STP-NU-051-1

# CODE COMPARISON REPORT

## for

## Class 1 Nuclear Power Plant Components

ASME STANDARDS TECHNOLOGY, LLC

STP-NU-051-1

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for

# Class 1 Nuclear Power Plant Components

*Prepared for:*

Multinational Design Evaluation Programme

Codes and Standards Working Group

ASME STANDARDS TECHNOLOGY, LLC

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Summary of Changes

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The following changes have been made to the first revision of STP-NU-051.

| *Rev. 1 Page* | *Location* | *Change* |
|---|---|---|
| *iv-xii* | Table of Contents | Updated to reflect changes |
| *xiv* | Abstract | Updated to reflect addition of NIKIET input |
| 1-128 | Report Body | General editorial and formatting corrections |
| 34 | Added Section 2.6 | Added background information on NIKIET |
| 46 | Added Section 3.5 | PNAE G-7 General Layout Comparison |
| 129 | Added Section 8 | Added PNAE G-7 vs ASME BPVC III comparison |
| 281 | Appendix B2 | Added JSME comparison for pumps, valves and piping |
| 385 | Appendix C2 | Updated tables to correct formatting errors |
| 454 | Appendix E | Added PNAE G7 Detailed Comparison Tables |

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# FORWARD

ASME Standards Technology, LLC (ASME ST-LLC) appreciates the collaborative effort put forth by all those involved in the development of this report. The report is the result of a multinational effort by Standards Development Organizations (SDOs) from the United States of America, France, Japan, Korea, Canada and Russia. We also acknowledge the nuclear regulatory authorities who supported this work, which was initiated with a global vision of codes and standards consistency.

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# ABSTRACT

The Multinational Design Evaluation Programme (MDEP) Code Comparison Project was initiated in late 2006 in response to a request by the MDEP Codes and Standards Working Group (CSWG) formerly known as the Working Group on Component Manufacturing Oversight (WGCMO). The CSWG invited the organizations responsible for development of major nuclear component construction codes and standards, Standards Development Organizations (SDOs), to make presentations regarding the requirements of their respective codes and standards pertaining to light water cooled nuclear power plants along with comparisons between those respective codes and standards.

In an effort to facilitate consistent design and manufacturing processes for Nuclear Power Plant Class 1 components among the ten MDEP countries, the CSWG requested the various SDOs to develop a comparison of the requirements of their respective codes and standards and those of the others.

The SDOs from the USA, France, Japan, Korea, Canada and Russia (ASME, AFCEN, JSME, KEA, CSA, and NIKIET respectively) agreed to participate in this code comparison project and develop comparisons of the requirements for Class 1 vessels, piping, pumps, and valves.

The objective of this report is to identify and summarize the differences between major international nuclear codes and standards for Class 1 equipment; namely those of AFCEN (RCC-M), ASME (Section III), CSA (N-285), JSME (S NC1), KEA (KEPIC-MN) and NIKIET (PNAE-G7).

The reader is reminded that each of the codes is a set of consistent rules. The requirements of one area may be, and often are, dependent on the requirements in other sections. Since a line-by-line comparison has been done, it may be tempting to judge the entire code based on the differences between these individual points, but this may not lead to a correct conclusion. This exercise identifies the different requirements of the different codes. It was not within the scope of this report to provide conclusions relative to the full implementation of the various codes.

# 1 INTRODUCTION

## 1.1 Background and Scope

The Multinational Design Evaluation Programme (MDEP) Code Comparison Project was initiated in late 2006 in response to a request by the MDEP Codes and Standards Working Group (CSWG) formerly known as the Working Group on Component Manufacturing Oversight (WGCMO). The CSWG invited the organizations responsible for development of major nuclear component construction codes and standards, Standards Development Organizations (SDOs), to make presentations regarding the requirements of their respective codes and standards pertaining to light water cooled nuclear power plants along with comparisons between those respective codes and standards.

In an effort to facilitate consistent design and manufacturing processes among the 10 MDEP countries for Class 1 Nuclear Power Plant components, the CSWG requested the various SDOs to develop a comparison of the requirements of their respective codes and standards and those of the others.

