NuScale Power™

August 3, 2017

Docket No. 52-048

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Submittal of Changes to Final Safety Analysis Report, Section 5.2.3.

REFERENCES:

1. Letter from NuScale Power LLC, to Nuclear Regulatory Commission, "NuScale Power, LLC Submittal of the NuScale Standard Plant Design Certification Application," dated December 31, 2016 (ML17013A229)
2. NRC Meeting Summary of June 27th, 2017, Public Meeting with NuScale Power, LLC, dated July 26, 2017 (ML17206A238)

During a June 27th, 2017 public teleconference with Bruce Bavol and other members of the NRC staff, NuScale Power, LLC (NuScale) discussed potential updates to Final Safety Analysis Report (FSAR), Section 5.2.3, and Section 6.1.1. As a result of this discussion, NuScale changed Sections 5.2.3, 5.3, 5.4.2, and 6.1.1. The Enclosure to this letter provides a mark-up of the FSAR pages incorporating revisions to Sections 5.2.3, 5.3, 5.4.2, and 6.1.1, in redline/strikeout format. NuScale will include this change as part of a future revision to the NuScale Design Certification Application.

This letter makes no regulatory commitments or revisions to any existing regulatory commitments.

Please feel free to contact Marty Bryan at 541-452-7172 or at mbryan@nuscalepower.com if you have any questions.

Sincerely,

Zackary W. Rad
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NuScale Power, LLC

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Enclosure: Changes to NuScale Final Safety Analysis Report Sections 5.2.3, 5.3, 5.4.2, and 6.1.1

Enclosure:

Changes to NuScale Final Safety Analysis Report Sections 5.2.3, 5.3, 5.4.2, and 6.1.1

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- GDC 4 - The RPV and pressure retaining components associated with the RCPB are designed and fabricated to be compatible with the environmental conditions of the reactor coolant and containment atmosphere.
- GDC 14 and 31 - The RPV and pressure retaining components associated with the RCPB are designed and fabricated with sufficient margin to ensure the RCPB behaves in a non-brittle manner and to minimize the probability of rapidly propagating fracture and gross rupture of the RCPB.

- Criterion XIII of 10 CFR 50, Appendix B - Measures are established to control the on-site cleaning of RPV and pressure retaining components associated with the RCPB during construction.

COL Item 5.2-3: ~~A COL applicant that references the NuScale Power Plant design certification will establish measures to control the on-site cleaning of RPV and pressure retaining components associated with the RCPB during construction.~~

- Appendix G to 10 CFR 50 - The RPV ferritic pressure retaining and integrally attached materials are tested and meet applicable fracture toughness acceptance criteria.

5.2.3.1 Material Specifications

The materials for the Class 1 components that comprise the RCPB, including the RPV and SGs, are provided in Table 5.2-4. Table 5.2-4 also includes materials and specifications associated with the RPV attachments and appurtenances. The table lists the grade or type, as applicable, of the ferritic low allow steels, austenitic stainless steels, and nickel-based alloys specified for the RCPB. Except where noted in Table 5.2-4, the final metallurgical condition is provided in the associated ASME BPVC material specification. Further discussion of the materials associated with the RPV is provided in Section 5.3.

The RCPB surface materials normally in contact with reactor coolant or in contact with pool water during refueling, including welds, are austenitic stainless steel or nickel-based alloy.

Processing and welding of unstablized American Iron and Steel Institute Type 3XX series austenitic stainless steels for pressure retaining components comply with RG 1.44, Revision 1, to prevent sensitization caused by chromium depletion at the grain boundaries during welding and heat treatment operations. For unstablized American Iron and Steel Institute Type 3XX series austenitic stainless steel subjected to sensitizing temperatures subsequent to solution heat treatment, the carbon content is limited to no more than 0.03 weight percent (wt%).

Nickel-based Alloy 690 is used as a base metal in the RCPB components and structures along with Alloy 52/152 cladding and weld metals and similar alloys developed for improved weldability. Alloy 690 and 52/152 have a high resistance to general corrosion, high resistance to fast fracture, and superior tensile properties at elevated temperature. Steam generator tubes use Alloy 690 in the thermally treated condition. Alloy 600 base metal and Alloy 82/182 cladding and weld metal are not used in the RCPB design.

~~Monitoring and control of primary coolant water chemistry parameters are based on fuel vendor recommendations and plus industry operating experience and guidance as summarized in the EPRI PWR Primary Water Chemistry Guidelines. The plant's Strategic Water Chemistry Plan provides the optimization strategy for maintaining primary coolant chemistry and is implemented by plant procedures that provide requirements for sampling and analysis frequencies, and corrective actions for control of primary water chemistry.~~The water chemistry program is based on industry guidelines as described in Electric Power Research Institute Technical Report 3002000505, Pressurized Water Reactor Primary Water Chemistry Guidelines, (Reference 5.2-3). The program includes periodic monitoring and control of chemical additives and reactor coolant impurities listed in Table 5.2-5. Detailed procedures implement the program requirements for sampling and analysis frequencies, and corrective actions for control of reactor water chemistry.

The frequency of sampling water chemistry varies (e.g., continuous, daily, weekly, or as needed) based on plant operating conditions and the EPRI water chemistry guidelines. Whenever corrective actions are taken to address an abnormal chemistry condition, increased sampling is utilized to verify the effectiveness of these actions. When measured water chemistry parameters are outside the specified range, corrective actions are taken to bring the parameter back within the acceptable range and within the time period specified in the EPRI water chemistry guidelines. Following corrective actions, additional samples are taken and analyzed to verify that the corrective actions were effective in returning the concentrations of contaminants to within the specified range. Chemistry procedures will provide guidance for the sampling and monitoring of primary coolant properties.

