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Rulemaking, Directives, and Editing Branch
Office of Administration
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Comments on Draft Regulatory Guide DG-1203, "Containment Performance for Pressure Loads," 73 Federal Register 74764 (December 9, 2008).

Project Number: 689

On December 9, 2008, the NRC issued a Federal Register notice (73 FR 74764) soliciting public comments on DG-1203, "Containment Performance for Pressure Loads". DG-1203 appears to be aimed primarily at Advanced Light Water Reactors (ALWRs) and evolutionary plants. The Nuclear Energy Institute (NEI) has solicited comments from the industry and appreciates the opportunity to submit the comments in the enclosure.

Overall, this proposed regulatory guide imposes significant requirements on plant Probabilistic Risk Assessments (PRA) which, in turn, would translate into a substantial resource commitment for each new LWR. It adds a significant burden to the licensee requirements for containment analysis required for future plants. Many of the requirements are open ended and without currently accepted techniques for analysis. This can lead to the potential for unclear expectations regarding compliance with this guide in future submittals. Therefore, extensive resources could be required to respond to this Regulatory Guide for future plants.

If there are any questions regarding these comments, please contact me at 202.739.8137; jhr@nei.org or Mike Melton at 202.739.8049; mam@nei.org.

Sincerely,

James H. Riley

James H. Riley

Enclosure

c: Ms. Tanya M. Mensah, NRR/ADRO/DPR/PSP, NRC

SUNSI Review Complete
Template = ADM-013

E-RIDS= ADM-03
Add = M. Bayssie (MMB1)

ENCLOSURE

COMMENTS ON DG-1203 CONTAINMENT PERFORMANCE FOR PRESSURE LOADS

COMMENTS ON DG-1203

The proposed Regulatory Guide should be clarified in the following areas:

- Purpose
- Applicability
- Methodology
- Acceptable Codes
- Definitions
- Limitations
- Criteria

1. PURPOSE

A clear statement of the purpose of the Regulatory Guide tied to a specific regulation and a specific set of plants is considered necessary to avoid confusion.

PRA

If the purpose of the proposed regulatory guide includes the objective to support the determination of the ultimate pressure and temperature capability of containment used in the PRA, this should be clearly stated.

Severe Accidents

The deterministic goals in C.3 for containment capability up to 24 hours and then beyond 24 hours appears to be too ill-defined at the present time and should be better formulated. A consensus group of NRC and industry experts would provide valuable guidance regarding the formulation of C.3.

The Section B discussion is not adequately focused on the Section C Regulatory position. In addition, the focus of the DG-1203 is stated to be on Design Engineering and System Engineering. However, there is extensive impact on the PRA, both in required analysis and on the effects of the analysis on the remainder of the PRA evaluation.

Title

Confusion exists regarding whether this is a pressure and temperature transient load and ultimate pressure capability assessment or an ultimate pressure capability assessment to compare with the design basis (i.e., at low temperatures). (For Section C.3, it is clear that it is the former.) Therefore, change the title of the DG-1203 to reflect the true scope of the Regulatory Guide.

Multiple Purposes

Clear definition of the differences in purpose and expectations for the Regulatory Positions C.1, C.2, C.3, and C.4 are needed.

If Section C.1 of the Regulatory Position is to have a special meaning with regard to "ultimate pressure capability", it should be defined (e.g., limited to design basis only). Currently, the definition is vague and its relationship with Section C.3 is not clear. What regulation requires this assessment for ALWRs that are not a passive design?

The items not addressed include the following:

- The probabilistically determined failure locations at the ultimate limits. These are deferred to:
  - SECY-90-016
  - SECY-93-087

  The PRA needs to define the containment failure locations. This DRAFT RG provides no guidance with regard to this determination.

Realistic Analysis

What is the purpose of incorporating conservatisms into the analysis and performance goals? This is supposed to be a "realistic" method and performance goal for containments for use within a PRA. Dictating the use of Service Level C as the criteria for the Containment Ultimate Pressure and Temperature may introduce significant conservatisms that are inappropriate for the realistic PRA evaluation.

2. APPLICABILITY

2.1 Applicability

The applicability of the proposed Regulatory Guide is not clearly defined. A few items are cited as examples.

2.1.1 PLANTS

R.G. 1.57 (Rev. 1) describes the differences between requirements for combustible gas control for current generation reactors compared with future reactors. This same clarity appears to be missing from DG-1203.

DG-1203 states in Section B that applicability is for light water reactors (current and future). This is confusing because current LWRs clearly do not meet this DG's requirements. Section C does not seem to state or imply that the DG applies to current LWRs. Additional comments on this are included in Section 2.1.3.

2.1.2 ACCIDENT PROFILE

The severe accident profile to be used in the assessment of containment capability is ill-defined and leaves this open to interpretation and broad expectation. A consensus group of NRC and industry experts would provide valuable guidance regarding the formulation of the criteria to be used in selecting the severe accident profile.

2.1.3 PLANT TYPES

Separate Regulatory Guides should be provided for:

- Future ALWRs
- Passive ALWRs
- Non-ALWRs Future Plants

Reference to current generation plants should be deleted from the Regulatory Guide.

