment 27:** As discussed above in response to Question 2, testing conducted as part of the fuel vendor program is likely on a pass/fail basis judged against a specification test time that is (or is longer than) being considered for LOCA analysis. Test results are expected to reflect merely compliance with specification requirements, which is generally required as part of the fuel reload certification process. As discussed earlier, the vendor quality control and assurance program is capable of achieving the broader goal of assuring only loading unaffected fuel into reactors. The more narrow objective in DG-1261 of periodically testing for and reporting on variations in onset time to

Comments on DG-1261	
presumed that the time for the onset of breakaway will always be measured.	breakaway oxidation is unnecessary in light of meeting the broader objective; this narrow objective of testing for variation cannot be easily addressed. Recommendation: GEH/GNF recommends that the NRC reconsider the technical basis and hence the need to conduct periodic testing and associated reporting.
DG-1261 page 5 on Periodic Testing and referenced sections in Appendix A discuss doing 5 repeats for the test condition (temperature and time) under which breakaway oxidation does not occur.	**GEH/GNF Position/Response/Comment 28:** Perusal of NUREG/CR-6976, specifically Tables 19, 20, 23, 29 and 36 containing test results for breakaway oxidation of various Zr-alloys, showed that no more than two repeats were conducted at any given test condition, i.e. temperature and time combination. Recommendation: in keeping with not introducing undue burden, GEH/GNF recommends that the test repeats be set as two repeats.
DG-1261 A-6.3 on Weight-Gain Benchmarks discusses weight-gain for 2000 seconds or less at 1000 °C should be within +/- 10% of CP correlation, and that tests should not continue unless the requirement is met.	**GEH/GNF Position/Response/Comment 29:** As discussed in the April 30th, 2014 Public Meeting, most available data do not fall within +/- 10% of CP correlation (NUREG-17); the 1000 °C test data in Table 8 of NUREG/CR-6967 also do not fall within +/- 10% of CP correlation. In NUREG-17, it is stated that the CP correlation is not applicable below ~ 1000 °C. Recommendation: For the purpose of conducting breakaway oxidation test at mostly 1000 °C or lower, GEH/GNF recommends elimination of the requirement to be within +/- 10% of CP correlation; instead weight-gain benchmark could be achieved by comparing with available database, such as generated by the industry round-robin.
DG-1261 A-7.1 on Water Quality states that, as an option, Grade A water with ≤45 parts per billion (ppb) of oxygen be used for testing.	**GEH/GNF Position/Response/Comment 30:** As discussed in the April 30th, 2014 Public Meeting, tests conducted at GNF have shown that whether or not measures are taken to address the 45 ppb oxygen criterion can have an effect on the timing for breakaway oxidation onset. Most laboratories do

Comments on DG-1261	
	not follow the option of addressing the 45 ppb oxygen criterion. Recommendation: in keeping with available database generated by a number of laboratories, GEH/GNF recommends that the 45 ppb oxygen criterion be removed from the water quality section.
DG-1261 A-9.2 on Weight Measurement and Use of Weight-Gain to Verify Oxidation Temperature states that weight-gain is not used for determining onset of breakaway oxidation; instead, onset is to be determined based on post-test visual examination or hydrogen measurement described in A-9.3 and A-9.4 respectively.	**GEH/GNF Position/Response/Comment 31:** These considerations appear to be tied to the types of furnaces listed in A-5, which generally test one sample at a time, and hence only permit one visual examination or one measurement of hydrogen or weight-gain to be performed per test. As discussed at the June 2014 Public Meeting, ML14175A116, weight-gain is an inevitable result of oxidation and breakaway oxidation should be in principle detectable based on weight-gain, provided multiple weight-gain measurements are available. In the literature on high temperature steam oxidation testing of Zr-alloys, continuous on-line measurement of weight-gain has been used in studies related to breakaway oxidation by researchers in Germany, Japan and Korea. For this type of on-line weight-gain measurements, Thermogravimetric Analysis (TGA) instruments that can handle a steam environment have been used. Recommendation: consistent with testing methods used by a number of laboratories, GEH/GNF recommends that a) TGA type of instruments is included as an acceptable type of device for assessing breakaway oxidation, and b) on-line weight-gain measurement from TGA instruments is an acceptable method for detecting onset of breakaway oxidation.
DG-1261 A-8 contains conditions for steam introduction and temperature ramping.	**GEH/GNF Position/Response/Comment 32:** Associated with the previous recommendation, the steam introduction and temperature ramp up conditions described in A-8 would not be applicable to TGA type

Comments on DG-1261	
	of instruments. Recommendation: GEH/GNF recommends that provisions in A-8 be made to include steam introduction and temperature ramp conditions appropriate to oxidation equipment, such as TGA instruments, used.
DG-1261 A-4.2 states that the minimum sample length should be 25 mm but justification for the numeric value is not given.	**GEH/GNF Position/Response/Comment 33:** In the literature since 1999, the majority of researchers investigating high temperature steam oxidation of Zr-alloys, including the breakaway phenomenon, use cladding samples with 8 – 20 mm in length; cladding length as low as 5 mm has been used. Recommendation: GEH/GNF recommends that the minimum sample length be set at 8 mm.

