Current & Proposed Revisions, Changes, & Modifications to American Codes & Standards to Address Packaging, Handling, & Transportation of Radioactive Materials & How They Relate to Comparable International Regulations

William H. Borter & Carl H. Froehlich
BNFL Fuel Solutions, Campbell, California, USA

ABSTRACT

This paper addresses current and proposed revisions, additions, and modifications to American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) (i.e., "ASMEthe Code") Section III, Division 3 and American National Standards Institute (ANSI)/ASME N14.6. It provides insight into the ongoing processes of the associated committees and highlights important revisions, changes, and modifications to this Code and Standard.

The ASME Code has developed and issued Division 3 to address items associated with the transportation and storage of radioactive materials. It currently only addresses "General Requirements" in Subsections WA and "Class TP (Type B) Containments" (Transportation Packages) in Subsection WB, but is in the process of adding a new Subsection WC to address "Class SC" (Storage Containments). ANSI/ASME Standard N14.6 which interacts with components constructed to Division 3 by addressinges special lifting devices for radioactive material shipping containers. This Standard is in the process of a complete re-write.
This Code and Standard can be classified as "dynamic" in that their committees meet at least four times a year to evaluate proposed modifications and additions that reflect current safety practices in the nuclear industry. These evaluations include the possible addition of new materials, fabrication processes, examination methods, and testing requirements. An overview of this ongoing process is presented in this paper along with highlights of the more important proposed revisions, changes, and modifications and how they relate to United States (US) and international regulations and guidance like International Atomic Energy Agency (IAEA) Requirement No. TS-R-1."

1. INTRODUCTION

This paper addresses current and proposed revisions, additions, and modifications to American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) (i.e., "ASMEthe Code") Section III, Division 3 [1](d) and American National Standards Institute (ANSI)/ASME N14.6 [2]. It provides insight into the ongoing processes of the associated committees and highlights important revisions, changes, and modifications to this Code and Standard.

The ASME Code has developed and issued Division 3 to address items associated with the transportation and storage of radioactive materials. It currently only addresses "General Requirements" in Subsections WA and "Class TP (Type B) Containments" (Transportation Packages) in Subsection WB, but is in the process of adding a new Subsection WC to address "Class SC" (Storage Containments). ANSI/ASME Standard N14.6 which interacts with components constructed to Division 3 by addressinges special lifting devices for radioactive material shipping containers. This Standard is in the process of a complete re-write.

This Code and Standard can be classified as "dynamic" in that their committees meet at least four times a year to evaluate proposed modifications and additions that reflect current safety practices in the nuclear industry. These evaluations include the possible addition of new materials, fabrication processes, examination methods, and testing requirements. An overview of this ongoing process is presented in this paper along with highlights of the more important proposed revisions, changes, and modifications and how they relate to United States (US) and international regulations and guidance like International Atomic Energy Agency (IAEA) Requirement No. TS-R-1 [3]."

2. ASME BPVC

Proposed changes to the ASME Code relating to the construction of items utilized in the storage and transportation of commercial spent nuclear fuel (SNF) impact the design, fabrication, testing, and maintenance of these items. These proposed changes include modifications of Division 3 Subsections WA (General Requirements) and WB (Class TP (Type B) Containment) and the issuance of new Subsection WC (Storage Containment). The changes or clarifications to Subsections WA and WB are designed to ease use of the ASME Code, whereas the proposed

issuance of Subsection WC will provide requirements for the construction of commercial SNF storage containments like canisters in the dry storage industry.