The SDOs from the USA, France, Japan, Korea, and Canada (ASME, AFCEN, JSME, KEA, and CSA, respectively) agreed to participate in this code comparison project and develop comparisons of the requirements for Class 1 vessels, piping, pumps and valves. The SDO from Russia (NIKIET) subsequently also joined in this effort, and this revision of the report includes a comparison of the NIKIET PNAE-G-7 requirements to those of ASME Section III for Class 1 components.

As the project was initiated, the SDOs determined that development of comparisons between every code and each of the others would be very complicated. Recognizing that the CSA, JSME, KEA, and AFCEN Codes were all originally developed based on ASME Section III, the SDOs agreed to define ASME Section III as the baseline for the comparison and compare each of the other Codes to ASME Section III and also to base the comparisons on the 2007 editions of each of the Codes.

## 1.2 Objectives

The objective of this report is to identify and summarize the differences between major international nuclear codes and standards for Class 1 equipment; namely those of AFCEN (RCC-M), ASME (Section III), CSA (N-285), JSME (S NC1), KEA (KEPIC-MN), and NIKIET (PNAE-G-7).

The results of this work are intended for use by regulatory bodies, component designers, and component manufacturers.

The reader is reminded that each of the codes is a set of consistent rules. The requirements of one area may be, and often are, dependent on the requirements in other sections. Since a line-by-line comparison has been done, it may be tempting to judge the entire code based on the differences between these individual points, but this may not lead to a correct conclusion.

This exercise in summarizing the differences between major international nuclear codes and standards for Class 1 equipment identifies the different requirements of the different codes. It was not within the scope of this report to provide conclusions relative to the full implementation of the various Codes.

## 1.3 Contents of the Report

The report is organized into nine sections. Section 1 provides a general Introduction. The main body of the report begins with Section 2, which provides a general presentation of the background for each code along with a description of the organizations responsible for administering the Codes. A summary list of the standards applied within each respective code is also provided. Section 3 provides a comparison of the general layout for each of the Codes relative to ASME Section III. Sections 4 through 8 summarize the individual code comparisons for the AFCEN RCC-M, JSME S NC-1, KEA

KEPIC-MN, CSA N-285, and NIKIET PNAE-G-7 Codes, each compared relative to ASME Section III. Section 9 provides the applicable References. The detailed Code Comparisons prepared by each of the respective SDOs are provided in the Appendices.

Sections 4 through 8 are organized in a similar fashion and provide a comparison between the codes consistent with the order of the paragraphs in ASME Section III Division 1. The first subsection after the Introduction compares the NB-1000 preliminary paragraphs from the ASME Boiler & Pressure Vessel Code (BPVC) to their equivalents from the other codes. The second subsection addresses the NB-2000 paragraphs related to materials and the third deals with the NB-3000 paragraphs related to design. The NB-4000 requirements associated with fabrication and installation are discussed in the subsection entitled Fabrication and Welding. Examination requirements from NB-5000 are dealt with in the same subsection. The NB-6000 paragraphs related to testing are partially covered in the Pressure Tests subsection. NB-7000, which deals with overpressure protection, is addressed in the last subsection before a short overview on Quality aspects of the codes and the Conclusion.

The code comparison is organized in three levels. First, in each of the subsections mentioned in the previous paragraph, the structure is very similar: they all start with highlights. These highlights summarize the main warnings that need to be communicated. They represent major differences that exist between the ASME BPVC and the other codes. The second level is the text after these highlights; it develops the ideas given by providing comments and background information but it also lists additional differences between the codes. Finally, the third and more detailed level of comparison can be found in the Appendices. Here, the reader will find detailed tables comparing the ASME Section III Division 1 line by line to the other codes.

Sections 4 through 8 each include tables that present the general layouts of the codes from the ASME point of view as well as from the perspective of the code being compared to the ASME Code.

## 1.4 Comparison Scale

The following comparison scale is used in this report, specifically in the Appendices:

A1 = Same
A2 = Equivalent
B1 = Different – Not Specified
B2 = Technically Different

These categories of the comparison scale are defined in the following paragraphs.

