**Response to Public Comments on Draft Regulatory Guide (DG)-1304**
**"Safety-Related Steel Structures and Steel-Plate Composite Walls for other than Reactor Vessels and Containments."**
**Proposed Regulatory Guide (RG) 1.243**

On February 10, 2021 the NRC published a notice in the *Federal Register* (86 FR 8928) that Draft Regulatory Guide, DG-1304, a proposed new Regulatory Guide was available for public comment. The Public Comment period ended on March 29, 2021. The NRC received comments from the individuals or organizations listed below. The NRC has combined the comments and NRC staff responses in the following table.

Comments were received from the following:

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| Lawrence F. Kruth for<br>American Institute of Steel Construction<br>130 E. Randolph Street, Suite 2000<br>Chicago, Illinois 60601S<br>ADAMS Accession No. ML21084A005 | ADAMS Accession No. ML21084A005 |
| Carrie Fossaen<br>NuScale LLC<br>1100 NE Circle Blvd. Suite 200<br>Corvallis, Oregon 97330<br>ADAMS Accession No. ML21092A005 | ADAMS Accession No. ML21092A005 |

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| AISC | A | **AISC_1.** 10 CFR Part 50 and 10 CFR Part 52 are referenced, but no reference is made to 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, Reactor-Related Greater than Class C Waste." The draft Regulatory Guide should include this reference since ANSI/AISC N690-18, including Steel-Plate Composite (SC) construction, may be used in these applications. | The NRC staff does not agree with the comment. The intended scope of this RG is to provide guidance for applicants and licensees under Title 10 of the Code of Federal Regulations (10 CFR), Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." However, the regulatory guide is available for case-specific use for a Part 72 facility should an applicant wish to use this RG for, as an example, steel-plate composite walls. |

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| AISC | - | **AISC_2.** The draft Regulatory Guide should also apply to Research and Test Reactors, and Fuels and Materials Facilities. | The NRC staff does not agree with the comment. The intended scope of this RG is to provide guidance for applicants and licensees under Title 10 of the Code of Federal Regulations (10 CFR), Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." Because the current research and test reactor fleet is licensed under 10 CFR part 50, the regulatory guide is already applicable to these reactors. However, this regulatory guide is available for case-specific use for fuels and materials facilities should an applicant wish to use this RG for, as an example, steel-plate composite walls. |
| AISC | C.4.2, C.4.3.1, C.5, C.7, C.7.2, C.7.3, C.7.4, C.7.5, C.8, and C.11.4 | **AISC_3.** There appears to be an inconsistent use of "AISC 360-16" versus "ANSI/AISC 360-16." The appropriate designation is the latter, i.e. ANSI/AISC 360-16. | The NRC staff agrees with the comment. References to "AISC 360-16" will be replaced with "ANSI/AISC 360-16." |
| AISC | A | **AISC_4.** Section A of the draft Regulatory Guide lists RG 1.29. The text uses the phrase "must be." Since this document is listed under Related Guidance, the phrase should be changed to "should be." | The NRC staff does not agree with the comment. The words "must be" refer to features of light-water-reactor nuclear power plants that must be designed to withstand the effects of a safe-shutdown earthquake per NRC regulations. |
| AISC | A, References | **AISC_5.** ASCE 43-19 should be included in the section of Related Guidance, as well as the References. | The NRC staff does not agree with the comment. This standard is not NRC guidance and has not been endorsed via an NRC guidance document. |
| AISC | C.1.2 | **AISC_6.** Editorial: In Section C.1.2 of the draft Regulatory Guide, revise "N690 s1-15" to "ANSI/AISC N690s1-15. " | The NRC staff agrees with the comment. References to "N690 s1-15" will be replaced with "ANSI/AISC N690 s1-15." |
| AISC | C.1.2 | **AISC_7.** Section C.1.2 of the draft Regulatory Guide adds the requirement for UT testing of welded connections (in ANSI/AISC N690-18 Sections NA3.1c and NA3.1d) that are susceptible to lamellar tearing. UT testing is not required since these provisions are focused on the need for the | The NRC staff agrees with the comment. The regulatory guidance position 1.2 for the plan developed to mitigate the conditions creating the potential for lamellar tearing should not prescribe the |

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| | | responsible party to develop a plan to mitigate lamellar tearing so that no UT testing is needed. UT testing will identify a delamination/discontinuity if there is enough loss of back reflection to identify the discontinuity. Lamellar tearing can occur on a plate that passes a through thickness UT exam. The concern is that if the UT exam is mandated and the plate passes, then the possibility of lamellar tearing created because of a highly constrained joint design will not be addressed and can occur. Also, as an editorial comment, in the last sentence, change “NA31.c” to “NA3.1c.” | specific testing to be performed. Using the guidelines provided in the User Notes of Section NA3.1c and NA3.1d of ANSI/AISC N690-18, the plan developed by the engineer of record should be extensive and detailed enough to not only identify welded connections that are susceptible to lamellar tearing but also include steps to mitigate the conditions that might create the potential for lamellar tearing. Therefore the staff will remove this Regulatory Guidance Position from the guide. |
| AISC | C.2 | **AISC_8.** AISC has asked Professor Bruce Ellingwood to perform an independent review of Table 1, “Load Combinations for the LRFD Method.” AISC has reviewed his report and agrees with his recommendations and comments. His report is included as an attachment to this letter. | Professor Ellingwood’s review comments are part of the AISC comments. They specifically address Table 1. They are designated as AISC8.1 through AISC8.4 in the column to the left. The responses to them are found below. |
| AISC/ Bruce Ellingwood | | AISC8.1. <u>Normal Load Combinations:</u><br>▪ Combination NB2-1: This combination deals with permanent operating loads. The load factor on $R_O$ is 1.4 in AISC N690 and 1.0 in DG-1304. In my opinion, a load factor of 1.0 is not adequate to account for uncertainties in pipe reactions under normal operating conditions, including start-up and shut-down based on various transient conditions.<br>▪ Combination NB2-2: This combination addresses maximum operating live loads. Since the load combinations are based on a principal action/companion action approach to probabilistic load combinations, $1.2R_O$ is sufficient in this combination, especially if $1.4R_O$ appears in NB2-1. The load $1.6R_O$ is conservative and no evidence has been presented that it is needed for plant safety.<br>▪ Combination NB2-3: This combination addresses maximum roof loads. There is absolutely no rationale for reducing $1.6R_O$ to $0.8R_O$ in this combination; they should be the same in both combinations NB2-2 and NB2-3 (i.e., $1.2R_O$), as they are in | In response to Professor Ellingwood’s comments on Table 1, the staff agrees with the comment pertaining to the normal load combinations. For NB2-1, the comment addresses the normal operating load, Ro, and the importance to factor Ro in the normal load combination when the permanent loads, D and F, are also the primary loads in the load combination, especially when the live load, L, and the loads H, are small. The staff also agrees with the comments pertaining to the load factor for Ro in load combinations NB2-2, for which the primary loads are the live loads L and H, as well as for NB2-3 for which the primary load are the roof loads. The staff will revise the regulatory guidance position accordingly. |

