From: Carolyn Lauron
To: Justin Hawkins
Cc: Greg Cranston; Andrew Brenner; Jordan Glisan; Michael Dudek
Subject: NRC Staff Response to Question regarding "Equivalent Materials" for the SMR-160 design
Date: Wednesday, December 28, 2022 7:39:00 AM

Hi Justin –

Below is the NRC staff response to the question regarding equivalent materials with examples in a table that you provided previously.
If you have questions or need more information, please let us know.

Thanks,
Carolyn Lauron
US NRC

Question:
Regarding the use of the term(s) “or equivalent”, "suitable equivalent", and/or "equivalent materials," these terms seem to be used in many different places including for some safety-related and/or important to safety SSCs materials.

Can the SMR-160 PSAR define “equivalent materials” like the HI-STORM SAR does and potentially apply the term to primary and/or secondary plant system materials?

Table provided for reference and context:

AP1000 DCD Examples	NuScale DCD Examples	HI-STORM SAR
Pg 2.2.3-22 à ix) The type of insulation used on these lines and equipment is a metal reflective type **or a suitable equivalent**. If an insulation other than metal reflective insulation is used, a report must exist and conclude that the insulation is a **suitable equivalent**. **5.2.3 Reactor Coolant Pressure Boundary Materials - Materials Specifications**	**3.8.4.1.7 Reactor Building Pools** The liner is a 304L, or **equivalent**, stainless steel that is 0.25 in. thick in most locations and covers the pool floor and walls up to the 100 foot elevation. **3.8.4.6.1.3 Connections -** Welds Welding electrodes shall be E70XX or unless otherwise noted on drawings or within	**HI-2114830 HI-STORM FW FSAR R9** **Definition: Equivalent (or Equal) Material is a material with critical characteristics (see definition above) that meet or exceed those specified for the designated material.** **Section 8.2.3 Critical Characteristics and Equivalent Materials** “As defined in the Glossary, the ***critical characteristics*** of a material are those attributes that have been identified, in the associated material specification, as necessary to render the material’s intended function. However, material designations adopted by the International Standards Organization (ISO) also affect the type of steels and steel alloys available from suppliers around the world. Therefore, it is necessary to provide for the ability in this

… The nonsafety-related portion of the chemical and volume control system inside containment in contact with reactor coolant is constructed of or clad with corrosion resistant material such as Type 304 or Type 316 stainless steel **or material with equivalent corrosion resistance**. The materials are compatible with the reactor coolant.

5.2.3.2.2 Compatibility of Construction Materials with Reactor Coolant
Ferritic low-alloy and carbon steels used in principal pressure-retaining applications have corrosion-resistant cladding on surfaces exposed to the reactor coolant. The corrosion resistance of the cladding material **is at least equivalent to** the corrosion resistance of Types 304 and 316 austenitic stainless steel alloys or nickel-chromium-iron alloy, martensitic stainless steel, and precipitation-hardened stainless steel. These clad

specification for ASTM A36 steel and E308L-16 or **equivalent** for ASTM A240, type 304- L stainless steel.

9.2.3.2.2 Component Description
The DWS materials, except for the demineralized water treatment degasifiers, are stainless steel or corrosion resistant **material equivalent**.

Table 9A-2: In Situ Combustible Material Classification
Qualified electrical cable à IEEE-383/IEEE-1202 (Reference 9A-6) and **equivalent cables**

FSAR to substitute materials with equivalent materials in the manufacture of the equipment governed by this FSAR. As defined in the Glossary, ***equivalent materials*** are those materials with **critical characteristics** that meet or exceed those specified for the designated material. Substitution by an equivalent material can be made after the equivalence in accordance with the provisions of this FSAR has been established. The concept of equivalent materials explained above has been previously used in this FSAR to qualify four different austenitic stainless steel alloys (ASME SA240 Types 304, 304LN, 316, and 316LN) to serve as candidate MPC materials. The equivalence of materials is directly tied to the notion of *critical characteristics*. A critical characteristic of a material is a material property whose value must be specified and controlled to ensure an SSC will render its intended function. The numerical value of the critical characteristic invariably enters in the safety evaluation of an SSC and therefore its range must be guaranteed. To ensure that the safety calculation is not adversely affected properties such as Yield Strength, Ultimate Strength and Elongation must be specified as *minimum* guaranteed values. However, there are certain properties where both minimum and maximum acceptable values are required (in this category lies specific gravity and thermal expansion coefficient). Table 8.2.1 lists the array of properties typically required in safety evaluation of an SSC in dry storage and transport applications. The required value of each applicable property, guided by the safety evaluation needs defines the critical characteristics of the material. The subset of applicable properties for a material depends on the role played by the material. The role of a material in the SSC is divided into three categories:

Type Technical Area of Applicability
S Those needed to ensure structural compliance

materials may be subjected to the ASME Code-required postweld heat treatment for ferritic base materials.