A1 = Same

Requirements classified as category A1 are considered to be technically identical. Requirements are classified as category A1 and considered to be the same even if there are inconsequential differences in wording, such as might result due to translation from one language to another, as long as the wording does not change the meaning or interpretation of the requirement. Likewise, differences in paragraph numbering are not considered when classifying requirements as long as the same requirement exists in both codes being compared.

A2 = Equivalent

Requirements are considered to be equivalent when applying either code or standard, if compliance with the applied code or standard will also meet the requirements of the other code or standard. Equivalence is not affected by differences in level of precision of unit conversions.

B1 = Different – Not specified

Requirements are considered to be different – not specified, if one code or standard includes requirements that the compared code or standard does not specify. This classification may result because of differences in the scope of equipment covered by a respective code, the scope of industrial practices applied in context of the respective code, differences in regulatory requirements applicable in conjunction with application of a particular code or simply as a result of differences in requirements addressed in one code versus those of another.

B2 = Technically Different

Requirements are considered to be technically different if either code requires something more or less than, or otherwise technically different from, the requirements imposed by the other. These differences might be due to different technical approaches applied by a code or imposition of regulatory requirements within the country from which a code originates.

# 2 GENERAL PRESENTATION OF CODES

## 2.1 Background Information on ASME

The present ASME Section III organization is provided in Figure 1; a list of the standards used in the ASME BPVC is provided in Figure 2.

In the second half of the 19th century, an important establishment of schools and institutions in engineering was witnessed in the USA. As an example, in 1880, there were no less than 85 engineering colleges throughout the country. At that time, many groups in different fields of engineering were seeking to create organizations of specialized professional standing. The Institution of Chartered Mechanical Engineers had been successfully established in England, 33 years earlier in 1847. In the United States, the American Society of Civil Engineers had been active since 1852, and the American Institute of Mining Engineers had been organized in 1871. But in the USA, for mechanical engineers, no group was devoted to machine design, power generation, or industrial processes to a degree that was capable of projecting a broader national or international role to advance technical knowledge and systematically facilitate a flow of information from research to practical application. Finally, in 1880, the ASME was founded to bridge the gap.

ASME then acted in various domains: it formed its research activities in 1909 and has led in the development of technical standards; for instance, for the screw thread in 1901. But the Society is best known for improving the safety of equipment, especially boilers. From 1870 to 1910, at least 10,000 boiler explosions in North America were recorded. By 1910, the rate jumped to 1300 to 1400 a year. A Boiler Code Committee was formed in 1911 that led to publication of the Boiler Code in 1914-15 and its later incorporation in laws of most U.S. states and territories and Canadian provinces.

By 1930, 50 years after ASME was founded, the Society had grown to 20,000 members, though its influence on American workers was far greater. New standards and codes were published in various domains of mechanical engineering to ensure safety in the design of components. In 1921, the first elevator code was issued; in 1939, standards for turbine generators were laid down.

Today, ASME is a worldwide engineering society with 125,000 members focused on technical, educational, and research issues. Its diversity in the mechanical engineering field can be seen in ASME's 36 Technical Divisions (plus one subdivision) and 3 Institutes. Today’s structure of Technical Divisions was established in 1920, when eight were founded: Aerospace, Fuels, Management, Materials, Materials Handling Engineering, Power, Production Engineering, and Rail Transportation. Two more were formed the next year: Internal Combustion Engine and Textile Industries. The most recent addition is the Information Storage and Processing Systems Division (June 1996). The organization chart can be seen Figure 1.

Now, focusing more specifically on the nuclear industry, ASME first established in 1956 a committee in charge of writing a new code that would be named the “ASME Boiler and Pressure Vessel Code for Nuclear Age.” A few years later, in 1963, this committee finally proposed to add a new section to the ASME BPVC to cover the rules and good practices to be followed in the newborn civil nuclear industry. This section was Section III and still is the code section of reference for the nuclear industry. Further, the ASME committees that formulate the Sections and Subsections of the Boiler and Pressure Vessel Code are made up of technical experts from many countries and there are no limitations or membership requirements for participation in the committees.