Comments on DG-1262	
DG-1262, Section 6.3 on Weight-Gain Benchmarks, states that weight-gain (up to 10% ECR) at 1200, 1100 and 1000 °C should be within 10% of the CP correlation.	**GEH/GNF Position/Response/Comment 34:** As discussed above for DG-1261 A-6.3, expecting Zircaloy oxidation to be within 10% of CP correlation is not warranted for testing at 1000 °C. Recommendation: GEH/GNF recommends that 1000 °C be removed in section 6.3 for the purpose of weight-gain benchmarking.

Comments on DG-1263	
Regarding post-quench ductility and determination of transition ECR	**GEH/GNF Position/Response/Comment 35:** DG-1263 contains much prescriptive details for determining the transition ECR at a given cladding hydrogen level. The approach taken presumes that multiple test samples of the same hydrogen content can be produced by appropriate hydrogen charging of the cladding. Testing of samples with the same hydrogen level but different ECR levels is needed to determine the transition ECR for the hydrogen content. The variation of transition ECR is then plotted separately as a function of different hydrogen levels. In practice, considerable variation can result from typical hydrogen charging processes, so that large uncertainties are introduced when attempting to find the transition ECR at a nominal hydrogen content that can in reality vary considerably, as determined, for example, by post-test hydrogen measurements on the test specimens. In order to reduce uncertainties associated with determining transition ECR at different hydrogen levels, other methods are needed. <u>Recommendation:</u> GEH/GNF recommends that DG-1263 should provide provisions for other methods for determining the transition ECR. A simple approach would be to use a scatter plot of pre-test ECR versus post-test hydrogen, in which the transition ECR is determined by defining a line that separate tests showing brittle and ductile behaviors.
Regarding alloy specific hydrogen model and ECR versus burnup plot	**GEH/GNF Position/Response/Comment 36:** During the June Public Workshop, a suggestion was made regarding the staff providing an ECR versus burnup plot for each approved cladding alloy. The suggestion in effect incorporates a hydrogen model (hydrogen as a function of burnup) for each alloy. GEH/GNF welcomes such a suggestion. <u>Recommendation:</u> GEH/GNF recommends the NRC follow through with the suggestion of providing an ECR versus burnup plot for each approved cladding alloy.

Comments on DG-1263	
Regarding use of pre-hydrided cladding as surrogate for irradiated cladding	**GEH/GNF Position/Response/Comment 37:** The research work on hydrogen effect on embrittlement oxidation limit as summarized in Figure 1 of DG-1263 showed no significant difference between pre-hydrided and irradiated cladding. This observation is true for the different Zr-alloys that were tested; in other words, there is little sensitivity to alloy type for the suitability of using pre-hydrided cladding, which would be cost-effective, as a surrogate for irradiated cladding. <u>Recommendation:</u> GEH/GNF recommends that testing of pre-hydrided cladding be an acceptable surrogate for irradiated cladding, for Zr-alloys similar in composition to ones tested at ANL, and that testing of irradiated cladding is optional.
Regarding to analytical limit associated with breakaway oxidation.	**GEH/GNF Position/Response/Comment 38:** There appears to be inconsistencies in DG-1263 regarding the temperature at which the time to onset of breakaway oxidation, determined from DG-1261, should be applied. In the proposed rule (g.1.iii), and also in section B, Applying Analytical Limits - Breakaway Oxidation Analytical Limits on page 14 of DG-1263, the phrase "temperature at which the zirconium alloy has been shown to be susceptible" is used; however, on pages 11 and 17 of DG-1263, a temperature of 650 °C is given. The origin of 650 °C appears to be not based on test results, such as generated from following DG-1261, and according to page 11 of DG-1263 appears to be based on Leistikow-Schanz (1987) data and lack of hydrogen data between 650 °C and 800 °C in NUREG-IA0211 (2005). As discussed during the Public Meetings in April and June of 2014 (ML14175A116), modern Zircaloy-4 cladding showed low hydrogen content, i.e. not developing breakaway oxidation, after 7000 seconds of testing at 800°C. The risk of developing cladding embrittlement due to breakaway oxidation is therefore low at 800°C, and even lower for temperatures below 800°C.

Comments on DG-1263	
	Recommendation: GEH/GNF recommends that a) the term "temperature at which the zirconium alloy has been shown to be susceptible" should be used consistently throughout DG-1263, and b) both time and temperature obtained using DG-1261 be used to define analytical limit in DG-1263. For example, the analytical temperature limit could be based on testing for 5000 seconds at different temperatures.
Regarding Qualification of Hydrogen Pickup Models	**GEH/GNF Position/Response/Comment 39:** Under Qualification of Hydrogen Pickup Models and also under Accounting for Uncertainty and Variability in Hydrogen Content, quantifying axial, radial, and circumferential variability is discussed. However, last paragraph under Accounting for Uncertainty and Variability in Hydrogen Content states that predicted peak circumferential average hydrogen content should be used when applying analytical limit shown in Figure 2. The quantification and modeling of radial and circumferential variability is therefore not necessary. Recommendation: GEH/GNF recommends that DG-1263 provides consistent wording to the effect that models should address circumferentially averaged hydrogen content.