2.1 **Subsections WA & WB**

Although some of the changes to Subsections WA and WB are considered to be editorial in nature in that they have no technical impact, other changes will affect the design, fabrication, inspection, and maintenance of casks, canisters, and baskets. The editorial changes make the terminology of both Subsections WA and WB[1] consistent and correct as they pertain to the construction of components for transportation of commercial SNF. Subsection WA provides the general requirements associated with Division 3 (currently only Subsection WB) andwhich is being expanded to include Subsection WC for canisters and Subsection WD for canister internals. Highlights of the proposed changes to Subsections WA and WB are as follows:

- Consistent usage of the term "containment." Replaces use of "item" and "containment" terms in earlier editions. (General for WA & WB)
- Requirement that Quality Assurance Programs (QAPs) for Division 3 Certificate Holders be updated within 6 months of the issuance of a new ASME BPVC Edition/Addenda. (WA-1140)
- Replacement of "Operating Limits" with "Service Limits" to reflect the concept of Division 1. Service Limit Level A will address "Normal Operating Conditions"; Service Limit Level B will not be used; Service Limit Level C will address "Off-Normal Operating Conditions; and Service Limit Level D will address "Accident Operating Conditions." (WA-2121, WA-2133 & WB-3100)
- Requirement that a Fabrication Specification include examination and testing for closure welds. (WA-3360)
- Certificate Holder clarification to establish that there is no separate "Division 3 NPT" Certificate Holder. The Certificate Holder will be certified to Subsection NCA [1](a), Divisions 1 and 2, along with any additional requirements of Division 3. (WA-3400)
- Clarification that the required QAP associated with material organizations and fabricators meet Paragraphs NCA-3800 and NCA-4000 as applicable. (WA-3800 & WA-4000)
- Addition of "Class SC Containments" to the stamping symbols. (WA-8000)
- Clarification of the Division 3 Glossary to only list terms not provided in the Paragraph NCA-9000 Glossary or terms with modified definitions. (WA-9000)

2.2 **Subsection WC**

Proposed Subsection WC addresses the construction of canisters for the storage of commercial SNF. This subsection is based on the provisions of Subsection NC [1](c) for Class 2 vessels and modified to include aspects from Title 10, Code of Federal Regulation, Part 72, (10CFR72) [4]. Proposed Code Case N-717 [5](b) should provide most of the proposed construction requirements of this new subsection. Highlights of this Code Case and proposed subsection include the following:

- General – Deletion of requirements associated with items that are not applicable to the storage of commercial SNF and high-level radioactive material and waste. This includes piping, valves, pumps, and pressure relief devices designed as part of the containment. If designed as containment components, they would be required to be meet the requirements of Subsections NB [1](b) or NC [1](c). Terminology used in Division 1 for the boundary of a "pressure retaining" component has been replaced in Division 3 with "containment." Although the concept is the same, the term "containment" more closely reflects the service conditions of Division 3 components.

[1] The original issuance of WB was essentially a "word-for-word" copy of Subsection NB [1](b) which addresses the construction of Class 1 vessels and, as such, did not provide a clear translation into the construction of a cask for the transportation of commercial spent nuclear fuel.

- Permitted materials are limited to materials listed in Section II, Part D [6], Tables 2A, 2B, and 4 with Class 2 (Subsection NC) material examination rules[2]. Material requirements that pertain to product forms, which are not considered to be applicable to containments, have been removed. There are two additional new requirements: (1) Plate used in the containment shell is required to be UT examined in the area where a closure lid(s) will be welded, and (2) The provisions of WB-2539.7 have been added to address the weld repair of cladding.

- Although Subsection WC is based on the provisions of Subsection NC, the only permitted method of design is "design by analysis" (NC-3200); the "design by formula" option permitted by NC is not permitted in WC.

- "Operating Limits" is replaced with "Service Limits" to reflect the concept of Division 1. Service Limit Level A will address "Normal Operating Conditions"; Service Limit Level B will not be used; Service Limit Level C will address "Off-Normal Operating Conditions"; and Service Limit Level D will address "Accident Operating Conditions".

- Requirements for Division 3 castings are in the Code Case preparation process.

- Requirements for the design, fabrication, examination, and testing of the final closure welds in storage canisters have been provided. These requirements are based on Code Case N-595 [5](a).

- A helium leak test of the containment boundary welds has been added. This leak test is based on the ASME Code Section V [7], Articles 4 (Ultrasonic Examination Methods for Welds) and 5 (Ultrasonic Examination Methods for Materials).