The nuclear sections of the Boiler and Pressure Vessel Code are currently available in English, Korean, and Chinese. In addition to the ASME Code for Class 1 components, which is the code discussed in this report and focuses on construction rules for mechanical components of nuclear

reactor pressure boundary, ASME has published multiple other Sections and Subsections for nuclear application:

- Rules for Construction of Nuclear Facility Components, Subsection NCA – General Requirements for Division 1 and Division 2
- Rules for Construction of Nuclear Facility Components, Division 1 – Class 2 Components
- Rules for Construction of Nuclear Facility Components, Division 1 – Class 3 Components
- Rules for Construction of Nuclear Facility Components, Division 1 – Class MC Components (Steel Containments)
- Rules for Construction of Nuclear Facility Components, Division 2 – Code for Concrete Containments
- Rules for Construction of Nuclear Facility Components, Division 1 – Supports
- Rules for Construction of Nuclear Facility Components, Division 1 – Core Support Structures
- Rules for Construction of Nuclear Facility Components, Division 1 – Class 1 Components in Elevated Temperature Service
- Rules for In-Service Inspection of Nuclear Power Plant Components

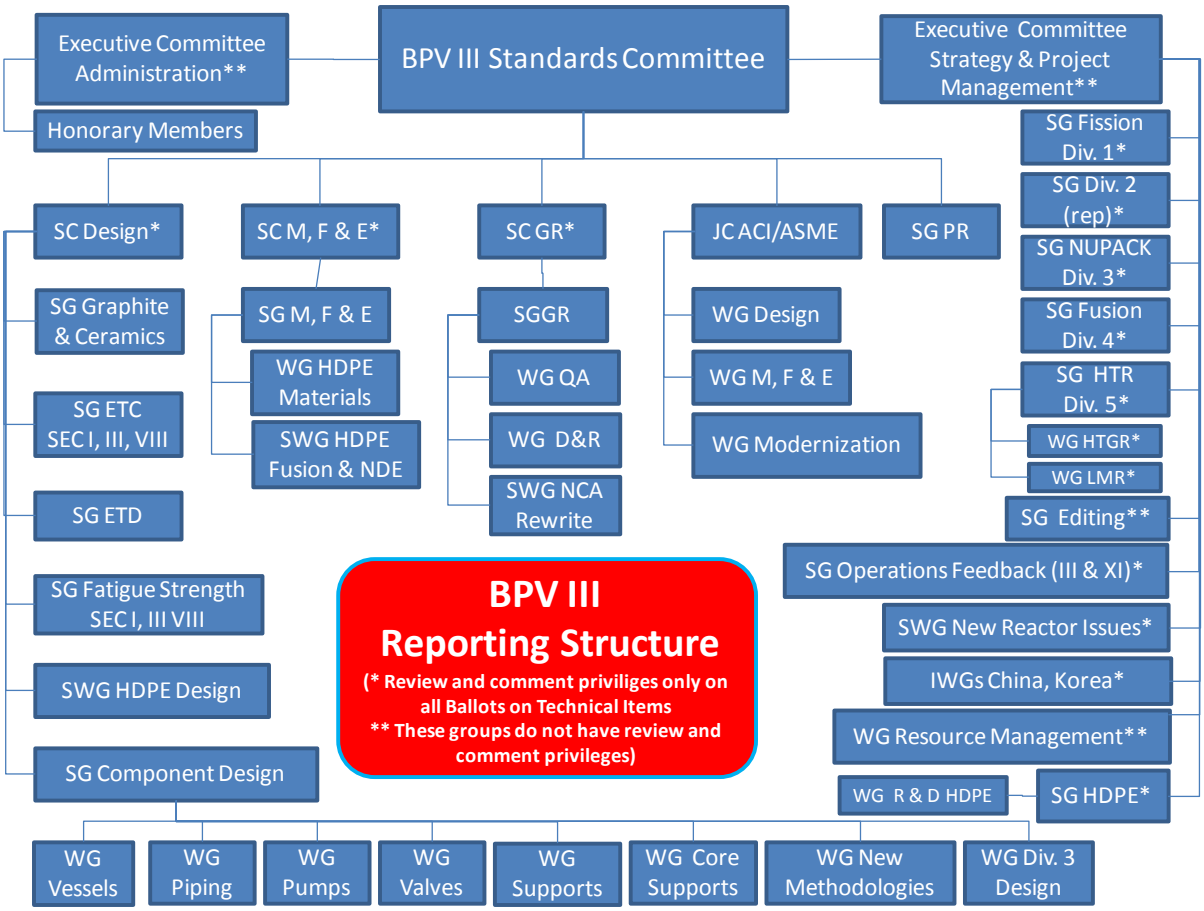


**Figure 1—ASME Section III Organization Chart**

| Standard ID | Standard ID | Standard ID |
|---|---|---|
| Pipes and Tubes | Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS) | American Society for Testing and Materials (ASTM) |
| ASME B36.10 | MSS SP-43 | ASTM C 231 |
| ASME B36.19 | MSS SP-44 | ASTM C 260 |
| Fittings, Flanges and Gaskets | MSS SP-87 | ASTM C 266 |
| ASME B16.5 | U.S. Army Corps of Engineers | ASTM C 289 |
| ASME B16.9 | CRD-C 36 | ASTM C 295 |
| ASME B16.11 | CRD-C 39 | ASTM C 311 |
| ANSI B16.18 | CRD-C 44 | ASTM C 342 |
| ASME B16.20 | CRD-C 119 | ASTM C 441 |
| Wound and Jacketed | CRD-C 621 | ASTM C 469 |
| ASME B16.21 | American Concrete Institute (ACI) | ASTM C 494 |
| ASME B16.22 | ACI 211.1 | ASTM C 496 |