Refueling operations will require the NuScale Power Module to be isolated, disconnected from the attached systems, and transported to the refueling pool for disassembly and refueling. The pool water will be purified by the pool cleanup system to ensure impurity levels in the pool water meet the impurity levels (i.e. chloride, fluoride, and sulfate) specified for reactor coolant system cold shutdown in the EPRI PWR Primary Water Chemistry Guidelines (Reference 5.2-3).

COL Item 5.2-4: A COL applicant that references the NuScale Power Plant design certification will develop and implement a Strategic Water Chemistry Plan. The Strategic Water Chemistry Plan will provide the optimization strategy for maintaining primary coolant chemistry and provide the basis for requirements for sampling and analysis frequencies, and corrective actions for control of primary water chemistry consistent with the latest version of the Electric Power Research Institute Pressurized Water Reactor Primary Water Chemistry Guidelines.

COL Item 5.2-5: A COL applicant that references the NuScale Power Plant design certification will develop and implement a Boric Acid Control Program that includes: inspection elements to ensure the integrity of the reactor coolant pressure boundary components for subsequent service, the type of visual or other nondestructive inspections to be performed, and the required inspection frequency.

5.2.3.2.2 Compatibility of Construction Materials with Reactor Coolant

The RCPB ferritic low alloy and carbon steels used in pressure retaining applications have austenitic stainless steel cladding on surfaces that are exposed to the reactor coolant. Low alloy steel forgings have an average grain size of five or finer in accordance with American Society for Testing and Materials standards. The cladding of ferritic type base material receives a post-weld heat treatment as required by ASME BPVC, Section III, Subsubarticle NB-4622.

The inside and outside surfaces of the RPV low alloy steels are clad with austenitic stainless steel. The cladding on the inside surfaces is deposited with at least two layers; the first layer is Type 309L and subsequent layers are Type 308L. The cladding on the outside surfaces is deposited with at least one layer of Type 309L.

The through-holes in the baffle plate of the low alloy steel integral steam plenum for the twelve incore instrumentation guide tubes are sleeved with Alloy 690 inserts. Larger through-holes in the baffle plate, for the CRD shafts and holes for pressurizer insurge and outsurge flow, approximately 2 in diameter or greater, are cladded with austenitic stainless steel.

The use of cobalt based alloys is minimized and limits are established to minimize cobalt intrusion into the reactor coolant. Cobalt based alloys are used for hard surfacing and wear resistant parts in the CRDMs and the core support locking assembly. Refer to Section 4.5 for additional details regarding the materials of the CRDMs and reactor vessel internals. Low cobalt or cobalt-free alloys may be used for hardfacing and wear resistant parts in contact with the reactor coolant if their wear and corrosion resistance are qualified by testing.

5.2.3.3 Fabrication and Processing of Ferritic Materials

5.2.3.3.1 Fracture Toughness

The fracture toughness properties of the RCPB components comply with the requirements of 10 CFR 50, Appendix G, "Fracture toughness requirements," and ASME BPVC, Section III, Subarticle NB-2300. Discussion of the fracture toughness requirements of the RPV materials are provided in Section 5.3.

5.2.3.3.2 Welding Control - Ferritic Materials

Welding of ferritic materials used for components of the RCPB is conducted utilizing procedures qualified in accordance with the applicable requirements of ASME BPVC, Section III, Subarticle NB-4300 and Section IX.

Stainless steel corrosion resistant weld overlay cladding of low alloy steel components conforms to the requirements of RG 1.43, Revision 1. Controls to limit underclad cracking of susceptible materials also conform to the requirements of RG 1.43.

Prior to cladding, the surfaces to be clad are examined using magnetic particle or liquid penetrant tests in accordance with ASME BPVC Section III, Paragraphs NB-2545 or NB-2546, respectively.

Other than for austenitic stainless steel cladding of low alloy steel, electroslag welding is not used.

Controls for preheating and interpass temperatures to support welding of carbon and low alloy steel in the RCPB, including preheat for weld deposited cladding, conform to the requirements of ASME BPVC Section III, Division 1, Non-mandatory Appendix D and are specified in the welding procedure specification as required by ASME BPVC Section IX, Article V. Control of the preheat temperature for low alloy steel forgings is in accordance with the requirements of RG 1.50, Revision 1.

Procedure qualification records and welding procedure specifications used to support welding of low alloy steel welds in the RCPB are qualified per ASME BPVC Section III, Subarticle NB-4600 and Section IX. Welders and welding operators are qualified in accordance with ASME BPVC Section III, Subarticle NB-4300 and ASME Section IX. Controls imposed on welding ferritic steels under conditions of limited accessibility are in accordance with the recommendations RG 1.71, Revision 1.

Post weld heat treatment temperature of the RPV low alloy steel material is 1125 degrees F ± 25 degrees F. Alternative post weld heat treatment times and temperatures specified in Subparagraph NB-4622.4(c) of ASME BPVC Section III, Subsection NB are not used.

5.2.3.3.3 Nondestructive Examination of Ferritic Steel Tubular Products

The RCPB components do not contain ferritic steel tubular products. Nondestructive examination requirements associated with austenitic stainless steel tubular products are discussed in Section 5.2.3.4.5.

