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PWR Owners Group

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Washington, DC 20555–0001

Subject: PWR Owners Group
Transmittal of the PWROG Comments on the Draft Guidance Regarding the Draft Regulatory Guide (DG) DG-1322, "Alternate Risk-Informed Approach for Addressing the Effects of Debris on Post-Accident Long-Term Core Cooling", (PA-LSC-0793)

Enclosed are the PWROG comments regarding the Draft Regulatory Guide (DG) DG-1322, "Alternate Risk-Informed Approach for Addressing the Effects of Debris on Post-Accident Long-Term Core Cooling."

For technical questions regarding the enclosed PWROG comments, please contact Stanley Levinson (AREVA) at (434) 832-2768.

If you have any additional questions or comments on the enclosed information, feel free to contact Chad Holderbaum in the PWROG office at (412) 374-6230.

Sincerely,

Norman J. Stringfellow

Jack Stringfellow
Chief Operating Officer & Chairman
Pressurized Water Reactor Owners Group

NJS:CMH:rnf

SUNSI Review Complete
Template = ADM – 013
E-RIDS= ADM-03
Add= S.A. Lgur (Sal)
S. Burton (sxb3)

Enclosures: (1) PWROG Comments on Draft Regulatory Guide (DG) DG-1322, "Alternate Risk-Informed Approach for Addressing the Effects of Debris on Post-Accident Long-Term Core Cooling"

Reference: AREVA Letter 15-01668

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ENCLOSURE 1

PWROG Comments on Draft Regulatory Guide (DG) DG-1322, "Alternate Risk-Informed Approach for Addressing the Effects of Debris on Post-Accident Long-Term Core Cooling"

This enclosure provides comments and observations prepared and submitted by the Pressurized Water Reactor Owners Group (PWROG) on draft regulatory guide (DG) DG-1322, "Alternate Risk-Informed Approach for Addressing the Effects of Debris on Post-Accident Long-Term Core Cooling." The request for public comments was made via a Federal Register Notice (FRN), Vol. 80, No. 75, Monday, April 20, 2105, pages 21658-21659, NRC-2015-0095.

The PWROG previously provided comments on the draft rulemaking language for 10 CFR 50.46c specifically related to the risk-informed approach to address the impact of debris on long-term cooling; see letter from Jack Stringfellow, Chief Operating Office and Chairman, PWROG to Annette Vietti-Cook, Secretary, Nuclear Regulatory Commission (NRC), OG-14-289, August 20, 2014. Those comments addressed four questions raised by the staff in the FRN.

The PWROG assumes, for the purpose of these comments on DG-1322, that the 10 CFR 50.46c rulemaking language pertaining to the risk-informed option (i.e., 50.46c(e) and 50.46c(m)(4)(vii)) remain unchanged from what was released in the FRN Vol. 79, No. 56, Monday, March 24, 2014.

Regulatory Guide (RG) 1.174 is explicitly cited in DG-1322. The NRC expects licensees to consider risk, defense-in-depth, safety margin, and implementation of performance measurement strategies (four of the principles taken directly from RG 1.174 - refer to Section A. Introduction/ *Related Guidance*.) DG-1322 is intended to describe a risk-informed approach acceptable to the NRC that licensees can use to address the effect of debris on long-term cooling (refer to Section B. Discussion/*Reason for Issuance*). Without this alternative, licensees would need to seek an exemption request to implement a risk-informed approach. The objective of GSI-191 is to ensure that post-accident debris blockage will not impede or prevent the operation of the emergency core cooling system (ECCS) or containment spray system in recirculation mode at pressurized water reactors (PWRs) during loss of coolant accidents (LOCAs) or other high energy line breaks (HELBs) for which recirculation is required. The use of a risk-informed approach **is optional**; some plants have already dealt with the issue deterministically, e.g., redesigned strainers, replacing fibrous insulation with reflective metal insulation (refer to Section B. Discussion/*Background*).

<u>Generic Observations/Comments</u>

1. The draft regulatory guide, DG-1322, contains an acceptable methodology to the NRC that a licensee could use as a risk-informed approach to address the effects of debris on post-accident long-term core cooling. The option of using a risk-informed approach to

address the effects of debris on post-accident long-term cooling is provided in 10 CFR 50.46c. All of the process requirements, e.g., probabilistic risk assessment (PRA) technical adequacy, reporting requirements, etc. apparently still remain in the draft rulemaking language.