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| | | AISC N690. | |
| AISC/ Bruce Ellingwood | | AISC8.2. <u>Severe environmental load combinations:</u><br>▪ Combination NB2-4: This combination addresses maximum non-tornadic winds (with a return period of 3,000 years for Risk Category IV structures in ASCE Standard 7-16). 1.6L + 1.6Ro appear as companion actions in this equation. The implication is that the maximum live load and maximum pipe reaction occur at the same time as the 3,000-yr return period wind, which is nonsense. In AISC N690, these loads are 0.8L + 1.2Ro, which are consistent with the reliability analyses performed three decades ago at BNL.<br>▪ Combination NB2-5: This combination addresses the OBE earthquake, and its companion actions have exactly the same deficiency as those on combination NB2-4. | The staff partly agrees with ProfessorEllingwood's comments on Table 1 for load combinations NB2-4 and NB2-5. The primary loads in those load combinations are the wind load, W, and the OBE seismic load, Eo. The staff agrees that the load factor for Ro should be 1.2 for load combinations NB2-4 and NB2-5. The staff does not agree to the use of a load factor of 0.8 for the live load L. Given that the annual frequencies of exceedance for W and Eo are significantly greater than those for Es and Wt in load combinations NB2-6 and NB2-7, which use a load factor of 0.8 for L, a load factor greater than 0.8 for L should be justified for loads combination NB2-4 and NB2-5. In addition, these are operational loads up to which the plant is expected not to have to be shutdown, for example the load Eo, which also justifies a higher load factor for L. ASCE 7-16 (Minimum Design Loads and Associated Criteria for Buildings and Other Structures) also uses load factors greater than 0.8 for the combination of live loads with earthquake and wind loads with annual frequencies of exceedance of the order of those for W and Eo. The staff will retain the load factor for L at 1.6 in NB2-4 and NB2-5 and will revise the regulatory guidance position for the load combinations NB2-4 and NB2-5 to change the Ro load factor to 1.2. |
| AISC/ Bruce Ellingwood | | AISC8.3. <u>Extreme environmental and abnormal load combinations:</u><br>▪ Combination NB2-8: The load factor on accidental pressure has been increased from 1.2 to 1.4. I see no rationale for this increase; 1.2 also appears in ACI 349-13 and in several ASME standards as well. However, there may be some more recent information that I am not aware of to support this increase. | The staff does not agree with Professor Ellingwood's comment. The staff has been accepting a load factor of 1.4 for the accident pressure in load combination NB2-8 to reflect uncertainties in the calculation of the accident pressures. The codes and standards have not provided a justification for the generic reduction of the load factor from 1.4 to 1.2. However, uncertainty analysis on the calculation of the design accident pressure can justify the use of a load factor less than 1.4. The staff will add a regulatory guidance position after Table 1 to clarify this possibility. |
| AISC/ Bruce Ellingwood | | AISC8.4. I have reviewed statements 2.1.1 - 2.1.5 which appear below Table 1 in Draft RG 1304 and agree with them. I have three additional | The staff does not agree with Professor Ellingwood's comment that changes to the DG are necessary to address this comment. |