5.2.3.4 Fabrication and Processing of Austenitic Stainless Steels

5.2.3.4.1 Prevention of Sensitization and Intergranular Corrosion of Austenitic Stainless Steel

In aggressive environments, sensitized austenitic stainless steels are susceptible to intergranular corrosion. Grain boundary carbide sensitization occurs when metal carbides precipitate on the grain boundaries when the material is heated in the temperature range of 800 degrees F to 1500 degrees F.

Avoidance of sensitization and intergranular attack in unstablized Type 3XX austenitic stainless steels is accomplished by ~~five primary methods~~compliance with RG 1.44, Revision 1.~~:~~

- ~~use of austenitic stainless steels with a carbon content not exceeding 0.03 wt%~~
- ~~monitoring of the ferrite number (FN) of weld filler metals to ensure correct ferrite content~~

- ~~utilization of materials in the solution annealed plus rapid cooled condition and, where possible, avoiding subsequent heat treatments between 800 degrees F and 1500 degrees F~~
- ~~control of primary water chemistry to maintain an environment that minimizes intergranular attack~~
- ~~control of welding processes and procedures to avoid heat affected zone sensitization as described in RG 1.44, Revision 1~~

Austenitic stainless steel weld materials for RCPB are analyzed for delta ferrite content and limited to 5 FN to 20 FN in accordance with RG 1.31, Revision 4, and ASME BPV Code, Section III, Paragraph NB-2433.

The control of oxygen, chlorides, and fluorides in the reactor coolant during normal operation further minimizes the probability of stress corrosion cracking of unstabilized austenitic stainless steels. The primary water chemistry is maintained as described in Section 5.2.3.2. Additional information regarding the CVCS and the process for controlling RCS water chemistry is provided in Section 9.3.4.

The use of hydrogen in the reactor coolant inhibits the presence of oxygen during operation. Gaseous argon may also be added to reactor coolant at the same location as the hydrogen injection tee, if required, to support primary to secondary leakage controls. The effectiveness of these controls has been demonstrated by test and operating experience.

Precautions are taken to prevent the intrusion of contaminants into the system during fabrication, shipping, and storage.

~~Measures are taken to prevent sensitization of austenitic stainless steel materials during component fabrication that are welded or exposed to sensitizing temperatures between 800 degrees F and 1500 degrees F. Wrought products listed in Table 5.2-4 are solution annealed and rapidly cooled in accordance with RG 1.44. Heat treatment parameters for the material specifications comply with ASME BPVC, Section II. The material is cooled through the sensitization temperature range at a sufficient rate to avoid carbide formation at the grain boundaries and sensitization.~~

~~When rapidly cooled by a means other than water quenching, non-sensitization of the base materials is verified by a corrosion test in accordance with Practice A or Practice E of ASTM A262 (Reference 5.2-4) as required by RG 1.44.~~

Use of cold worked austenitic stainless steel is avoided to the extent practicable during fabrication of RCPB components. Cold worked austenitic stainless steel with a material yield strength greater than 90,000 psi, as determined by the 0.2 percent offset method, is not used in the fabrication of RCPB components.

5.2.3.4.2 Cleaning and Contamination Protection Procedures

Cleaning of austenitic stainless steel components complies with ASME NQA-1 requirements (Reference 5.2-5). The final cleanness of the RCPB internal surfaces meets the requirements for "Class B" of Subpart 2.1. The final cleanness of the RCPB external surfaces meets the requirements for "Class C" of Subpart 2.2.

Handling, storage, and shipping of austenitic stainless steel components comply with ASME NQA-1-2008, Part I, Requirement 13. Packaging, shipment, handling, and storage of RCPB components meet the applicable requirements of ASME NQA-1a-2009, Part II, Subpart 2.2 (Reference 5.2-5).

Austenitic stainless steel materials used in the fabrication, installation, and testing of nuclear steam supply components and systems are handled, protected, stored, and cleaned according to recognized and accepted methods that are designed to minimize contamination which could lead to stress corrosion cracking.

Procedures provide cleanliness controls during the various phases of manufacture and installation including final flushing. The suppliers implement a written cleanliness control plan prior to and during manufacturing and assembly of components and continues until components are sealed for shipment. The cleanliness control plan includes specific provisions for:

- maintenance of cleanliness
- controls to prevent foreign material from being introduced into the hardware
- water purity control
- controls to prevent detrimental material from contacting hardware
- support system cleanliness and inspection
- use of temporary plugs or seals to prevent entry of foreign material and objects and, as practical, prevent mechanical damage
- use of stickers or other devices identifying cleanliness control requirements, affixed to temporary plugs and seals in such a manner that removal of the plug or seal cannot be accomplished without breaking the sticker
- detection and removal of foreign objects
- maintenance of cleanliness immediately prior to and during welding, brazing, and heat treating
- tools and loose parts accountability
- complete removal of temporary markings prior to heating, welding, heat treating, assembly, or shipment

Controls are established to minimize the introduction of potentially harmful contaminants including chlorides, fluorides, and low melting point alloys on the surface of austenitic stainless steel components. In accordance with RG 1.44, cleaning solutions, processing equipment, degreasing agents, and other foreign materials are removed at any stage of processing prior to elevated temperature treatments. Acid pickling is avoided on stainless steel.

Use of abrasive work is minimized to avoid surface coldwork and contamination. Tools for abrasive work such as grinding, polishing, or wire brushing are not permitted to be contaminated by previous usage on carbon or low alloy steels or other non-corrosive resistant materials that could contribute to intergranular cracking or stress-corrosion cracking.