5.4.1.2 Pump Assembly Description
The materials in contact with the reactor coolant and cooling water (with the exception of the bearing material) are austenitic stainless steel, nickel-chromium-iron alloy, **or equivalent corrosion-resistant material**.

6.5.2.2.1 Containment Coverage
The containment spray nozzles are the Lechler (SPRACO Company) spray nozzles **or equivalent**, which provide a drop size distribution which has been established by testing and found suitable for fission product removal.

Table 10.4.1-1 Main Condenser Design Data
Note: 1. For fresh water plants, **an equivalent tube material** such as 304L, 316L, 904L, or AL-6X may be

T Those needed to ensure thermal compliance (temperature limits)
R Those needed to ensure radiation compliance (criticality and shielding)

The properties listed in Table 8.2.1 are the ones that may apply in a dry storage or transport application.

The following procedure shall be used to establish acceptable equivalent materials for a particular application.

Criterion i: Functional Adequacy: Evaluate the guaranteed critical characteristics of the equivalent material against the values required to be used in safety evaluations. The required values of each critical characteristic must be met by the minimum (or maximum) guaranteed values (MGVs of the selected material).

Criterion ii: Chemical and Environmental Compliance: Perform the necessary evaluations and analyses to ensure the candidate material will not excessively corrode or otherwise degrade in the operating environment.

A material from another designation regime that meets Criteria (i) and (ii) above is deemed to be an acceptable material, and hence, equivalent to the candidate material.

Equivalent materials as an alternative to the U.S. national standards materials (e.g., ASME, ASTM, or ANSI) shall not be used for the Confinement Boundary materials. Equivalent materials as alternative to Holtec's specialty engineered Metamic-HT material shall not be used for the MPC fuel basket. For other ITS materials, recourse to equivalent materials shall be made only in the extenuating circumstances where the designated material in this FSAR is not readily available.

As can be ascertained from its definition in

substituted.		the glossary, the *critical characteristics* of the material used in a subcomponent depend on its function. The overpack lid, for example, serves as a shielding device and as a physical barrier to protect the MPC against loadings under all service conditions, including extreme environmental phenomena. Therefore, the critical characteristics of steel used in the lid are its strength (yield and ultimate), ductility, and fracture resistance. The appropriate critical characteristics for structural components of the HI-STORM FW System, therefore, are: i. Material yield strength ii. Material ultimate strength iii. Elongation iv. Charpy impact strength at the lowest service temperature for the part Thus, the carbon steel specified in the drawing package can be substituted with different steel so long as each of the four above properties in the replacement material is equal to or greater than their minimum values used in the qualifying analyses used in this FSAR. The above *critical characteristics* apply to all materials used in the primary and secondary structural parts of the steel weldment in the overpack. In the event that one or more of the *critical characteristics* of the replacement material is slightly lower than the original material, then the use of the §72.48 (**similar to the Part 50 – 50.59 process for license holders**) process shall be necessary to ensure that all regulatory predicates for the material substitution are fully satisfied.”

NRC Staff Response:
The NRC staff appreciates the desire for a firm definition of “equivalent material,” and recognizes that the designer retains primary responsibility for identifying which properties of a material constitute “critical characteristics.”

The NRC staff notes that its review of the selection of critical characteristics in an

applicant's submittals is not limited to the physical properties of a material. Some aspects of how critical characteristics are described, measured, and ensured may themselves constitute "critical characteristics." Specifically, the NRC requires many materials to be selected with defined pedigrees, such as being ASME Code Class Materials subject to requirements in 10 CFR 50.55a via application of the ASME Boiler and Pressure Vessel Code. The HI-STORM SAR definition appears to include a similar consideration in the paragraph beginning with "equivalent materials as an alternative to…" The NRC staff believes that a clearer and more restrictive paragraph could adequately encompass the regulatory requirements of the NRC without negatively impacting the rest of the sample discussion provided.

Without modification, applying the HI-STORM SAR definition to the SMR-160 PSAR would likely require an Exemption request due to allowing the designer to use non-nuclear grade materials in applications where such are currently required (for example, by 10 CFR 50.55a). The NRC staff would be challenged to approve such a request as it circumvents the basis of the requirements.