The approaches for some items from the rulemaking language are included in DG-1322, e.g.,

- (e)(1)(i) small change in core damage frequency (CDF) and large early release frequency (LERF)
- (e)(1)(ii) maintain defense-in-depth and safety margins
- (e)(2)(i) description of an alternative approach

Items for which DG-1322 does not provide an acceptable approach in the draft rulemaking language include:

- (e)(1)(iii) consider results and insights from PRA
- (e)(1)(iv) PRA approach scope, level of detail, and technical adequacy
- (e)(2)(ii) PRA scope, etc. are commensurate with the reliance on risk information
- (e)(2)(iii) PRA review process
- (e)(2)(iv) description and basis of evaluations to satisfy (e)(1)(i) and (ii)
- (e)(3) NRC approval
- (m)(4)(vii) for operating licenses (other parts deal with design certification and COLAs – not directly applicable to PWROG scope)

In the PWROG letter of August 20, 2014, in response to a question posed in the FRN, the PWROG recommended that the rule-making language should be limited to high-level requirements and acceptance criteria. The rationale being that rule language is difficult to change once promulgated and different interpretations, requiring clarification, are often identified during implementation. As noted above, there are a number of areas where the rule language could be moved to the regulatory guide. *The PWROG recommends that the staff considers moving as much language as possible from the rule language to the regulatory guide.*

2. The basic steps of the risk-informed alternative approach, as delineated in Section C. Staff Regulatory Guidance, are very high level. An analyst would not be able to perform a technical task based solely on the information provided in DG-1322. So while DG-1322 is valuable in laying out the elements of a risk-informed program (e.g., debris creation, debris, transport, screen head loss, chemical effects, etc.), the analytical methods

to achieve these elements are likely to be varied; the language of the draft regulatory guide would permit multiple, equivalent approaches to be used, all of which would need to be reviewed by the NRC staff.

Further, while DG-1322 provides a risk-informed approach to address the effects of debris on post-accident long-term cooling, the draft regulatory guidance is heavily dependent on deterministic analyses. However, the probabilistic/Monte Carlo process that is intended to be used is not well described in DG-1322. *The PWROG recommends that the staff considers adding text to better explain acceptable methods related to the use of Monte Carlo simulation used to generate the necessary inputs to the PRA model.*

3. DG-1322 relies on a number of specific approaches and acceptance criteria that were developed for the current fleet of pressurized water reactors (PWRs). It is recognized that these approaches and criteria may not be universally applicable across the industry, and that licensee "should justify that the application of each approach or method used meets the intent of this guidance." Some of the specific approaches include WCAP-16530-NP-A (for chemical effects), WCAP-16793, Revision 2 (define in-vessel debris limits), WCAP-16406-P (evaluate downstream ex-vessel effects of debris), and NEI 04-07 (guidance for quantifying debris). The draft regulatory guide does not provide guidance when one or more of these approaches are not applicable, as might be the case for a new generation plant. *The PWROG recommends that the staff considers delineating applicability requirements for the identified approaches provided in DG-1322.*

<u>Specific Observations/Comments on C. Staff Regulatory Guidance</u>

The process in Section C. Staff Regulatory Guidance is complex. As is often the case, the approach presented in the form of a flowchart may be warranted. This would permit a high-level view of the entire process and provide a context and the interrelationship of the various elements.

<u>Editorial</u>

a. In the third paragraph of paragraph C.1, a quote is begun on the first line, and never closed. A close-quote should be added at the appropriate location.

b. In paragraph C.17.c, in the last sentence, consider the following change: "…are addressed by the next element so **<u>they</u>** do not have to be addressed …"

c. In paragraph C.17.d, in the first sentence, consider the following change: "… new common cause failure mechanisms are **to be** assessed and addressed."

Comments by Paragraph in Section C.

1. Paragraph C.1 states that the PRA required by 10 CFR 50.46c(e) must include all relevant initiators and operating modes for all hazard groups "for which debris could adversely affect core damage frequency (CDF) or large, early release frequency (LERF)." This is somewhat contrary to the draft rulemaking language, which states in Section 10 CFR 50.46c(e)(1)(iv) to use "a PRA that, as a minimum, models severe accident scenarios resulting from internal events occurring at full power operation …" The expectation for the PRA scope and level of detail is not consistent. Note that DG-1322 goes on to say that hazard groups and operating modes may be excluded using quantitative or qualitative approaches if the risk contribution would not affect decisions being made or overall results of the risk-informed analysis. *Nonetheless, DG-1322 should be consistent with the draft rulemaking language.*

   Also, note that NRC Question #6 from the March 24, 2014 Federal Register Notice (FRN) asked whether some plant operational modes could be generically excluded. The PWROG (OG-14-289) response was that in general the at-power modes should be bounding as a break at higher pressure is likely to result in a larger zone of influence that generates more debris.