5.2.3.4.3 Compatibility of Construction Materials with External Reactor Coolant

The external surfaces of the RPV are clad with austenitic stainless steel. External surfaces of the RCPB do not contain exposed ferritic materials and are compatible with a borated water environment and resistant to general corrosion.

5.2.3.4.4 Control of Welding - Austenitic Stainless Steel

Welding is conducted utilizing procedures qualified according to the rules of ASME BPVC, Sections III, Subarticle NB-4300 and IX. Control of welding variables, as well as examination and testing during procedure qualification and production welding, is performed in accordance with ASME Code requirements.

Welders and welding operators are qualified in accordance with ASME Section IX and RG 1.71, Revision 1.

5.2.3.4.5 Nondestructive Examination for Austenitic Stainless Steel Tubular Products

Nondestructive examinations performed on austenitic stainless steel tubular products to detect unacceptable defects comply with ASME BPVC, Section III, Subsubarticles NB-2550 through NB-2570, and Section XI examination requirements. For Class 1 piping welds requiring an ultrasonic preservice examination, the welds meet the surface finish and marking requirements of ASME BPV Code, Section III, Subparagraph NB-4424.2 except that the surface finish has an average roughness (Ra) of 125 in or better and the surface flatness is less than 0.03125 inches for a minimum distance of 2 times the thickness of the part from the weld centerline.

5.2.3.5 Prevention of Primary Water Stress-Corrosion Cracking for Nickel-Base Alloys

Nickel-base alloy components in the RCS are protected from PWSCC by:

- using Alloy 690/152/52 in nickel-based alloy applications.
- controlled chemistry, mechanical properties, and thermo-mechanical processing requirements that produce an optimum microstructure for resistance to intergranular corrosion for nickel-based alloy base metal.
- limiting the sulfur content of nickel-based alloy base metal in contact with RCS primary fluid to maximum 0.02 wt%.

The nickel-based alloy materials that are used in the RCPB, including weld materials, conform to the fabrication, construction, and testing requirements of ASME BPVC Section III. Material specifications comply with ASME BPVC Section II Parts B and C.

Chemistry, mechanical properties, and thermo-mechanical processing requirements are controlled in nickel-based alloy base metal by solution annealing and by thermal

Table 5.2-3: Reactor Safety Valve Materials

Component	Specification	Alloy Designation (Grade, Class, or Type)
Valve main body	SA-182	Grade F316 (Note 1)
Valve end caps	SA-479 OR SA-182	Type 316 or Grade F316 (Note 1)
Pilot body, bonnet, disc and seat	SA-479	Type 304 (Note 1) Type 304L
RSV cap bolts	SA-453	A286
Main disk, piston, and rings	SA-564	Type 17-4; Grade 630; Condition H1100
Main and pilot springs	AMS 5699	Alloy X-750
Welding material (Note 2)	SFA 5.4 SFA 5.9	E308, E308L, E309, E309L, E316, E316L ER308, ER308L, ER309, ER309L, ER316, ER316L

Note 1: 0.03% maximum carbon if exposed to 800-1500°F subsequent to final solution anneal treatment during manufacturing.

Note 2: 0.03% maximum carbon.

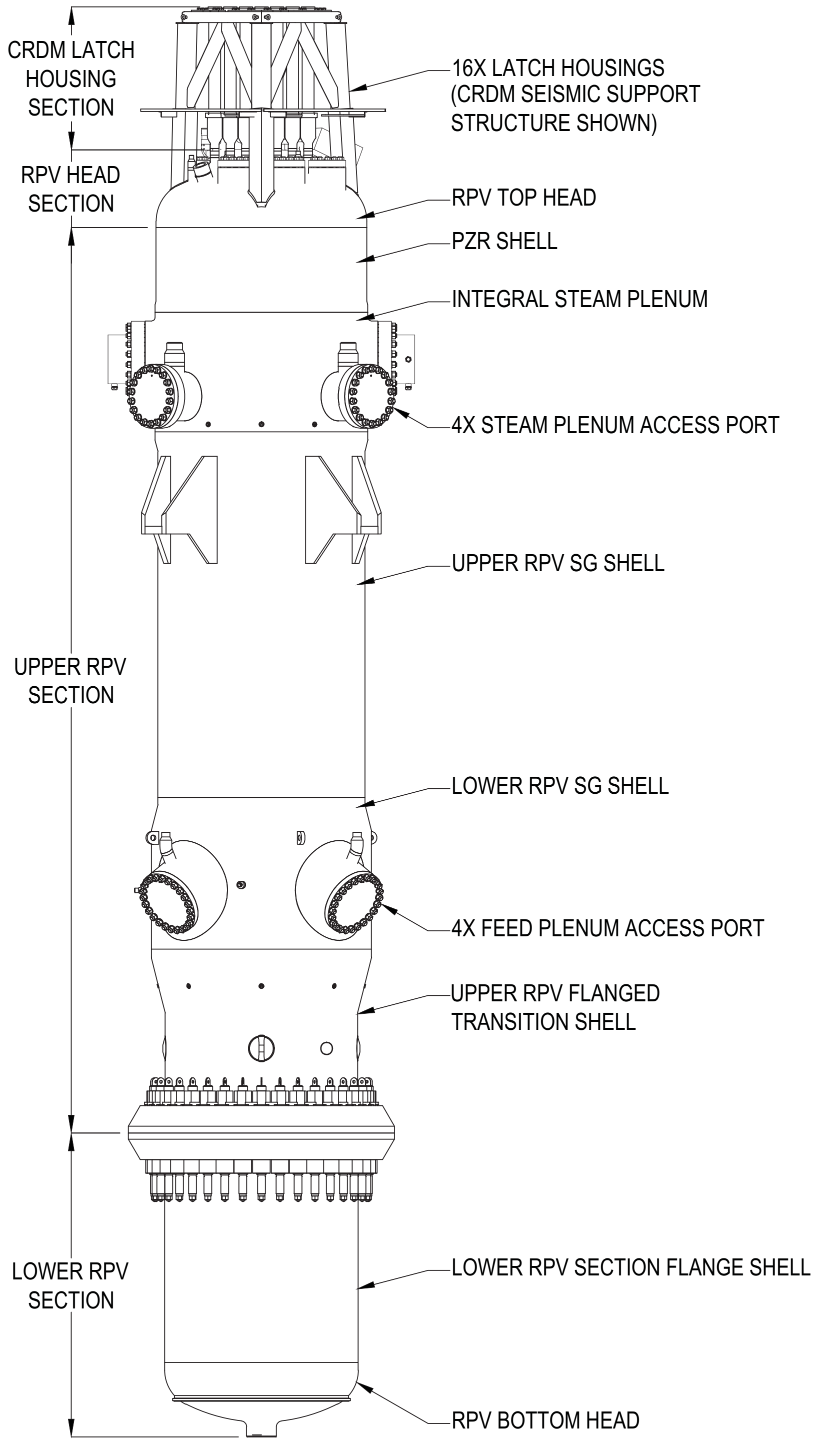
Table 5.2-4: Reactor Coolant Pressure Boundary Component Materials Including Reactor Vessel, Attachments, and Appurtenances