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| | | comments, which are tangentially related to the proposed load combination requirements. I noted these previously in my May 5, 2020 report, and would like to emphasize them:<br>▪ 5d(2) states that if the structural effect of differential settlement is significant, it shall be included with the dead load. I do not agree with this requirement. While the load factor may or may not be the same (see, e.g., Commentary C2.3.4 of ASCE 7-16), differential settlement is a self-straining structural action similar to creep or shrinkage, whereas dead load is force-controlled. Thus, their fundamental characteristics and structural effects are different, even if the load factors are the same, and engineers should not be encouraged to think of them as equivalent; they are not.<br>▪ Fluid pressure, F, is treated the same as a dead load in the N690 load combinations. I suggest that you revise 5d(3) and 5d(4) to state that if F acts to stabilize the structure against the destabilizing effects of lateral force or uplift, F shall be equal to zero.<br>▪ Load H includes loads due to weight and lateral pressure of soil, ground water pressure, or pressure of bulk materials. If H acts to stabilize the structure, H shall be equal to zero. | • 5d(2) – The version of N690 in the scope of the DG is ANSI/AISC N690-18. ANSI/AISC N690-18 refers to soil pressures in 5d(2) while ANSI/AISC N690s1-15 refers to dead loads as in comment AISC8.4. Section 2.3.4 in ASCE 7-16 says that where the structural effects of self-straining demands are expected to adversely affect structure performance, the self-straining demands shall be considered in combination with other loads. The purpose of provision 5d(2) in ANSI/AISC N690-18 is to consider the effects of self-straining demands with a factor equal to those used for soil pressure loads, which is greater than the factor used for dead loads. The staff agrees with that provision. The staff guidance in the Chapter 3.8.4 of the Standard Review Plan (SRP), NUREG-0800, already says that provisions shall be made for anticipated self-straining forces and effects arising from differential settlements of foundations during construction and operation of the plant. The guidance in the SRP also says that a monitoring program for settlements is expected by the staff for the constructed facility.<br>• The comments pertaining to the fluid pressure, F, and to the soil pressures, H, can be case-specific and those conditions are reviewed on a case-specific basis.<br>Accordingly, no changes will be made to the DG. |
| AISC | C.2.1 | **AISC_9.** Editorial: Suggest to add "(LRFD)" at the end of the title for Section C.2.1 of the draft Regulatory Guide. | The NRC staff agrees with the comment. "(LRFD)" will be added at the end of the heading for RGP 2.1 of the DG. |
| AISC | C.2.2.6 | **AISC_10.** In Section C.2.2.6 of the draft Regulatory Guide, revise "N690-18" to "ANSI/AISC N690-18;" also, in the first sentence of this section, correct "NB2-7" to "NB2-16." | The NRC staff agrees with the comment. References to "N690-18" will be replaced with "ANSI/AISC N690-18." Also, references to "NB2-7" will be replaced with "NB2-16" in RGP 2.2.6 of the DG. |
| AISC | C.3.1 | **AISC_11.** Sections C.3.1 and C.3.2 of the draft Regulatory Guide are generally agreeable. First, please note that Appendix 7 is for the "effective" length method, and not the "equivalent" length method. The wording "and minimum judgment is required to determine K" in Section C.3.1 is vague and | The NRC staff agrees with the comment. "Effective length method" will be used in lieu of "equivalent length method." The second part of this sentence related to using "minimum judgement" will be deleted. |

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| | | may be subject to interpretation. With the exception of textbook definitions of end conditions (e.g. pinned, free, or fixed), the determination of effective length factors almost always requires some significant degree of judgement. One may argue that the use of alignment charts is pretty straight forward, but it is rare that all ten of the assumptions for using this approach are satisfied for most design conditions encountered – as a result, adjustments in the use of the alignment charts are often required and such adjustments require judgement. Does requiring "minimum judgement" mean that the effective length method can only be used for pinned, free, or/and fixed end conditions? Or is "minimum judgement" extended to equally rare conditions satisfying all assumptions that correspond to the use of the alignment charts. In either case, such a definition of "minimum judgement" would severely limit the use of a design method that has been successfully used in the U.S. since the early 1960's. We do agree that it is essential that care must always be taken in computing reasonable effective length factors. With this in mind, the first part of the sentence in Section C.3.1 alone should suffice, and we suggest deleting the second part related to using minimum judgment. | |
| AISC | C.3.3 | **AISC_12.** With respect to Section C.3.3 of the draft Regulatory Guide, AISC questions its validity. First, it is not clear where prediction of elastic stability using the direct second-order analysis method appears or used in the ANSI/AISC 360-16 Specification. The Specification does have a design method termed the direct analysis method (DM) that accounts for the five most significant effects for steel structures that are known to impact stability (see ANSI/AISC 360-16 Section C1 as referenced from ANSI/AISC N690-18 Chapter NC). This design method ensures the stability of structures and its elements. One of these effects includes consideration of second-order effects (P-Δ and P-δ), which most often results in the use of a second-order elastic analysis. Further Section C.3.3 could be misleading because: i) In addition to including the effects of geometric nonlinearity and initial imperfections, DM also considers stiffness reduction due to inelasticity (another one of the five effects mentioned above) via the use of EI* and EA*, both of which are approximations accounting for potential inelasticity; ii) Realistic stress states, and the corresponding degree of yielding, are not known from the analysis; iii) An instrumental part of the DM method is to provide required strengths | The NRC staff agrees with the comment. Regulatory guidance position 3.3.3 will be removed from the RG. |

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| | | (e.g. forces and moments and not stresses) for the design of members and connections by elastic analysis under factored loads, with such demands often in excess of first-yield conditions per AISC's limit states design philosophy; iv) Unless a rigorous second order analysis is performed, which is not a requirement of DM as it is defined in ANSI/AISC 360-16 Chapter C (noting that approximate methods of analysis, such as B1 and B2 analyses, are permitted), equilibrium and compatibility may not necessarily be satisfied on the deformed geometry. Thus, the stress state at the onset of instability can't be determined or assessed from the typical analysis used in the DM design method. It is further noted that limiting stresses to only be elastic within the analysis would essentially prohibit any members or components from yielding to any degree under loads factored to the strength limit-state level – a requirement that would be unreasonably conservative. It is AISC's opinion that the application of the DM method (per Chapter C) does not require engineers to verify if the stresses in structure are elastic at the onset of instability and therefore recommends that the draft Regulatory Guide Section C.3.3 be removed. | |
| AISC | C.4.2 | **AISC_13.** ACI codes are adopting 80,000 psi as the new limit for high strength steel reinforcement. The ACI 349 Code Committee has approved 80,000 psi and it is expected to be a part of the next edition of the ACI 349 Code. Section C.4.2 of the draft Regulatory Guide should adopt this higher limit. | The NRC staff does not agree with the comment. Use of high-strength (HS) rebar reinforcement (Grade 75 and 80) as used in ACI 349-13 is not endorsed for general use for the scope of Chapter NI. Research and development that integrates implications for the general use of, for example, crack control, material and component ductility, deflection limits, and strength-reduction factors, is ongoing and, therefore, its use is not generically endorsed. The staff will wait for the issuance of the new edition of ACI 349 and the justification therein for further consideration for general use. |
| AISC | C.4.3.1 | **AISC_14.** Section C.4.3.1 of the draft Regulatory Guide needs to provide criteria and discussion why stability sensitive structures are a concern to the NRC staff. | The NRC staff does not agree with the comment. Regulatory guidance position 4.3.1 is provided as a guidance for the designer. For additional discussion regarding regulatory guidance position 4.3.1, refer to BNL report# BNL-220652-2020-INRE, section 4.10.3 AISC 360-16 Comparison to AISC 360-10. |
| AISC | C.4.3.2 | **AISC_15.** Section C.4.3.2 of the draft Regulatory Guide should provide | The NRC staff does not agree with the comment. The Specification has not traditionally accounted for long-term effects due to creep |