| Fittings | ACI 214 | ASTM C 512 |
| ASME B16.25 | ACI 304R | ASTM C 535 |
| ASME B16.28 | ACI 305R | ASTM C 586 |
| ASME B16.47 | ACI 306R | ASTM C 595 |
| SAE J513 | ACI 309R | ASTM C 618 |
| MSS SP-43 | ACI 347R | ASTM C 637 |
| MSS-SP-44 | American Institute of Steel Construction (AISC) | ASTM C 642 |
| MSS SP-87 | … | ASTM C 937 |
| Piping Applications | … | ASTM C 939 |
| MSS SP-97 | American Public Health Association (APHA) | ASTM C 940 |
| Socket Welding, Threaded and Buttwelding Ends | APHA-4500-5 | ASTM C 943 |
| ANSI/AWWA C207 | American Society for Nondestructive Testing (ASNT) | ASTM C 953 |
| API 605 | SNT-TC-1A & Supplements | ASTM C 1017 |
| Bolting | American Society for Testing and Materials (ASTM) | ASTM C 1077 |
| ASME B18.2.1 | ASTM A 108 | ASTM D 92 |

**Figure 2—List of Standards Used in the ASME BPVC**

| Standard ID | Standard ID | Standard ID |
|---|---|---|
| ASME/ANSI B18.2.2 | ASTM A 416 | ASTM D 512 |
| ASME B18.3 | ASTM A 421 | ASTM D 609 |
| Threads | ASTM A 490 | ASTM D 610 |
| ASME B1.1 | ASTM A 513 | ASTM D 937 |
| ANSI/ASME B1.20.1 | ASTM A 519 | ASTM D 938 |
| ANSI B1.20.3 | ASTM A 576 | ASTM D 974 |
| Standards Supports | ASTM A 615 | ASTM D 1411 |
| MSS SP-89 | ASTM A 673 | ASTM D 1888 |
| Valves | ASTM A 687 | ASTM E 23 |
| ASME B16.34 | ASTM A 706 | ASTM E 94 |
| MSS SP-100 | ASTM A 722 | ASTM E 142 |
| The American Society of Mechanical Engineers (ASME) | ASTM A 779 | ASTM E 165 |
| ASME NQA-1 | ASTM B 117 | ASTM E 186 |
| ASME QAI-1 | ASTM C 31 | ASTM E 208 |
| American Society for Nondestructive Testing (ASNT) | ASTM C 33 | ASTM E 280 |
| SNT-TC-1A | ASTM C 39 | ASTM E 328 |
| American Society for Testing and Materials (ASTM) | ASTM C 40 | ASTM E 446 |
| ASTM A 275 | ASTM C 42 | ASTM F 436 |
| ASTM A 673 | ASTM C 78 | |
| ASTM E 8 | ASTM C 94 | |
| ASTM E 23 | ASTM C 109 | |
| ASTM E 94 | ASTM C 114 | |
| ASTM E 142 | ASTM C 115 | |
| ASTM E 185 | ASTM C 117 | |
| Power Reactor Vessels | ASTM C 123 | |
| ASTM E 186 | ASTM C 127 | |
| ASTM E 208 | ASTM C 128 | |
| ASTM E 213 | ASTM C 131 | |
| ASTM E 280 | ASTM C 136 | |