Component	Specification	Alloy Designation (Grade, Class, or Type)
Reactor Vessel		
Lower RPV section flange shell RPV bottom head Core support blocks	SA-508	Grade 3, Class 1
RPV top head PZR Shell Integral steam plenum Upper RPV flanged transition shell Integral steam plenum Steam plenum access ports Upper RPV SG shell Lower RPV SG shell Feed plenum access ports ~~Upper and lower RPV steam generator shells~~	SA-508	Grade 3, Class 2
RPV support gussets RPV support plates	SA-533	Type B, Class 2
Core barrel guides	SA-193	Type 304/304L; Grade B8, Class 1
Vessel alignment pins RPV flange stud threaded inserts Pressure instrument tap swagelok reducers	SA-479	Type 304/304L
Instrumentation and Controls (I&C) access port covers	SA-240	Type 304/304L
I&C access port cover threaded fasteners	SB-637	Alloy 718 (UNS N07718)
RPV flange leak detection tube	SA-312	Type 316L; Seamless
RPV flange closure stud bolts, nuts, and washers RSV flange threaded fasteners, nuts, and washers	SB-637	Alloy 718 (UNS N07718)
I&C swagelok male connectors	SA-479	Type 316/316L
PZR pressure taps Thermowell nozzles	SB-166	Alloy 690 (UNS N06690)
Safe ends for: • RRV • CVCS charging and letdown nozzles • CRDM nozzles • RVV • High point degasification nozzle • Pressurizer Spray nozzle	SB-166 or SB-167	Alloy 690 (UNS N06690)
PZR heater closure flange	SB-168	Alloy 690 (UNS N06690)
Ultrasonic testing sensor nozzles	SA-182	Grade F304/F304L
Low alloy steel weld filler material	SFA 5.5 SFA 5.23 SFA-5.28 SFA-5.29	Weld filler metal classifications compatible with low alloy steel base metal

Table 5.2-4: Reactor Coolant Pressure Boundary Component Materials Including Reactor Vessel, Attachments, and Appurtenances (Continued)

Component	Specification	Alloy Designation (Grade, Class, or Type)
Stainless steel weld filler material (includes filler material for cladding)	SFA 5.4 SFA 5.9 SFA-5.22	E308, E308L, E309, E309L, E316, E316L ER308, ER308L, ER309, ER309L ER316, ER316L, EQ308L, EQ309L E308, E308L, E309, E309L, E316, E316L
Nickel-based alloy weld filler material	SFA-5.11 SFA-5.14	ENiCrFe-7 ERNiCrFe-7, ERNiCrFe-7A, ~~ERNiCrFe-13,~~ EQNiCrFe-7, EQNiCrFe-7A
Steam Generators		
SG tubes	SB-163	Alloy 690 (UNS N06690)
SG tube supports	SA-240	Type 304/304L
Integral steam plenum cap	SB-564	Alloy 690 (UNS N06690)
Nickel-based alloy weld filler material	SFA-5.11 SFA-5.14	ENiCrFe-7 ERNiCrFe-7, ERNiCrFe-7A, ~~ERNiCrFe-13,~~ EQNiCrFe-7, EQNiCrFe-7A
RVVs and RRVs		
Refer to Table 6.1-1		
RCS ~~Injection and Discharge and High Point Vent Class I~~ Piping		
~~Containment to check valve piping~~ ~~Check valve to RPV piping~~RCS Injection Line, CNV to RPV RCS Discharge Line, RPV to CNV RPV High Point Degasification Line, RPV to CNV PZR Spray Supply Line, CNV to RPV	SA-312	Type 304/304L
Stainless steel weld filler materials	SFA 5.4 SFA 5.9	E308, E308L, E316, E316L ER308, ER308L, ER316, ER316L
RCS Check Valves		
Refer to Section 5.4.2.5		
RCS Injection and Discharge Isolation Valves		
Refer to containment isolation valves in Table 6.1-1~~2~~		
Reactor Safety Valves		
Refer to Table 5.2-3		
CRDM Pressure Retaining Components		
Latch housing Rod travel housing Rod travel housing Plug	SA-965	Grade F304LN

Figure 5.3-1: Reactor Vessel



maximum expected RCS discharge flow during a plant startup. The RPV high-point degasification line excess flow check valve is designed to be capable of stopping fully developed flow of 150 percent in the forward direction within one second during accident conditions.