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| | | guidance on how to address long-term effects since AISC standards do not address this potential concern. | and shrinkage and, as such, the stiffness prescribed is based on studies examining only short-term behavior. The guidance in regulatory guidance position 4.3.2 identifies that long-term effects due to creep and shrinkage should be analyzed. |
| AISC | C.5 | **AISC_16.** Editorial: In the title for Section C.5 of the draft Regulatory Guide, revise to "ANSI/AISC N690—18, Chapter NJ – Design of Connections." Corrections are also required in Section C.11.1, C.11.2, C.11.3, and C.11.4. | The NRC staff agrees with the comment. References to "ANSI/AISC N690-8" will be replaced with "ANSI/AISC N690-18." |
| AISC | C.5 | **AISC_17.** Section C.5 of the draft Regulatory Guide indicates that an exception to ANSI/AISC N690-18 Chapter NJ is required because it should refer exclusively to ACI 349 and not ACI 318. The draft Regulatory Guide also states that the "requirements" in ACI 349-13 should be used along with the regulatory provisions of RG 1.142 Revision 3, and RG 1.199 Revision 2, unless otherwise justified. AISC comments that many facilities are designed to ACI 318, and to limit its use to ACI 349 would be restrictive. Additionally, AISC comments that generically referring to the "requirements" of ACI 349 is rather vague and could lead to misinterpretation. AISC proposes that no exception be taken in the draft Regulatory Guide against Chapter NJ. | The NRC staff does not agree with the comment. The standard endorsed by the NRC staff for anchoring to concrete in nuclear power plants is Appendix D of ACI 349-13, which the staff endorses in RG 1.199.<br><br>The staff will edit the regulatory guidance position for clarity as follows:<br><br>ANSI/AISC 360-16, Chapter J, section J9 refers to Chapter 17 of ACI 318-14 (Ref. 25). Appendix D of ACI 349-13 (Ref. 26) should be used instead of Chapter 17 of ACI 318-14. In addition, requirements in ACI 349-13 should be used along with the regulatory guidance positions in RG 1.199, Revision 1, unless otherwise justified. |
| AISC | C.3.3, C.7.4 | **AISC_18.** Unlike in the DM method, stability analysis per ANSI/AISC N690-18 Appendix N1 that is based on ANSI/AISC 360-16 Appendix 1, Section 1.2, requires the use of a rigorous second order analysis, which can indicate whether or not the structural system or any of its components approach instability. However, it still requires consideration of residual stresses and stiffness reduction due to potential yielding. It also requires the analysis be with loads factored to the strength limit-state level. As per our above comments of the draft Regulatory Guide Section C.3.3, design would be unreasonably conservative if stresses under factored loads at the onset of instability must be kept at or below an elastic limit. Thus, the elastic stress | The NRC staff agrees with the comment. Regulatory guidance position 7.4 will be removed from the RG. |

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| | | requirement of draft Regulatory Guide Section C.7.4 is not appropriate and AISC suggests it be removed. | |
| AISC | C.7.5 | **AISC_19.** Draft Regulatory Guide Section C.7.5 appears trivial and perhaps unnecessary, unless there is concern that engineers need to be reminded that ANSI/AISC 360-16 Appendix 1, Section 1.3, modified in accordance with ANSI/AISC N690-18 Appendix N1, Section N1.3, is acceptable for use in the design of safety-related steel building structures. It is noted that the inelastic stability analysis of Section 1.3 is the most sophisticated second order analysis available, and is typically reserved by designers for assessing complex and/or overstressed structures. It is clear from the provisions appearing in Section 1.3 that the analysis shall take into account: second order effects, geometric imperfections, material nonlinearity, member and connection ductility and deformation capability. | The NRC staff agrees with the comment. Regulatory Guidance Position 7.5 neither takes any exception to the ANSI/AISC N690-18 provisions nor adds anything to the ANSI/AISC N690-18 provisions. Therefore, it will be removed from the RG. |
| AISC | C.9 | **AISC_20.** Section C.9 of the draft Regulatory Guide indicates that the use of ANSI/AISC N690-18 Appendix N4 will not be endorsed. However, no alternative guidance is provided, nor is any basis of not accepting Appendix N4 is provided. This guidance should be provided in the draft Regulatory Guide. | The NRC staff does not agree with the comment. The DG does not endorse ANSI/AISC N690-18, Appendix N4, on structural design for fire conditions because Appendix N4 is outside the scope of the DG. The provisions in Appendix N4 are for structural design for life safety associated with the evacuation of building occupants in the event of a design-basis fire. In addition, the provisions in Appendix N4 do not address structural safety members 'important to safety' or the loading conditions associated with a facility fire. The scope of the DG is the design of safety-related structures and structural components which are required to perform their intended safety functions under design basis conditions. Those conditions are outside the scope of Appendix N4. Regulatory Guide 1.189, "Fire Protection for Nuclear Plants,' provides information on fire protection performance goals.<br><br>Regulatory guidance position 9 will be edited for clarity to be:<br><br>This RG does not endorse ANSI/AISC N690-18, Appendix N4, on structural design for fire conditions because it is outside the scope of the RG. |