**Figure 2—List of Standards Used in the ASME BPVC (cont.)**

| Standard ID | Standard ID | Standard ID |
|---|---|---|
| ASTM E 446 | ASTM C 138 | |
| ASTM E 606 | ASTM C 142 | |
| ASTM E 883 | ASTM C 143 | |
| American Welding Society (AWS) | ASTM C 150 | |
| AWS A4.2 | ASTM C 151 | |
| American Welding Society (AWS) | ASTM C 157 | |
| AWS A4.2 | ASTM C 172 | |
| AWS A5.1 | ASTM C 173 | |
| AWS A5.5 | ASTM C 183 | |
| AWS A5.18 | ASTM C 191 Standard Test Method for Time of Setting Hydraulic Cement by Vicat Needle 1999 | |
| AWS A5.20 | ASTM C 192 | |
| AWS A5.28 | ASTM C 204 | |
| AWS D1.1 | ASTM C 227 | |

**Figure 2—List of Standards Used in the ASME BPVC (cont.)**

## 2.2 Background Information on AFCEN

AFCEN is an association that was founded in October 1980 by Electricité de France (EDF) and Framatome. The first RCC-M Specification was issued in 1980 and the first official and complete issue was released in 1984. At that time, it was based on a combination of the ASME Section III Code, Westinghouse pressurized water reactor (PWR) Design Specifications, and French construction practices. Over time, it evolved to adopt provisions and experience feedback from the French regulatory requirements, then later from the German and French cooperation, and even later from the European standard practices. The recent modifications of this code now integrate any international regulation.

AFCEN's purpose is:

- To establish detailed and practical rules for the design, manufacture, installation, commissioning, and in-service inspection of components for nuclear islands used for power generation stations
- To publish, under code form, the texts corresponding to these rules, after approval by expert groups
- To revise and update these rules on the basis of, in particular:
  - Experience
  - Technological advancements
  - Changes in regulatory requirements
  - Operational feedback

In 2008, AFCEN integrated associate members APAVE Group, Bureau VERITAS, and AIB-VINCOTTE (Belgian), all three being notified inspection bodies recognized by the French Nuclear Safety Authority. Later in 2009, the Commissariat à l'Energie Atomique Français (CEA) and other services such as AREVA-TA and the French DCN (known as DCNS since 2007), both involved

in PWR activities related to nuclear boilers, submarines and ships, were also integrated as associate members of AFCEN.

In 2010, AFCEN expanded membership to allow any nuclear organization to become a member and participate in AFCEN activities.

The AFCEN working methods are similar to those of the ASME Section III working organization, through Boards, Committees, Subcommittees, Working Groups, Task Groups, etc., that meet periodically to answer Code Interpretation Sheets and work on Code Modification Sheets in support of modification review/approval and incorporation into addenda or new editions. The AFCEN Organization Chart is provided in Figure 3.

AFCEN publications are currently available in French, English, and Chinese. In addition to the RCC-M Code, which is the code discussed in this report and focuses on Design and Conception Rules for Mechanical Components of PWRs, AFCEN has published multiple other RCCs and RSEs, which are mentioned in Figure 4.

A list of the standards referenced in the RCC-M is provided in Figure 5.