5.4.2.3 Performance Evaluation

Section 3.9, Section 3.12, and Section 5.2 provide information regarding the RCS piping criteria, methods, and materials, and include the design, fabrication, and operational provisions to control those factors that contribute to stress-corrosion cracking. The RCS piping supports the functional aspects of the chemical volume and control system (CVCS) as summarized in Section 9.3.4.

The RCS piping reverse flow and excess flow check valves provide a backup to the containment isolation valves in the event of a line break outside containment and both containment isolation valves fail to isolate the line. The RCS piping reverse flow and excess flow check valves do not provide an operational safety function but they do form a portion of the RCPB along with the RCS piping. Analysis demonstrates that flow induced vibration is either not predicted to occur or the effects are shown to be acceptable for the design life of the RCS piping and check valves.

5.4.2.4 Tests and Inspections

Preservice and ISI requirements associated with ASME Class 1 components, which include the RCS piping and associated check valves, are summarized in Section 5.2. No socket welds are used for RCS piping including piping of NPS 2 or less.

The reverse flow check valves and excess flow check valves are included in the augmented inservice testing and stroke tested in accordance with ASME Operational and Maintenance Code (OM Code) OM-2012, Division 1, Paragraph ISTC-3522. The testing is performed every 96 months on a staggered test basis between the reverse flow and excess flow check valves during refueling conditions.

5.4.2.5 Reactor Coolant System Piping and Check Valve Materials

Descriptions of the RCPB and materials associated with the RCS piping are provided in Section 5.2.

The RCS check valves are classified as Quality Group A and are designed, fabricated, constructed, tested, and inspected as Class 1 in accordance with ASME BPVC and the applicable conditions promulgated in 10 CFR 50.55a(b). The check valve materials, including weld materials, conform to fabrication, construction, and testing requirements of ASME BPVC, Section III, Subsection NB. The materials selected for fabrication conform to the applicable material specifications provided in ASME BPVC, Section II and meet the requirements of ASME BPVC, Section III, Article NB-2000. The check valves are constructed of materials with a proven history in light water reactor environments. Surfaces of pressure retaining parts of the valves, including weld filler materials and bolting material, are corrosion resistant materials such as stainless steel or nickel-based alloy. The RCS check valve weld filler metals are in accordance, as applicable, with SFA-5.4 and SFA-5.9, of BPVC, Section II, Part C.

heaters. Fluid that enters the RCS from the PZR is effectively mixed with the rest of the reactor coolant as it flows down over the SG helical tube bundles, down the remainder of the downcomer, and into the reactor core. As a result, the reactor coolant entering the reactor core has a uniform temperature and boron concentration.

Shutdown Operations

Pressurizer heaters are de-energized and spray is used as needed to reduce RCS pressure. The SG steaming continues cooldown in conjunction with the pressurizer pressure reduction, to reduce the temperature of the RCS. When the RCS is sufficiently cool and pressure is sufficiently reduced the PZR steam bubble may be replaced with a nitrogen bubble. Nitrogen is introduced to the pressurizer via the high-point degasification line. Pressurizer spray is performed, and PZR heater power is reduced and then secured as the steam bubble collapses and is replaced by a nitrogen bubble.

5.4.5.4 Tests and Inspections

The RCPB portions of the pressurizer are tested and inspected as a part of the RPV testing and inspections. All regions of the pressurizer region are constructed to permit required inspections. See Section 5.2 for a discussion of RPV testing and inspections.

The pressurizer baffle plate is subject to the BPVC and the ANSI/ASME NQA-1 program. The plate support structure and attachments are inspected as a reactor vessel internal structure in accordance with the requirements of BPVC requirements.

Pressurizer heaters are monitored and tested in accordance with applicable BPVC requirements as a part of the RCPB. Testing is performed to verify their functionality in accordance with vendor recommended acceptance criteria. Each finished heater bundle is tested to verify the power rating is within 2 percent of the nominal rated power.

5.4.5.5 Pressurizer Materials

The pressurizer includes the top portion of the RPV upper shell, the RPV upper head, the pressurizer baffle plate, heater bundles, and spray nozzles. The material of the RPV upper shell and upper head is described in Section 5.2. The pressurizer spray nozzles and pressurizer spray nozzle safe ends are described in Section 4.5 and Section 5.2, respectively.

The pressurizer baffle plate is an integral part of one of the RPV upper shell forgings and is thus constructed of a Grade 3, Class 2, low alloy steel in accordance with material specification SA-508 of BPVC, Section II. The upper and lower surfaces of the baffle plate are weld clad with two layers of stainless steel for corrosion protection in accordance with material specification SFA-5.9 of BPVC, Section II; the first layer being Alloy Type ER309L and the second layer being Alloy Type ER308L. Additionally, the upper surface of the baffle plate in the regions of the SG integral steam plenums is clad with nickel-based ~~Alloy 690 material (UNS N06690)~~Alloy 52/152 for compatibility.