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| AISC | C.11.1.6, C.11.1.7 | **AISC_21.** The following discussion and comments pertain to Section C.11.1.6 of the draft Regulatory Guide:<br>Revision 3 of RG 1.142 is based on ACI 349-13. Accordingly, this response references the relevant sections of ACI 349-13. It is acknowledged that RG 1.142 takes exceptions to Section F3.5 of ACI 349-13. In particular, it permits local ductility up to 3.0, but requires that the structure should remain elastic (although it is unclear as to how this can be accomplished). Also, when shear controls, the ductility ratio is limited to 1.3 and 1.0 when shear reinforcement is and is not provided, respectively (note that the additional exceptions related to ACI 349-13 Section F3.8 are not relevant for a compartment pressurization situation since it does not cause horizontal compression load in the compartment walls). The following response takes these exceptions into account.<br><br>The commentary for ACI 349-13 Section F3.5 indicates that the reduced ductility limit of 3 (from 10) has to do with the effect of compartment pressure loading on the compartment's overall structural integrity such that there is a need to minimize the level of permanent deformation. It is understood that response at higher ductility ratio manifests in increased permanent deformation as well as more degraded condition for RC compartment walls (especially in the vicinity of their vertical edges where significant cracking and spalling can occur due to lack of ties and confinement). Aside from structural integrity concerns, such state of permanent deformation, likely accompanied by significant cracking and spalling, can be problematic from the compartment's functionality standpoint. This limitation is necessary for RC compartments because ACI 349 does not require special detailing at a compartment's corners (e.g., increased rebar development length and/or lack of ties); the presence of direct tension and flexure leads to severe cracking/spalling as the rebars undergo large tensile strains associated with increased ductility ratio.<br><br>In contrast to ACI 349, ANSI/AISC N690-18 Section NB3.14 requires the connections to be designed for full expected strength of the connected members (or with significant overstrength); also, ties are required in SC walls | The NRC staff partially agrees with the comment. The comment address two regulatory guidance positions, 1.1.6, on the acceptable ductility ratios for compartment pressurization, and 11.1.7 on the acceptable docility ratios for shear-controlled SC walls.<br><br><u>Comment for regulatory guidance position 11.1.6</u> – This regulatory guide position addresses the special case of impulsive loads associated with compartment pressurization that could affect the integrity of the whole structure which can include the pressurized compartment structure and, for example, the larger structure tat contains the compartment. For general use, the upper limit of the ductility is conservatively set at 3.0 to address overall stability effects associated with compartment pressurization, for example, progressive collapse. Flexural deformations of the compartment walls associated with ductility ratios higher than 3.0 may be justified by assuring overall structural integrity, namely the stability of the structure as a whole under the impulsive loads that originate inside the compartment as well as the follow-on pressurization that may remain inside the compartment depending on the compartment venting, and all loads acting concurrently with the impulsive loads and the follow-on compartment pressurization.<br><br>The regulatory guidance position will be revised to be:<br><br>The permissible displacement ductility ratio in flexure should not exceed 3.0 for loads such as internal blast overpressure and compartment pressurization, which could affect the integrity of the structure as a whole. Flexural deformations of the compartment walls or slabs associated with ductility ratios greater than 3.0 can be justified by assuring the structural integrity of the structure. The justification should consider the impulsive loads originating from within the pressurized compartment including the follow-on pressurization that may remain inside the compartment and act as |

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| | | (typically the ties and shear connectors are more closely spaced within the connection region). These features and the resulting confining action enhance the SC compartment's structural integrity. For SC walls, aside from absence of crack control related concerns, the prospect of spalling under large strains is also entirely prevented because of the presence of faceplates. For these reasons, unlike RC compartment walls, the SC compartment walls need not be subjected to reduced ductility limitation (i.e., ductility limit of 10, which is explained below, remains appropriate for all SC applications).<br><br>[As an aside, it is noted that ACI 349 Section F3.3 permits the limit of 10 for doubly-reinforced RC beams and walls/slabs (except for compartment applications, for which ACI 349 Section F3.5 limits the ductility ratio to 3). This provision is quite applicable to SC walls, and ANSI/AISC N690-18 therefore simply (conservatively) adopted it. This is because SC sections are doubly reinforced with equal reinforcement on both faces (and it is on the exterior in the form of faceplates); this arrangement essentially prevents the prospect of flexure- induced concrete crushing due to increasing tensile strain on the tension reinforcement (i.e., this cross- sectional/curvature related ductility consideration, which is particularly relevant to singly-reinforced cross- sections, is less of a concern for doubly-reinforced sections, especially ones with equal reinforcement). It is further noted that the presence of small-to-moderate magnitude of simultaneous membrane tension force due to compartment pressurization does not adversely impact the cross-sections flexural/rotational ductility because the tension force it continues to ensure that the behavior is controlled by steel yielding, rather than by concrete crushing.]<br><br>The following rationale is provided regarding why ANSI/AISC N690-18 Section N9.1.6b does not adhere to the RG 1.142 exception concerning differentiation between local and global ductility. When subjected to internal pressurization, compartment walls experience significant flexure in combination with low-to- moderate membrane tension forces (as explained above, an SC wall's behavior is steel-controlled and hence quite ductile against these force effects at a cross-section level). Each wall will encounter | sustained loads depending on the compartment venting as well as all other loads acting concurrently with the impulsive loads and the follow-on compartment pressurization.<br><br>Comment for regulatory guidance position 11.1.7 – The staff does not agree with the comment. Test data for four-point beam test setups show that the ductility depends on, for example, the shear span ratio and may not be the same for all conditions. In addition, the information on the cited Figure C-A-N9.3.6(a) is for strength rather than for ductility. Test data reviewed shows that while ductilities such as those in the ANSI/AISC N690-18 can be achieved, they are likely to depend on structural configuration factors on factors such as the shear span ratio. The higher ductilies may be justified for specific design conditions but those conditions for general use have not been defined. The regulatory guidance position will be revised for clarification to read:<br><br>For shear-controlled SC walls with yielding shear reinforcement spaced at section thickness divided by two or smaller, the ductility ratio is no greater than 1.3. For shear-controlled SC walls with yielding shear reinforcement spaced in excess of the section thickness divided by two or for shear-controlled SC walls with nonyielding reinforcement, the ductility ratio is limited to 1.0. Higher ductility factors up to the values in ANSI/AISC N690-18, Section N9.1.6b should be justified on a case-specific basis. |