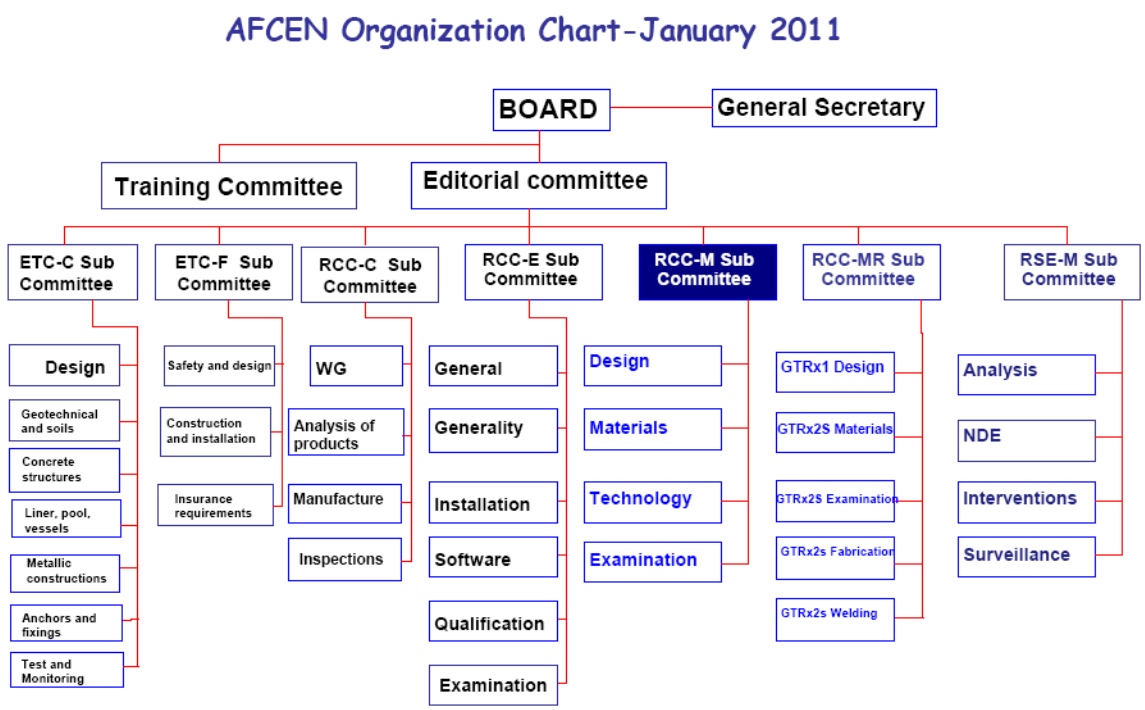


**Figure 3—AFCEN Organization Chart**

## The AFCEN Codes

**AFCEN PWR reactors codes:**

- RCC-M Mechanical components
- RCC-C Nuclear Fuel
- RCC-E Electrical Equipment
- ETC-C Civil Works
- RSE-M In-service surveillance of mechanical components
- ETC-F Fire protection

**AFCEN FBR and experimental reactors codes**:

- RCC-MR Mechanical components of FBR reactors (2007)

  To be replaced by:
- RCC-MRx Mechanical components for Experimental Reactors

**PWR:** Pressurized Water Reactor
**FBR:** Feed Breeder Reactor
**RCC**: **R**ules for Design and **C**onstruction of **C**omponents of PWR Nuclear Islands
**ETC**: **E**PR™ **T**echnical **C**ode