The specific materials for the heater bundle assemblies are austenitic stainless steel or Ni-Cr-Fe Alloy. Materials for the cover plate, bolting, and heater sheaths are corrosion

Table 5.4-3: Steam Generator Piping, Tube and Piping Supports, and Flow Restrictor Materials

Component	Specification	Alloy Designation (Grade, Class, or Type)
SG Class 2 piping	SA-312	Type 340/304L
SG piping reducers and elbows	SA-182	Grade F304/F304L
SG piping supports	SA-479	Type 304/304L
Flow restrictors and flow restrictor bolts	SA-479	Type 304
Flow restrictor mounting plates	SA-240	Type 304
Flow restrictor mounting plate spacer	SB-166	Alloy 690 (UNS N06690)
Flow restrictor stud bolts, nuts, and washers Integral steam and feed plenum port cover threaded fasteners	SB-637	Alloy 718 (UNS N07718)
Integral steam and feed plenum access ports	SA-508	Grade 3, Class 2
Integral steam and feed plenum access port covers	SA-240	Type 304/304L
Low alloy steel weld filler material	SFA 5.5 SFA 5.23 SFA-5.28 SFA-5.29	Weld filler metal classifications compatible with low alloy steel base metal
Stainless steel weld filler material (includes filler material for cladding)	SFA 5.4 SFA 5.9 SFA-5.22	E308, E308L, E309, E309L, E316, E316L ER308, ER308L, ER309, ER309L ER316, ER316L, EQ308L, EQ309L E308, E308L, E309, E309L, E316, E316L
Nickel-based alloy weld filler material	SFA-5.11 SFA-5.14	ENiCrFe-7 ERNiCrFe-7, ERNiCrFe-7A, ~~ERNiCrFe-13,~~ EQNiCrFe-7, EQNiCrFe-7A

To avoid cracking of the base material, the stainless steel weld overlay cladding process conforms to the guidelines of RG 1.43 and the underlying low alloy steel satisfies fine grain requirements. The weld cladding processes are qualified in accordance with ASME Code Section III, Subsection NB-4300 and the low-alloy steel forgings that have cladding applied are manufactured to an ASTM grain size of 5 or finer. Electroslag welding is not used other than for austenitic stainless steel cladding of low alloy steel.

Implementation of RG 1.44 guidelines minimizes the potential for stainless steel intergranular stress corrosion cracking. Prior to fabrication, unstabilized austenitic stainless steel of the AISI Type 3XX series is solution treated per the guidance of RG 1.44, which describes acceptable criteria for preventing intergranular corrosion of stainless steel components. Where austenitic stainless steel materials are subjected to sensitizing temperatures for greater than 60 minutes during post weld heat treatment, non-sensitization of the materials is verified by testing in accordance with ASTM A262, Practice A or E. Furnace-sensitized austenitic stainless steel is not used in NuScale ESF components.

Delta ferrite content of stainless steel weld filler material conforms to the guidelines stipulated in ASME BPV Code,BPVC, Section III, Subsections NB-2433, NC-2433 or NF-2433 and RG 1.31 to ensure sufficient ferrite content to avoid microfissures in welds, offset dilution and reduce thermal aging. The delta ferrite content in stainless steel weld metal is controlled between ferrite number 5 and 20. Ni-Cr-Fe filler metals used for Alloy 690 to low alloy material welds are made with Alloy 52/152/52M filler metal to provide a high level of corrosion resistance.

The guidelines of RG 1.31 or ASME BPV Code,BPVC, Section III, Subsection NB-2433 for determining the delta ferrite of stainless steel welds do not apply to the filler materials used for depositing cladding because the cladding is deposited as a corrosion resistant layer and does not have a structural function. The delta ferrite content in the austenitic stainless steel weld cladding is controlled between ferrite number 5 and 20.

The chemical composition of low-alloy steel filler metals used for the ESF components meets the requirements of the ASME BPV Code,BPVC, Section II material specifications. The weld metal filler metals are listed in Table 6.1-1.

Pressure retaining bolting and stud materials (studs, nuts and flat washers) used in ESF systems are fabricated of corrosion resistant alloys; SB-637, Alloy 718 (UNS N07718) for connection of the upper and lower CNV shell flanges, top head and reactor pressure vessel (RPV) to CNV support ledge shell; and, SA-564, Grade 630, heat treated at 1100 °F for CNV appurtenance flanges, and manways and inspection or access ports. Due to its resistance to general corrosion, the concerns addressed by RG 1.65, Revision 1, Position 2(b) do not apply to Alloy 718. These bolting and stud materials are consistent with ASME BPV CodeBPVC, Section III, Subsection NB-2128 and are inspected to the requirements of NB-2580.

Threaded inserts for CNV bolting are fabricated of corrosion resistant alloy SA-479, Type 304/304L.

To minimize the potential for stress corrosion cracking, cold-working of austenitic stainless steel surfaces from abrasive work, such as grinding or wire brushing, is

The DHRS consists of two redundant trains, each including a passive condenser with piping. With the exception of some portions of the steam side piping, the DHRS is immersed within the reactor pool. The DHRS piping including the portion that penetrates the CNV boundary is designed to ASME Class 2 criteria. The DHRS piping material internal and external to the CNV is selected to be compatible with the secondary fluid in contact with the DHRS components and with borated water present in the reactor coolant system and the reactor pool. A more detailed discussion and description of the DHRS is provided in Section 5.4.