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| | | the following sequence of plastic hinge formation before a mechanism state is formed for that wall: hinges at ends (negative moment regions), followed by a hinge along midspan (the walls will essentially behave like a collection of adjoining beam segments that span horizontally). It is noted that the mechanism state at an individual wall level is not immediately tantamount to sudden failure because the rotational ductility of the midspan hinge is not necessarily exhausted (this is especially true for dynamic/short-lasting load). A global mechanism state will be reached only after all four walls of the compartment have formed the three hinges in each wall segment (furthermore, all walls can simultaneously reach their individual mechanism state only if the compartment is doubly symmetric). Compared to this backdrop, the ductility provisions of Section N9.1.6b are written in terms of displacement ductility, which will have to be evaluated for each wall segment. Accordingly, the real question is whether a displacement ductility ratio of 10 can lead to (or exceed) the response state associated with the mechanism formation for an SC wall segment (and even if it does, will that lead to the mechanism state for the compartment as whole). This concern is in turn related to the limitation imposed in Section F3.5 of ACI 349-13 because of a concern about the extent of permanent deformations and the degraded wall condition that can occur for RC walls. In contrast, because they are equally reinforced in tension and compression, SC walls can support very large curvature and rotational ductility that would equal or exceed a comparable RC beam. Being that the ductility limit of 10 is acceptable for a doubly-reinforced beam, it follows that the same should be conservatively acceptable for SC wall in a compartment application. It is expected that each constituent wall segment of the compartment will be below its mechanism state this response ductility level (and thus the compartment on the whole will be at a response state that is below its global mechanism state).<br><br>Regarding ductility limits for shear-controlled walls, the following comments are provided:<br><br>It is important to note that there is no such thing as SC wall without cross-ties (i.e., the ties are required as part of the standard's General Requirements). | |

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| | | As such, the accompanying ductility limits are predicated on whether the ties are ductile and spaced at less than or equal to half the wall thickness. A ductility limit of 1.6 is imposed for the condition when the associated shear failure is steel controlled and hence reasonably ductile (as evidenced from numerous SC specimens tested as beams in four-point test setups). The ductility ratio is limited to 1.3 for situations with non-ductile ties and/or when the tie spacing is in excess of half the wall thickness. This is considered reasonable because of the expected overstrength since the corresponding out-of-plane shear capacity provision is conservative (this is due to the expected overstrength since a shear-controlled section signifies that the shear span-to-depth ratio must be quite small, whereby as seen from Figure C-A-N9.3.6(a), the concrete resistance to out-of-plane shear increases due to the strut-and-tie action).<br><br>Finally, there is no basis provided in the draft Regulatory Guide for reducing the ductility ratios to 1.3 and 1.0 in Section C.11.1.7. | |
| AISC | | **AISC_22.** The following discussion and comments refer to Section C.11.2 of the draft Regulatory Guide:<br>The User Note to ANSI/AISC N690-18 Section N9.2.1(a) refers the designer to the accompanying commentary for analysis guidelines (as well as the refined modeling requirements around openings provided in Section N9.1.7). The commentary recommends that at least four to six elements should be used along the short direction of a wall panel, and six to eight elements along its long direction (this guidance is further illustrated in Fig. C-A-N9.2.9, which also clarifies that the element size for elements in the connection region is to be less than or equal to the SC wall thickness). Because of these provisions/guidelines, it is unlikely that an analyst will use only a few panel sections for modeling a wall panel, and therefore no further caution is deemed necessary in the draft Regulatory Guide. Hence, ANSI/AISC N690-18 stipulated an upper limit of demand averaging equals to 2xtsc in the interior regions and 1xtsc in connecting regions and around openings. See Figure C-A-N9.2.9. The ANSI/AISC N690-18 code committee provided these rules in order to minimize evaluation on a case-specific basis which potentially would result in a high number of requests from NRC to | The NRC staff agrees in part with the comment.<br><br>Regulatory guidance position 11.2 will be revised to read:<br><br>Section N9.2.5 specifies that the required strength for each member load type may be determined by averaging the demand over areal extents of the wall (referred to as “panel sections”) that are less than or equal to twice the wall thickness in length and width, except at connections and openings, where the panel section dimensions are limited to the wall thickness. These averaging guidelines are acceptable in conjunction with recommendations in the commentary to N9.2.1.2. Other conditions will be reviewed on a case-specific basis. |