2.3 **Comparison to International Regulations**

TS-R-1 establishes "…standards of safety which provide an acceptable level of control of radiation, criticality, and thermal hazards of persons, property, and the environment that are associated with the transport of radioactive material…" Like 10CFR71 [8], this IAEA document provides general provisions; basic radionuclide activity limits and material restrictions; transport requirements and controls; radioactive materials, packagings, and packages requirements; test procedures; and approval and administrative requirements for the transport of these materials. Relative to the proposed changes to Subsections WA and WB, the following appear to be part of a growing consensus of agreement in the use and understanding of industry terms:

- "Containment" vs. "containment system" – Per TS-R-1, Section II, "Definitions," Paragraph 213, a "containment system" is the "…assembly of components of the packaging specified by the designer as intended to retain the radioactive material during transport." Per WA-9000, "Glossary, a "containment" is "A component that serves as a leak tight barrier for spent nuclear fuels and high level radioactive waste and materials within a prescribed volume for storage or transportation and is demonstrated not to exceed the maximum allowable leakage rate required by the Design Specification." These definitions clearly have the same intent and are clearly different from similar terms they are often confused with (i.e., "confinement" or "confinement systems"). Neither of these latter terms is addressed by the ASME Code while TS-R-1 states that a "Confinement system shall mean the assembly of fissile material and packaging components specified by the designer and agreed to by the competent authority as intended to preserve criticality safety."

- "Service limits" vs. "general severity levels" – Per TS-R-1, Section I, "Introduction", Paragraph 106, "general severity levels" include:

  (a) Routine conditions of transport (incident free);

  (b) Normal conditions of transport (minor mishaps); and

  (c) Accident conditions of transport.

[2] These are the same materials that are permitted for Class 1 vessels/components.

As discussed above, the proposed replacement of “Operating Limits” with Service Limits A (for “Normal Operating Conditions”), C (for “Off-Normal Operating Conditions”), and D (for “Accident Operating Conditions”) in Subsections WA and WB clearly echo/parallel the TS-R-1 general severity levels.

The remainder of the proposed changes to Subsections WA and WB are at a level of design, analysis, fabrication, examination, etc. that are outside the scope of TS-R-1 and, as stated in the “Introduction” to TS-R-1, are subject to the “…laws and customs of different countries and the international conventions into which these countries have entered.”

3. **ANSI STANDARD**

3.1 **Proposed Changes**

In addition to the proposed changes to theASME Code Section III, Division 3, there is a re-write to ANSI/ASME N14.6 that will provide clarifications and modifications to thise standard to improve its usability Standard and prevent misinterpretation of its requirements. The proposed re-write includes the following:

- Reorganization to clearly provide a separate section for design, fabrication, testing & maintenance, and quality assurance.

- Addsed provisions for both a “Design Specification” and a “Fabrication Specification”. This will to permit the designer to separately specify design vs. fabrication what the device is design for and what requirements have to be meet during the fabrication of the device.

- Providesd alternate methods of establishing that the materials in the load path have adequate fracture toughness to prevent failure during operation. This will include both physical testing of the materials (based on ASME Code Section III and VIII [9]) and evaluation based on fracture mechanics (based on the methodology of ASME Code Section XI [10]).

- Clarifiescation that a technical evaluation shall be performed following any incident that could have over loaded a load-bearing component of the device. This evaluation may or may not result in a repeat of the original load test.

- Re-defines design organizations responsibilities, some of which are listed under the fabricator and/or owner in the current standard.

- Thedesign organization shall prepare a Design Specification which shall include:

  -(a) Performance criteria for which the device is designed,

  -(b) Requirements for drawings, materials and their heat treatment (if any), in-process inspections, examinations, testing and documentation required,

  -(c) Any limitations on the use of the device with respect to temperature, corrosive environments,

  -(d) Specify information to be included on a name plate or otherwise marked on the device,

  -(e) Quality Items List, which identifies all components and defines their critical characteristics. In addition, material identification, qualification and control; in-process testing, examination, and inspection with acceptance criteria; and the extent to which 10CFR50 [11], Appendix B, 10CFR71, Subpart H, 10CFR72, Subpart G, or other QAquality assurance requirements apply shall be listed.