2. In paragraph C.2, while it seems reasonable to identify debris-related failure modes for each system, structure and component (SSC) whose success leads to mitigation of the postulated scenarios, the examples provided indicate the need for deterministic, thermal-hydraulic calculations. Such calculations could be burdensome, expensive, and/or uncertain. Depending on the results, it is possible that such calculations could obviate the need for a risk-informed approach by showing there are no creditable failure modes of the indicated equipment. While bounding analysis is permitted, the level of deterministic calculations in this approach could be prohibitive. One approach would be to perform a failure modes and effects analysis (FMEA), which would be more qualitative and likely involve failure modes that could be screened out without a deterministic calculation. *The PWROG recommends that the staff discuss the use of this type of an approach in DG-1322.*

In paragraph C.2.d, the concept of exceeding "ex-vessel limits" is suggested. *Could the staff provide some examples of what an "ex-vessel limit" is, or define the term?*

3. In paragraph C.3, the terms "baseline PRA," "negligible," and "clearly" (twice) are used. *Does "baseline" PRA refer to a base case PRA, i.e., PRA of record? What does "negligible" mean in this context, as referring to risk increase? What does "clearly" mean in this context?*

   Also "[c]hanges to the PRA" are mentioned. Are these changes to the "baseline" PRA, or changes that are used to determine a delta-CDF (or delta-LERF)?

   The integration of SSC failure modes into the PRA fault model needs to consider:

   a. Is the SSC modeled in the PRA?
   b. If the SSC is modeled, is the new failure mode comparable to the failure modes already modeled, e.g., would a debris-related failure mode result in a partial versus full SSC failure? Would the effects of a debris-related failure mode be different from the effect currently modeled for the SSC?
   c. Most currently modeled SSC failure modes are not (LOCA break) size or location dependent. The effect (impact) of a debris-related failure mode is likely to be both (LOCA break) size and location dependent. How should they be modeled in the fault tree? Does this impact the event tree analysis?
   d. Will mission success definitions need to be recalculated? What new deterministic calculations might be needed?

   The staff should address the above considerations in DG-1322.

4. In paragraph C.4, *the staff should clarify that some of the stated items in the integrated model could be handled via test results (i.e., chemical effects). The staff should also define what is meant by "integrated models."*

5. Paragraph C.6.e implies that use of conservative deterministic approaches (that may lead to overestimating CDF and LERF) obviates the need to propagate uncertainty. *The PWROG requests that the staff clarify that this is their intent.*

6. *With the effort needed to develop the deterministic models discussed in paragraphs C.6 and C.7, is there a possibility that the results from these models could obviate the need for a risk-informed model?* For example, if the deterministic model(s) shows that only a

small amount of debris is transported to the sump (under various LOCA break size and location assumptions), then using the PRA model might be moot.

7. In paragraph C.9, DG-1322 provides a "simple" method to determine if the debris load is sufficient to defeat long-term cooling by comparison to a threshold value. If the threshold value is exceeded, a conditional core damage probability (CCDP) of 1.0 is assigned, otherwise the CCDP is 0.0. Only sequences with CCDPs of 1.0 would need to be evaluated. If all sequences result in CCDPs of 0.0, there is no need for the PRA, and the "risk-informed" approach collapses into a deterministic approach.

   This simple method may be too conservative if the number of sequences (as evaluated on the basis of debris-related failure modes) yields a high CDF value. The use of a bounding threshold value may also introduce conservative results. This is the usual balance between conservatism and model complexity (more complex, generally less conservative). *What criteria should the analyst use to determine if the level of conservatism (for the simple model) is too great to produce usable results?*

   Two conditions are to be evaluated: (a) debris loads that are sufficient to fail the strainer, and (b) in-vessel debris loads that are sufficient to prevent adequate flow to the core. DG-1322 states multiple times that the determination of the threshold value is to be done by testing. (Note that in paragraphs C.6 and C.7, model validation can be done via testing, empirical data, analogy to other systems, or comparison with other calculations (or detailed computational fluid dynamic models); for the "simple" method, the only acceptable method in the draft regulatory guide is testing.) *The PWROG requests that the staff clarify that this is their intent.*

8. Paragraph C.13.c indicates that the licensee should address the potential for boric acid precipitation. Recent work to be published in WCAP-17788-NP will specifically address boric acid precipitation concerns relative to debris. *Should this document (or it safety evaluation report) or other documents be referenced in DG-1322? Should there be a more explicit discussion related to boric acid precipitation in DG-1322?*

   Item C.13.f appears to have one or more word missing at the end of the sentence.

9. Paragraph C.14 describes the need to integrate the models developed in paragraphs C.5 through C.9 (simple method) or in paragraphs C.5 through C.13 (excluding paragraph C.9).. *DG-1322 provides no explicit guidance on how these models should be integrated, or what characteristics are expected in an integrated model.* These sub-paragraphs are

all related to the development of a complex uncertainty model to permit the propagation of parameter and model uncertainty through the integrated model via a Monte Carlo simulation. *Does the staff recognize a Monte Carlo simulation based on the integrated deterministic models may be difficult and time-consuming to execute (and may limit the number of trials that are practical to run)?* See also generic comment 2.