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| | | applicants/licensees for additional information (RAI), a situation that the new Regulatory Guide wants to avoid. | |
| AISC | C.11.4 | **AISC_23.** Section C.11.4 of the draft Regulatory Guide should refer back to ANSI/AISC N690-18 Chapter ND instead of ANSI/AISC 360-16 Chapter D. | The NRC staff agrees with the comment. References to "ANSI/AISC 360-16 Chapter D" will be replaced with "ANSI/AISC N690-18 Chapter ND." |
| NuScale Power, LLC | Page 2, Additional Requirements | **NSP_1.** Citations to Part 52 requirements are incomplete. 10 CFR 52.77 is not relevant. It's unclear what portion of 10 CFR 52.47 and 52.79 are relevant. Similar requirements for SDA and manufacturing license applications are not cited. Further, analogous Part 50 application requirements are not cited.<br><br>Proposed Resolution: Either provide all applicable Part 50 and 52 regulations with the specific relevant provision, or omit the incomplete Part 52 regulations. | The NRC staff partially agrees with the comment. The staff agrees that 10 CFR 52.77 is not relevant and the reference to it will be removed from applicable regulations section of the RG. Even though 10 CFR 52.47 and 52.79 deal with the various subsets of the technical information in the contents of applications, this RG can be part of that technical information and thus should list these applicable additional requirements. The relevant Part 50 provisions that apply to this RG are already listed under Applicable Regulations in Part A, Introduction, of the RG. |
| NuScale Power, LLC | Page 3, Related Guidance | **NSP_2.** ASCE/SEI 37-14 is listed as related guidance. This standard is not NRC guidance and has not been endorsed via an NRC guidance document.<br><br>Proposed Resolution: Delete ASCE/SEI 37-14 from related guidance. If the contents of that standard are relevant and appropriate, it should be directly addressed within this guidance document as an acceptable standard. | The NRC staff agrees with the comment. The reference to the American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI) 37-14, "Design Loads on Structures during Construction" will be removed from this section and a reference to ASCE/SEI 37-14 will be added to regulatory gudiance position 2.1.1.<br>. |
| NuScale Power, LLC | Page 5, Section B, Paragraph 5 | **NSP_3.** BNL-220652-2020-INRE is discussed as technical background for this DG. It describes the assessment of ANSI/AISC N690-18 for use in nuclear power plants. BNL-220652-2020-INRE (page 4-10) Design for Corrosion Effects, states: "Where corrosion could impair the strength or serviceability of a structure, structural components shall be designed to tolerate corrosion or shall be protected against corrosion." The DG does not address design considerations for corrosion effects.<br><br>Proposed Resolution: Provide in the RG additional criteria, if any, for exterior SC walls susceptible to corrosion. | The NRC staff disagrees with the comment. ANSI/AISC N690-18 does not address the effects of corrosion on exterior SC walls. Conditions where corrosion could impair the strength or serviceability of an exterior SC wall can vary widely depending on the exposure and performance requirements of those walls. In the absence of provisions in the ANSI/AISC N690-18, design of exterior SC walls to tolerate corrosion or protect against corrosion where corrosion could impair their strength or serviceability will be subject to case-specific review and individual project specifications. |
| NuScale Power, LLC | Page 8, Section C, | **NSP_4.** The DG states "In load combination (NB2-9), 0.7Ess is to be combined absolutely with the accident loads." 0.7Ess appears to be a typo. | The NRC staff agrees with this editorial comment and will make the correction. |

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| | Paragraph 2.1.5 | Proposed Resolution: Replace with 0.7Es. | |
| NuScale Power, LLC | Page 10, Section C, Paragraph 4.2 | **NSP_5.** While section 4.2 is applicable to high strength reinforcement, clarify the use of high strength structural steel with yield stress up to 75 ksi.<br><br>Proposed Resolution: Provide a statement that if not using high strength reinforcement, this RG endorses the use of structural steel with yield stress not to exceed the 75 ksi in design using the rules of ANSI/AISC N690-2018, Chapter NI. | The NRC staff agrees with the comment. The Regulatory guidance position applies to steel reinforcing bars and it will be edited to be:<br><br>Consistent with RG 1.142, Revision 3, this RG does not endorse, in general, the use of high-strength steel reinforcing bars (yield strength greater than 60,000 pounds per square inch in design (ANSI/AISC N690-2018, Chapter NI, on the design of composite members refers to Chapter I of ANSI/AISC 360-16, which allows the use of high-strength reinforcing bars). If high-strength steel reinforcing bars are used, applicants should demonstrate its adequacy for specific use of the design by testing, analysis, or performance evaluation. |
| NuScale Power, LLC | Page 13, Section C, Paragraph 11.1.9 | **NSP_6.** It is unclear if the 25% increase in faceplate thickness as described in Section N9.1.6c is required.<br><br>Proposed Resolution: Clarify whether the 25% increase in Section N9.1.6c is applicable. | The NRC staff agrees with the comment. The last sentence of regulatory guidance position 11.1.9 will be edited for clarity to be:<br><br>The penetration depth as well as the concrete and faceplate thickness required to prevent penetration are from applicable rational methods or pertinent test data together with the conditions in N9.1.6c of ANSI/AISC N690-18 for the faceplate thickness. |
| NuScale Power, LLC | Page 13, Section C, Paragraph 11.2 | **NSP_7.** The DG states "These averaging guidelines are generic and may not be suitable in all cases. The implementation of these guidelines or any alternate averaging methodology will be subject to case-specific review by the NRC staff." Additional guidance on the suitability and implementation of averaging guidelines is needed.<br><br>Proposed Resolution: Provide criteria or examples of cases where the averaging guidelines are deemed not suitable. Identify considerations for acceptable implementation of the averaging guidelines or an alternate averaging methodology. | The staff agrees in part with comment. Regulatory guidance provision 11.2 will be modified to be:<br><br>Section N9.2.5 specifies that the required strength for each member load type may be determined by averaging the demand over areal extents of the wall (referred to as "panel sections") that are less than or equal to twice the wall thickness in length and width, except at connections and openings, where the panel section dimensions are limited to the wall thickness. These averaging guidelines are acceptable in conjunction with recommendations in the commentary to N9.2.1.2. Other conditions will be reviewed on a case-specific basis. |