  -(f) The design organization shall furnish a verified stress report that demonstrates compliance with the design specification, including the appropriate stress design factors.

- The design organization shall prepare a Fabrication Specification which shall include:

  -(a) Standards and, as applicable, code edition, addenda, and code cases to be used in the fabrication of the device.

-(b) Permitted materials.

-(c) Impact requirements of materials, including any materials that are exempted from impact testing.

-(d) Any restrictions on fabrication processes, including material handling, storage, thermal cutting and shipping restrictions.

-(e) Special processes along with procedural and personnel qualifications requirements associated with these special processes.

-(f) Welding procedures and personnel shall be qualified per the requirements of ANSI/American Welding Society (AWS) D1.1 [12] or ASME CodeB&PVC Section IX [13].

-(g) Identification of load bearing components and load path, including critical areas and welds that are considered to be in the load path.

-(h) As applicable, functional testing requirements and acceptance criteria.

-(i) In addition, to load bearing components, identification of additional components that are required to be part of any functional testing.

-(j) Identification of the acceptance test load magnitude.

-(k) In-process and/or final acceptance testing requirements and acceptance criteria. NDE and quality control (QC) inspection and test personnel shall be qualified to the requirements of the fabricators quality assurance program.

-(l) QAQuality assurance requirements applicable to procurement, fabrication, and testing of load path components.

-(m) Identification of any witnesses or hold points.

3.2 **Comparison to International Regulations**

As discussed above, TS-R-1 provides safety standards for the transport of radioactive material and is similar in scope to 10CFR71. Relative to lifting attachments, both TS-R-1 (paras. 606 through 608) and 10CFR71 (§71.45) require that these components be designed so that their failure under excess load would not impair the ability of the transport package to meet other TS-R-1 and 10CFR71 requirements. However, TS-R-1, para. 607, states that a lifting attachment's design "…take account of appropriate safety factors to cover snatch lifting" whereas 10CFR§71.45 states a lifting attachment "…must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner."

Neither TS-R-1 nor 10CFR71 address the lifting attachment concerns and resulting requirements of US Nuclear Regulatory Commission (NRC) Report No. NUREG-0612 [14] relative to the impact of a dropped transport package filled with spent nuclear fuel on "…stored spent fuel, fuel in the core, or equipment that may be required to achieve safe shutdown or permit continued decay heat removal." NUREG-0612, para. 5.1.1(4) states:

> "Special lifting devices should satisfy the guidelines of ANSI N14.6-1978, "Standard for Special lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More for Nuclear Materials." This standard should apply to all special lifting devices, which carry heavy loads in areas as defined above. For operating plants certain inspections and load tests may be accepted in lieu of certain material requirements in the standard. In addition, the stress design factor stated in Section 3.2.1.1 of ANSI N14.6 should be based on the combined maximum static and dynamic loads that could be imparted on the handling device based on the characteristics of the crane, which will be used. This is in lieu of the guidelines of Section 3.2.1.1 of ANSI N14.6 which bases the stress design factor on only the weight (static load) of the load and of the intervening components of the special handling device."

NUREG-0612, para. 1.2, “Definitions”, states:

> “Special lifting devices – A lifting device that is designed specifically for handling a certain load or loads, such as the lifting rigs for reactor vessel head or vessel internals, or the lifting device for a spent fuel cask.”

NUREG-0612, para. 5.1.6(3) states:

> “Interfacing lift points such as lifting lugs or cask trunnions should also meet one of the following for heavy loads handled in the area where the crane is to be upgraded unless the effects of a drop of the particular load have been evaluated and shown to satisfy the evaluation criteria of Section 5.1:
>
> (a) Provide redundancy or duality such that a single lift point failure will not result in uncontrolled lowering of the load; lift points should have a design safety factor with respect to ultimate strength of five (5) times the maximum combined concurrent static and dynamic load after taking the single point failure.
>
> OR
>
> (b) A non-redundant or non-dual lift point system should have a design safety factor of ten (10) times the maximum combined concurrent static and dynamic load.”