Over the life of the plant, the interior and/or exterior surfaces of ESF components, with the exception of the CNV head exterior, and the non-ESF piping and components within the CNV are routinely exposed to borated reactor coolant and/or borated reactor pool water. The CNV is partially immersed and DHRS condensers as well as the ECCS valve actuator assemblies are submerged in the reactor pool.

Socket welds are not used for piping in Table 6.1-2, including piping of NPS 2 or less in size.

During normal power operations the interior environment of the CNV is maintained dry, at a partial vacuum. The CNV is partially flooded with reactor pool water during cooldown prior to the movement of an NPM for refueling operations.

Emergency core cooling for the NuScale plant is facilitated by the reactor coolant discharged into the CNV. Reactor coolant chemistry is maintained consistent with the guidance found in the EPRI PWR Primary Water Chemistry Guidelines. As a result, during transients or accidents that result in reactor coolant discharge into the CNV, interior components are exposed to the same chemistry controlled coolant that is used in day- to-day operations. ESF component materials that are exposed to primary reactor coolant (internally or externally) are selected to be compatible with reactor coolant chemistry and the NuScale design prohibits the use of materials within the CNV that could significantly alter post-accident coolant chemistry. Additional information on reactor coolant water chemistry is located in Section 5.2.3.

The materials for ESF components that are partially immersed within the reactor pool are selected to be compatible with the reactor pool chemistry conditions maintained in the pool. No significant corrosion is expected based on the purity of the reactor pool water outside of the CNV. Section 9.1.3 describes operation of the pool cleanup system that maintains reactor pool water chemistry within the expected range of values shown on Table 9.1.3-2. A corrosion allowance is not included for ESF materials exposed to process fluids or reactor pool chemistry.

Piping, supports and components associated with CFDS and located in the CNV interior but defined as part of the CNTS are designed to be compatible with the reactor coolant chemistry that would be present under operation of ECCS conditions. The CNTS piping, fittings, pipe supports and components are constructed of austenitic stainless steel Type 304 or 304L with a carbon content not exceeding 0.03% to mitigate intergranular attack and are ASME Class 2 components. Non-ESF components in the CNV are listed in Table 6.1-2.

Table 6.1-1: Material Specifications for ESF Components (Continued)

Component	Material/Grade/Type
DHR (internal and external), ECCS Trip/Reset (external), ECCS Trip (external)	SB-166, UNS N06690
CNV Supports	
CNV Support Skirt and CNV Support Skirt Ring	SA-182 or SA-965, Grade F304/304L
RPV Ledge Bolts, Nuts, and Flat Washers	SB-637, UNS N07718
RPV Support Ledge and Gussets	SA-533, Type B, Class 2
RXM Platform Mount Assemblies	SA-508, Grade 3, Class 2
Weld Filler	
Low alloy steel weld filler	SFA-5.5, SFA-5.23, SFA-5.28 or SFA-5.29
Austenitic SS weld filler[1]	SFA-5.4: E209, E308, E308L, E309, E309L, E316, E316L SFA-5.9: ER209, ER308, ER308L, ER309, ER309L, ER316, ER316L, EQ308L, EQ309L SFA-5.22: E308, E308L, E309, E309L, E316, E316L
Nickel Based (Ni-Cr-Fe) alloy weld filler	SFA-5.11: ENiCrFe-7 SFA-5.14: ERNiCrFe-7, ERNiCrFe-7A
Stainless Steel Weld Filler for Cladding on low alloy Steel Base Metal[1]	SFA-5.4: E308L, E309L SFA-5.9: ER308L, ER309L, EQ308L, EQ309L SFA-5.22: E308L, E309L
Containment Isolation Valves	Austenitic stainless steel or Ni-Cr-Fe alloy
DHRS	
Steam and Condensate Piping Condenser Tubing and Header Pipes	SA-312, TP304/304L
Actuator Valves	Austenitic stainless steel or Ni-Cr-Fe alloy
Steam Supply Piping Elbows and Tees Condenser Threadolets and Weldolets	SA-182, Grade F304/F304L
Steam Supply Side Pipe Clamp Condenser Manifold Brackets and Retaining Bar	SA-240, Type 304/304L
Condenser Fittings (Elbows, Tees, Caps, Reducers)	SA-403, WP304/304L
Condenser Bolts	SA-193, Grade B8M
Condenser Washers	304 SST
Weld Filler Material[1]	SFA-5.4, E308, E308L, E316, E316L SFA 5.9, ER308, ER308L, ER316, ER316L
ECCS	
Reactor Vent (RVV) and Recirculation (RRV) Valves (Valve Body)	Austenitic stainless steel or Ni-Cr-Fe alloy
RVV and RRV Bolts and Nuts	Austenitic stainless steel or Ni-Cr-Fe alloy
Valve Actuator Manifold Assembly (Trip and Reset)	Austenitic stainless steel or Ni-Cr-Fe alloy
Hydraulic Actuator Tubing	SA-213, Grade TP304/TP304L
Actuator Tubing Reducers and Tees	SA-182, Grade TP304/304L
Weld Filler Material[1]	SFA-5.4: E308, E308L, E309, E309L, E316, E316L SFA-5.9: ER308, ER308L, E309, E309L, ER316, ER316L

Note:
1) Carbon content of unstabilized Type 3XX weld filler materials is restricted to 0.03% maximum.