As an example, Sections C.3 and C.4 related to severe accidents appear to be derived from the passive advanced light-water reactor (ALWR) containment performance goal (CPG). Therefore, these requirements should not apply, for example, to the ABWR.

Extending these requirements of C.3 and C.4 to other plants is a significant back fit of requirements including to ABWR and EPR and would be quite expensive.

It is also noted that the DRAFT RG also references a CCFP of 0.1 in Section B, this should be removed from the RG.

2.2 Containment Fragility Under Pressure Loading (Section B.1 of DG-1203)

This section of DG-1203 has no purpose, no criteria, and no method specified. It contains very general guidance to include sensitivity studies, uncertainty analyses, and importance measures. This section is not useful to the licensee or the NRC reviewer. It does not focus the review.

In addition, no mention of the effects of temperature on the calculated margin is made.

This section (B.1) should be removed.

2.3 Fragility Analysis (Section C.4 of DG-1203)

As far as the containment fragility analysis cited in Section C.4 of draft guide, it is acknowledged that a PRA is required to support the certification and licensing of advanced plants. It is further acknowledged that an assessment of the containment ultimate pressure capability over the severe accident spectrum is needed to support the PRA.

However, certain items cited in Section C.4 are not necessary to perform the above. These items include the following:

a. *Fragility assessments should be a quality and depth sufficient to provide adequate insights on the design capability of the containment to withstand postulated severe accident sequences. The assessments should demonstrate that at the highest performance level of pressure and associated temperature load the containment can retain its integrity and there is a reasonable margin in the design.*

Comment
There are always pressures and temperatures that can be calculated that exceed the containment capability. This requirement cannot be met as written.

"Reasonable margin in the design" has no meaning without additional boundary conditions and criteria.

g. *The fragility analyses should be based on detailed 3D finite element modeling, appropriate material constitutive relations, and an assessment of uncertainties within a probabilistic framework. The development of the global and localized finite element models of* *the containment and the consideration of nonlinear behavior of the containment, using the approach described under Regulatory Position C.1, subject to the limitations discussed in this section, are acceptable. The uncertainties in the analysis results should be associated with the finite element modeling and analysis approach, the material properties of the structure at the time of the accident, failure criteria or limit states used in establishing the pressure capacity, and the loading conditions that lead to pressurization of the containment.*

Comment
A detailed 3D finite element analysis at all pressures and temperatures is not considered warranted.

m. ...the most severe accident temperature condition).

Comment
The "most severe accident temperature condition" is not defined here and should be in order to facilitate unambiguous guidance.

p. Accident conditions leading to overpressurization should also include properties and effects at elevated temperatures. Because of temperature-induced stresses and material property degradation at elevated temperatures, the fragility for overpressurization is also a function of temperature. Thus, the fragility analyses should be conducted for three different sets of temperature ranges—steady-state normal operating temperatures (referred to as ambient conditions), steady-state conditions representing long-term accident conditions, and transient thermal conditions, such as a temperature spike representative of direct containment heating conditions.

Comment
Direct containment heating is not well defined, nor is the thermal transient resulting from this event.

q. Model uncertainty exists in the analyses for determining the failure pressures for any given set of material properties, geometry, or other dependent parameters. This uncertainty arises from the mesh discretization used in finite element models, the type of element formulations used, the robustness of the constitutive models, the equilibrium iteration algorithms and convergence tolerances, geometric imperfections, allowable fabrication and construction tolerances, rebar placement locations, etc. The fragility calculation should quantify this modeling uncertainty.

Comment
On what basis is this request for a quantified modeling uncertainty justified? The ASME PRA Standard does not require this.

Is this RG intended to layer additional requirements on the PRA beyond those in the PRA Standard?

3. METHODOLOGY

Containment Structural Analysis

References describing the methods acceptable for finite element inelastic evaluation are referenced in C.1.

Containment Loadings

Acceptable methods for the calculation of imposed severe accident loads requires additional description. Specifically, it is desirable to provide a list of acceptable severe accident analysis codes that could be used to support the severe accident challenges to be evaluated in the structural analysis.

In addition, the criteria to be used in selecting the "more likely severe accident challenges" is necessary.

Similarly, guidance on an acceptable approach to the consideration of dynamic loads caused by excessive pool levels during containment flooding is necessary for BWRs.

Containment Fragility

Section C.4 regarding the development of a fragility curve for the containment structural capability as a function of pressures and temperatures is not considered necessary or even desirable. This resource intensive effort should be deleted. (See Section 2.3 above.)

Alternatively, a reference that defines the suggested method for fragility determination required to satisfy Section C.4 would be helpful.

4. ACCEPTABLE CODES

4.1 Plant Challenges

Computer analysis related to severe accident load calculations is required in Section C.3 to ensure that the ultimate pressure and temperature capability of the containment meets the intent of the Regulatory Guide. The basis for determining the acceptability of the codes used in calculating the severe accident challenges would appear to be in need of definition. An effective Regulatory Guide must provide an acceptable means to satisfy the calculational requirements used to impose the loads. Specifically, the use of MAAP by a qualified analyst with a verified parameter file should be listed as an acceptable example. Alternatively, a consensus group of NRC and industry experts would provide valuable guidance regarding the formulation of the criteria to be used in selecting the severe accident profile.