Therefore, there seems to be little or no overlap between ANSI N14.6 and TS-R-1. However, the TS-R-1 requirement that a lifting attachment’s design “…take account of appropriate safety factors to cover snatch lifting” seems to address the NUREG-0612 concern that “…the stress design factor stated in Section 3.2.1.1 of ANSI N14.6 should be based on the combined maximum static and dynamic loads that could be imparted on the handling device based on the characteristics of the crane which will be used.” Consequently, through NUREG-0612, this TS-R-1 concern is also addressed in the ANSI N14.6 design of special lifting devices and interfacing lifting points.

4. **SUMMARY AND CONCLUSIONS**

The ASME Code has developed and issued Section III Division 3 to address items associated with the transportation and storage of radioactive materials. It currently only addresses “General Requirements” in Subsections WA and “Class TP (Type B) Containments” (Transportation Packages) in Subsection WB, but is in the process of adding a new Subsection WC to address “Class SC” (Storage Containments). ANSI/ASME Standard N14.6, which is in the process of a complete re-write, interacts with components constructed to Division 3 by addressing special lifting devices for radioactive material shipping containers. This re-write will provide clarifications and modifications to thise standard to improve its usability Standard and prevent misinterpretation of its requirements.

The proposed changes to Subsections WA and WB appear to be part of a growing consensus of agreement in the understanding of industry terms including “containment” vs. “containment system” and “service limits” vs. “general severity levels” used in Division 3 and TS-R-1, respectively. The proposed re-write of ANSI N14.6 appears to not affect TS-R-1 to which it is only remotely connected through NUREG-0612. The great majority of proposed changes to Subsections WA and WB and ANSI N14.6 are at a level of design, analysis, fabrication, examination, etc. that are outside the scope of TS-R-1 and are addressed, per TS-R-1, within the “…laws and customs of different countries and the international conventions into which these countries have entered.”

53. **REFERENCES**

[1] American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) Section III, “Rules for Construction of Nuclear Facility Components”:

(a) Subsection NCA, “General Requirements for Division 1 and Division 2.”

(b) Division 1, Subsection NB, “Class 1 Components.”

(c) Division 1, Subsection NC, “Class 2 Components.”

(d) Division 3, “Containment Systems for Storage and Transport Packagings of Spent Nuclear Fuel and High Level Radioactive Materials and Waste.”

[2] American National Standards Institute (ANSI)/ASME N14.6, “American National Standard for Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More.”

[3] International Atomic Energy Agency (IAEA) Safety Standards Series Requirement No. TS-R-1 (ST-1, Revised), “Regulations for the Safe Transport of Radioactive Material,” 1996 Edition (Revised).

[4] Title 10, Code of Federal Regulations, Chapter 72 (10CFR72), “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste.”

[5] ASME BPVC Cases:

(a) N-595, “Requirements for Spent Fuel Storage Canisters, Section III, Division 1.”

(b) N-717, “Requirements for the Construction of Storage Containments for Spent Nuclear Fuel and High Level Nuclear Waste and Material, Section III, Division 3.”

[6] ASME BPVC Section II, “Materials,” Part D, “Properties.”

[7] ASME BPVC Section V, “Nondestructive Examination.”

[8] Title 10, CFR, Chapter 71 (10CFR71), “Packaging and Transportation of Radioactive Material.”

[9] ASME BPVC Section VIII, “Rules for the Construction of Pressure Vessels.”

[10] ASME BPVC Section XI, “Rules for the Inservice Inspection of Nuclear Power Plant Components.”

[11] Title 10, CFR, Chapter 50, “Domestic Licensing of Production and Utilization Facilities.”

[12] ANSI/American Welding Society (AWS) Code D1.1, “Structural Welding Code – Steel.”

[13] ASME BPVC Section IX, “Welding and Brazing Qualification.”

[14] United States Nuclear Regulatory Commission (USNRC) Report No. NUREG-0612, “Control of Heavy Loads at Nuclear Power Plants.”