The uncertainty analysis suggested in paragraph C.14 may not be very realistic, considering the important parameters in the deterministic models, and the need to estimate failure distributions for passive components. Further, the discussion in paragraph C.14 suggests the need to justify the use of "plant-wide" LOCA frequencies to individual locations. The staff indicates it is acceptable to use information from the In-Service Inspection (ISI) program, but provides no specific guidance on how this can be performed. It is expected that any LOCA frequencies developed for specific locations will be conservatively high. Further, paragraph C.14.e (2) states that the impact on CDF and LERF of assumptions (related to using plant-wide LOCA frequencies at specific locations) should be quantified – it is not clear how this quantification is to be accomplished.

This further suggests that some new, novel PRA modeling approach would be needed that would account for a series of individual LOCAs, i.e., by modeling specific locations (this is not addressed in paragraph C.15). This is contrary to the typical time-averaged approach in a PRA, and invites concern and comments about completeness and comprehensiveness of a model that considers specific LOCA locations.

10. Paragraph C.15 describes an acceptable approach for the licensee to estimate the change in risk that is attributable to the explicit consideration of debris in the PRA model. DG-1322 recommends that licensees follow their existing processes that comport with RG 1.200 and their PRA peer reviews. To ascertain that the change in risk (i.e., ΔCDF, ΔLERF) is small, the criteria established in RG 1.174 should be used. These are all common-sense, high-level, generic statements related to making a change to the PRA. *The draft regulatory guide is silent on how these changes can be effectively made, and how to treat changes that are new or novel (see comments on paragraph C.14). This underscores the need for a pilot program (see discussion below).*

    One specific concern with the paragraph C.15.f is the requirement for power plant states and configurations that are not explicitly modeled and not screened (as per paragraph C.1), they should be assumed to lead to core damage. This may be a conservative assumption. Further, the CDF and LERF for these unaccounted states and

configurations should be quantified. This may ameliorate the conservative concerns, but then necessitates the development a whole new portion of the PRA, whose risk contribution may not justify the development effort.
Paragraph C.15.g is not clear. The modified PRA model is to be used to estimate mean values of CDF and LERF. *On what basis is delta-CDF and delta-LERF to be estimated and used in Figures 4 and 5 of RG 1.174? How can and why should delta-CDF and delta-LERF be estimated if there is an a priori assumption that the debris effects are negligible?*

11. Paragraph C.16 provides guidance on what needs to be included in the documentation (summary description). This also serves to ensure that the analysis provides reasonable results.

    In paragraph C.16.b, it is not clear how "completeness" can be ensured.

<u>Additional Comments</u>

Based on comments above (particularly in paragraphs C.3, C.14, C.15), the PWROG re-iterates its comments provided on the draft rulemaking language of 10 CFR 50.46c that before the NRC proceeds with rule promulgation, a pilot program be established to test the development and potential pitfalls of the risk-informed method. If STP is considered a pilot[1], STP should be considered a first principles pilot. Subsequent pilots, "application pilots," will leverage the analytical and testing work performed by STP in their own NRC RG 1.174-like exemption request submittal. It will be important for an "application pilot" to identify those generic aspects of the STP process that can directly be used by any licensee and further identify the "hooks" that will be necessary to conduct plant-specific analyses (and possibly testing), where the STP effort is not directly applicable.

Both the industry and the NRC need to be assured that a PRA can be successfully integrated with deterministic models that comports with the peer-reviewed PRA modeling approaches. If there are new PRA modeling approaches that are necessary, the existing ASME/ANS PRA Standard may not be adequate to ensure the necessary level of PRA technical adequacy without resources

[1] STP did not have 10 CFR 50.46c(e) available when it developed and submitted its risk-informed approach to GSI-191 to the NRC; as such, STP submitted an exemption request. Submitting an exemption is what 50.46c(e) will make unnecessary, once the rule is promulgated. As such, STP's effort will be different than a licensee invoking the voluntary path of 10 CFR 50.46c(e).

to perform focused PRA peer reviews[2]. As this adds to the time and expense of using a risk-informed approach, the licensee needs to be aware of any limitations in the current PRA model. A pilot program would identify such issues and suggest solutions.

[2] Focused PRA peer reviews are not necessary under these circumstances if the adjusted PRA model is not the new model of record. STP treated the adjusted PRA model as a PRA engineering calculation, with a preparer, reviewer, and approver (as expected in paragraph C.19). The risk impacts of debris on long-term cooling were not considered significant enough to be permanently included in the PRA model. If ΔCDF did not satisfy the RG 1.174 criterion, compensatory actions would need to be taken to reduce to an insignificant level, e.g., removal of insulation at particular locations that would create debris of such characteristics that it posed a significant risk to long-term cooling.