4.2 Plant Structural Analysis

There is a conflict in that Section C.1 allows the use of 2D axisymmetric or partial finite element models, but Section C.4 Item (g) appears to contradict that allowance.

5. DEFINITIONS

Several terms appear to be in need of definition to effectively use the proposed Regulatory Guide and these include the following:

- "More Likely Severe Accident Challenges" is not defined. This leads to an open-ended analysis criteria.
- Containment should maintain "leak-tight barrier" for 24 hours. ("Leak-tight" is not defined.)
- Containment should continue to provide a barrier against "uncontrolled release" of fission products after 24 hours. ("Uncontrolled release" is not defined.)
- "Design Basis Accident Temperature" is not defined (See p.7 of DG-1203)

6. LIMITATIONS

Some of the limitations that should be stated more clearly include the following:

- Requirements for dynamic load effects:
  - Dynamic effects DO NOT need to be considered (page 7)
  - Dynamic effects DO need to be considered (page 12 a(2), page 8 Item l))
- Interface with seismic loading is not addressed
- Section C.3: For initial 24-hours, linear elastic material properties may be used. This does not appear to allow for use of inelastic material evaluations in a realistic ultimate pressure/temperature calculation.
- The fragility curve for a containment will vary significantly by temperature and location. For example, BWR drywells may be more significantly affected by temperatures during the core melt progression. The unique effects of different containment compartments would need to be addressed.
- No leakage criteria is identified for C.1 Item K.
- In addition, NUREG/CR-6906 indicates that the pressure rise time for certain severe accidents may impose a loading that cannot be terminated by leakage and will lead to rupture. Therefore, consideration of the ultimate rupture probability is a function of pressure, temperature, and transient pressure rise time. This is not addressed in the draft Regulatory Guide.
- The effects of corrosion are not specified for inclusion in the ultimate pressure capability calculation.

The Regulatory Guide does not address the following that may be critical:

- <u>Challenges</u>
  - Dynamic pressure loads (e.g., pressure suppression containments)
  - Missiles (Internal and External)
  - Direct interaction of containment boundary by debris
  - Containment bypass
- Failure location issues (only concerned with failure regardless of location)
- Leakage acceptance criteria are to be provided by the Licensee to the NRC for review. This remains open-ended.

7. CRITERIA

This section is a summary of some of the criteria that are interlaced within DG-1203 and appear to be either inconsistent with the objective of a realistic evaluation or represent some other potential conflict with the intent of DG-1203.

7.1 Service Level C

Why is Service Level C selected as the criteria for use in assessing severe accident challenges (see P. 6)? Service Level C is not the appropriate realistic ultimate pressure capability criteria to be used. This introduces unacceptable conservatisms. This is demonstrated by the extensive testing of containment structures (e.g., NUREG/CR-6906).

7.2 Strain

The draft guide. specifies use of 1.5% strain for cylindrical steel containments. This does not appear to be realistic (P. 7 of DG-1203).

NUREG/CR-6906 has concluded that the use of a general yield of 1% strain for steel containments may tend to underestimate the containment rupture pressure and provide non-realistic predictions of the maximum pressure capacity. Observed global, free field strains at rupture are in the range of 2 to 3% for instrumented tests.

NUREG/CR-6906, p. 137 observes:

> "The analyst should be focused on making a best estimate prediction. Consistent with the supposition that leakage is not likely prior to the onset of general yielding, some methods can be eliminated as candidates for predicting containment performance. For instance, a failure criterion often used in the past is based on rupture occurring at general yield of 1% strain. Simple axisymmetric models, either finite element or closed form formulations, could be used in conjunction with such a failure criteria. But such simplifications may tend to underestimate the rupture pressure and provide conservative predictions of maximum pressure capacity."

Similar conclusions apply to the concrete containments that should be reflected in this failure criteria.

Concrete containments have lower margins to failure, but they are likely to be leakage failures as opposed to catastrophic ruptures. In addition, prestressed concrete containments versus reinforced concrete containments may be significantly different pressure capability ranges (p. 13.8 of NUREG/CR-6906).

7.3 Direct Containment Heating (DCH)

Direct containment heating is not sufficiently well defined to allow effective communication on the issue of containment response (see P. 14 item P of DG-1203). Possible variations in the following parameters as they influence the DCH transient need to be clearly defined to allow effective communication:

- RPV pressure at RPV breach
- RPV breach failure modes
- RPV breach failure timing
- Core melt progression characterization of debris at RPV breach
- Active and passive mitigation available during DCH

7.4 Combustion

What's the purpose of 45 psig (p. 10)?

7.5 Severe Accident Sequence Evaluation

What is the meaning of limiting the steel containment analysis in C.3 to the use of linear elastic material properties? This would appear to result in unacceptably large conservatisms in the analytic results.