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| NuScale Power, LLC | Page 7, Section C, Table 1 | **NSP_8.** In response to Docket NRC-2019-0100, Safety Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments), DG-1283, the leadership of ACI 349 provided comments as documented in Adams Accession number ML19176A439. Comment 5 states as follows:<br><br>We disagree with the NRC position to require a load factor of 1.0 for live load. The load factors in Chapter 9 ACI 349- 13 are associated with lower strength (phi) factors; ACI 349-13 Appendix C load factors are used with higher strength (phi) factors. Thus, increasing load factors in ACI 349-13 Chapter 9 to match those of ACI-349-13 AppendixC erroneously alters the global safety factor. It is also noted that ACI 318 allows live load reductions that result in an equivalent load factor of 0.5L. These reductions are not permitted in nuclear safety-related construction. It is strongly recommend that the NRC review their position in this regard. Regarding the load factor in ACI 349-13 for live load, as explained in the commentary of ASCE 7 Section C2.3, the loads used in design account for the maximum lifetime value as well as arbitrary point-in-time values, with the maximum lifetime value always controlling. When many different types of loads are superimposed in a load combination, as is the case for abnormal or extreme load combinations, the arbitrary point-in-time value or the mean value of the load (accounting for industry variation) should be used. The live load mean value varies between 0.5 to 0.8 of the maximum lifetime value. The value of 0.8L is used for load combination 9-5 to 9-9 on this basis.<br><br>NuScale agrees and considers comment #5 on live load also applicable to DG-1304.<br><br>Proposed Resolution: Apply a value of 0.8 for live load instead of 1.0 for load combinations as per ANSI/AISC N690-18 Section NB2.5. | The staff agrees with the comment. The comment justifies the use of a load factor less than one based on two main considerations:<br>The first consideration is that the use of a load factor of 1.0 as in ACI 349-13, Appendix C, was associated with higher strength reduction factors than those in ACI 349-13, Chapter 9 and ANSI/AISC N690-18.<br>The second consideration is that the combination of loads should account for the expected maximum lifetime value of the dominat loads in the combination and an arbitrary point in time value of the other loads using established approaches in structural design. In the case of abnormal or extreme environmental load combinations, the dominat load are either the abnormal loads or the extreme environmental loads while the companion loads like the live load should act at their expected arbitrary point in time values. This is especially relevant for dominant loads with small annual probabilities of exceedance as is the case of the abnormal or extreme environmental loads. The peer-reviewed article “Probability-Based Design Criteria for Nuclear Plant Structures,” by H. Hwang, B. Ellingwood, M. Shinozuka and M. Reich, Journal of Structural Engineering, American Society of Civil Engineers (ASCE), 113(5), 1987, reports results from a NRC-sponsored research project. That paper refers to a survey of live loads in nuclear power plant which provides the mean live load at about 0.36 times the nominal value, L, with a coefficient of variation of 0.54. This result and the low annual probability of exceedance for the abnormal and extreme environmental loads contribute to justifying the use of a load factor of 0.8 for L in those load combinations. The load factors in Table 1 will be revised to use a factor of 0.8 for L in oad combinations NB2-6, 7, 8 and 9 in Table 1. |

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| NuScale Power, LLC | Page 7, Section C, Table 1 | **NSP_9.** In response to Docket NRC-2019-0100, Safety Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments), DG-1283, the leadership of ACI 349 provided comments as documented in Adams Accession number ML19176A439. Comment 4 states as follows:<br><br>In as much as Ro is computed mainly from thermally- induced elongation of piping, it is not clear why this should be associated with enhanced uncertainty as stated in the NRC position. Note also that there is already significant conservatism associated with the use of an envelope of temperatures for these cases. Please note that the nuclear industry has long struggled with the difficulty of dealing with temperature loads on nuclear structures. The self-relieving nature of the temperature load makes it less critical than other loads. Adding larger load factors sends a wrong message to the designers that the way to deal with temperature is to make the structure stronger. This again is counter-productive to a rational design. Furthermore, the codes recognize the cumulative approach contained in ASCE 7, which holds that as an increasing number of loading types are combined, the less likely it is that the peaks of these loads will occur concurrently. Ro is consistently addressed in this regard in ASCE 43, ACI 349 and AISC N690.<br><br>NuScale agrees and considers comment #4 on Ro applicable for DG-1304.<br><br>Proposed Resolution: Ro should not be treated same as live load (L) in load combinations. Apply Ro to be consistent with ANSI/AISC N690- 18 Section NB2.5. | The staff agrees with the comment. This comment is the same as comment AISC_8.1 and comment AISC_8.2 in what pertains the load Ro. As in the response to comments AISC_8.1 and AISC 8.2, the load factor for Ro in load combination NB2-1 will be changed to 1.4 and the load factor for Ro for load combinations NB2-2, NB2-4 and NB2-5 will be changed to 1.2 |