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U. S. Nuclear Regulatory Commission
Director of the Office of Nuclear Material Safety and Safeguards
Attn: Document Control Desk
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Subject: Proposed Additional Alternative to the ACI Code, Concrete Temperature Testing, Docket 72-1042, CoC 1042 Amendment 1

In accordance with Paragraph 4.4.4 of Certificate of Compliance (CoC) No. 1042 Appendix A, NUHOMS® EOS™ System Generic Technical Specifications (TS), Amendment 1, TN Americas LLC (TN) requests an additional alternative to American Concrete Institute (ACI) 349-06, Appendix E, Section E.4-Concrete Temperatures. The current alternative cites ACI 349-13 and specifies a 28-day test age for the specified concrete compressive strength, f_c'. This proposed additional alternative is to include a test age of up to 56 days to allow the use of the later-age specified concrete compressive strength of 7000 psi for horizontal storage module (HSM) fabrication. The HSM array will not be certified and loaded with DSCs until the specified concrete compressive strength of 7000 psi is achieved.

Proposed Alternative:

The proposed alternative to the Code alternatives for the HSM concrete specifications as listed in Paragraph 4.4.4 is as follows:

> The concrete temperature limit criteria in NUREG-1536, Section 8.4.14.2 is used for normal and off-normal conditions.
>
> Alternatively, per ACI 349-13, Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary, Section RE.4, the specified compressive strength, which may be tested up to 56 days, is increased to 7,000 psi for HSM fabrication so that any losses in properties (e.g., compressive strength) resulting from long-term thermal exposure will not affect the safety margins based on the specified 5,000 psi compressive strength used in the design calculations. Additionally, also as indicated in Section RE.4, short, randomly oriented steel fibers may be used to provide increased ductility, dynamic strength, toughness, tensile strength, and improved resistance to spalling.
>
> The safety margin on compressive strength is 40% for a concrete temperature limit of 300 °F normal and off-normal conditions.

Background:

Previous NUHOMS® storage module technology designs did not include the ACI Code alternative related to this request. Although the CoC 1042 NUHOMS® EOS™ design is based on ACI 349-06, ACI 349-13 commentary section offered flexibility and use of increased strengths in lieu of special aggregates. Therefore, TN proposed the alternative to ACI 349-06 Appendix E Section E.4 based on ACI 349-13 and NUREG-1536 Revision 1 Section 8.4.14.2, including the standard ACI code practice of indicating a 28-day compressive strength. TN did not intend to limit the test age to 28 days since the ACI allows for other designated test ages, but as written, the alternative only includes the 28-day provision. Consistent with the ACI code, TN desires to use the accepted flexibility provided by that code to be able to test for the concrete compressive strength up to 56 days.

Though CoC 1042 Amendment 0 is also effective, TN only requests this change for CoC 1042 Amendment 1. TN will also be submitting a supplement for this change to the application of CoC 1042 Amendment 2, currently under NRC review, concurrent with the resolution of ongoing interactions regarding a recent response to a Request for Additional Information.

Justification:

As demonstrated below, the proposed additional alternative will provide an acceptable level of quality and safety.

In various sections of ACI 349-06, provisions are given for use of other than 28-day test age for determination of the specified concrete compressive strength. Excerpts from ACI 349-06 are provided below:

> **5.1.3** Unless otherwise specified, f_c' shall be based on 28-day tests. If other than 28 days, test age for f_c' shall be as indicated in design drawings or specifications.
>
> **5.6.2.4** A strength test shall be the average of the strengths of a minimum of two cylinders made from the same sample of concrete and tested at 28 days or at test age designated for determination of f_c' .
>
> **R5.1.3** Concrete members 24 in. or thicker will retain sufficient moisture throughout the first 12 months to assure continuous curing and hydration of the major portion of the cross section. These large members rarely receive full service loads for many months and, therefore, the test age designated for the determination of compliance with the specified strength may be later than the usual 28 days. The use of such later age strength requirements may permit the use of a lower cement content and, therefore, help limit or control temperature rise due to hydration and the danger of cracking that may occur as these large members cool to ambient temperature levels. The need to control early temperature rise increases in proportion to the minimum thickness of the section.

All other concrete specification requirements such as sampling and testing methods, testing frequency, calculation of average strength, quality control and quality assurance requirements remain unchanged.

The concrete mix design intended for use for the EOS™ and Matrix™ HSM may contain mineral cementitious materials such as slag and fly ash. Using slag or fly ash to replace a portion of Portland cement in a concrete mixture has numerous advantages: better concrete workability, easier finishability, higher compressive and flexural strengths, lower permeability (which increases corrosion resistance), and improved resistance to aggressive chemicals. One disadvantage, however, is that strength gain is slow. It is an industry standard practice to designate 56 days, or even 90 days, as the test age for the specified concrete compressive strength when similar mix designs are used.

The proposed additional alternative to include a test age of up to 56 days and the specified concrete compressive strength of 7000 psi (unchanged from the current alternative) provides the same level of quality and safety as the original requirement as the test age has no relevance to the design basis compressive strength. The HSM array will not be certified and loaded with DSCs until the specified concrete compressive strength of 7000 psi is achieved. There is no change to the specified compressive strength and the safety margin on the compressive strength remains unchanged.

Regarding environmental impacts, this proposed additional alternative addresses the timing of certain concrete compressive strength testing and would, therefore, have no environmental impact with respect to the NRC's NEPA regulations in 10 CFR Part 51.

As previously discussed with NRC staff, in order to support planned HSM fabrication activities, NRC approval is respectfully requested by October 2, 2020. If the NRC staff has any questions regarding this submittal, please do not hesitate to contact Mr. Glenn Mathues at 410-910-6538 or glenn.mathues@orano.group.

Sincerely,

A. Prakash
DD

Prakash Narayanan
Chief Technical Officer

cc: Christian Jacobs (NRC-DFM)