**Figure 4—AFCEN Codes**

| Standard ID | Standard ID | Standard ID | Standard ID |
|---|---|---|---|
| NF A 03-652 | NF EN 1713 + Amendment A1 + Amendment A2 | NF EN 10283 | NF EN ISO 15614-8 |
| NF A 04-308 | NF EN 1779 | NF EN 10307 | NF ISO 68-1 |
| NF A 05-150 | NF EN 10002-1 | NF EN 12072 | NF ISO 262 |
| NF A 05-152 | NF EN 10002-2 | NF EN 12223 | NF ISO 965-2 |
| NF A 05-165 | NF EN 10002-4 | NF EN 12330 | NF T 30-900 |
| NF A 32-054 | NF EN 10002-5 | NF EN 12668-1 + Amendment A1 | NF T 30-901 |
| NF A 35-557 | NF EN 10021 | | NF T 30-903 |
| NF A 36-200 | NF EN 10025-1 | NF EN 12668-2 + Amendment A1 | ASME/ANSI B16.5 |
| NF A 36-210 | NF EN 10025-2 | | ASME/ANSI B16.9 |
| NF A 36-250 | NF EN 10027-2 | NF EN 12668-3 + Amendment A1 | ASME/ANSI B16.11 |
| NF A 36-605 | NF EN 10028-1 + Amendment A1 | NF EN 12681 | ASME/ANSI B16.25 |
| NF A 36-606 | NF EN 10028-2 | NF EN 13184 | ASME/ANSI B16.28 |
| NF A 45-201 | NF EN 10028-3 | NF EN 13185 | ASME/ANSI B16.34 |
| NF A 45-202 | NE EN 10028-7 | NF EN 20273 | ANSI/ASME B36.10M |
| NF A 45-205 | NF EN 10045-1 | NF EN 20898-2 | ANSI/ASME B36.19M |
| NF A 45-209 | NF EN 10045-2 | NF EN 24497 | ASTM A 370 |
| NF A 45-255 | NF EN 10052 | NF EN 25580 | ASTM E 83 |
| NF A 49-213 | NF EN 10083-1 | NF EN 45014 | ASTM E 186 |
| NF A 49-214 | NF EN 10083-2 | NF EN ISO 544 | ASTM E 192 |
| NF A 49-281 | NF EN 10083-2 | NF EN ISO 643 | ASTM E 208 |
| NF A 49-285 | NF EN 10084 | NF EN ISO 683-17 | ASTM E 272 |
| NF A 49-871 | NF EN 10088-2 | NF EN ISO 898-1 | ASTM E 280 |
| NF A 49-872 | NF EN 10088-3 | NF EN ISO 945 | ASTM E 446 |
| NF A 91-101 | NF EN 10160 | NF EN ISO 2162-2 | ASTM E 813 |
| NF E 05-017* | NF EN 10164 | NF EN ISO 3452-2 | ASTM G 36 |
| NF E 05-051 | NF EN 10204 | NF EN ISO 3452-3 | ASTM G 38 |
| NF E 25-403 | NF EN 10213-2 | NF EN ISO 3506-1 | AWS A 5.1 |

**Figure 5—List of Standards Used in the RCC-M Code**

| Standard ID | Standard ID | Standard ID | Standard ID |
|---|---|---|---|
| NF E 25-404 | NF EN 10213-3 | NF EN ISO 3506-2 | AWS A 5.4 |
| NF E 29-005 | NF EN 10213-4 | NF EN ISO 3887 | AWS A 5.5 |
| NF E 29-031 | NF EN 10216-1 + Amendment A1 | | AWS A 5.9 |
| NF E 29-851 | | NF EN ISO 4032 | AWS A 5.17 |
| NF E 29-882 | | NF EN ISO 4034 | AWS A 5.18 |
| NF E 29-883 | | NF EN ISO 4063 | AWS A 5.20 |
| NF E 29-884 | NF EN 10216-2 + | NF EN 10269 + Amendment A1 | NF EN ISO 9606-4 |
| NF E 32-103 | Amendment A1 | NF EN ISO 4126-1 | NF EN ISO 8493 |
| NF E 44-001 | NF EN 10216-3 + | NF EN ISO 4126-2 | NF EN ISO 14344 |
| NF E 44-002 | Amendment A1 | NF EN ISO 4126-3 | NF EN ISO 15609-1 |
| NF EN 287-1 + | NF EN 10216-5 | NF EN ISO 4126-4 | NF EN ISO 15614-1 |
| Amendment A2 | NF EN 10217-1 + | NF EN ISO 4126-5 | AWS A 5.23 |
| NF EN 462-1 | Amendment A1 | NF EN ISO 4126-6 | ISO 1027 |
| NF EN 462-2 | NF EN 10217-2 + Amendment A1 | NF EN ISO 4126-7 | ISO 4628/3 |
| NF EN 473 + Amendment A1 | NF EN 10217-7 | NF EN ISO 4759-1 | ISO 9001 |
| NF EN 499 | NF EN 10222-1 + Amendment A1 | NF EN ISO 6506-1 | ISO 9002 |
| NF EN 571-1 | NF EN 10222-2 | NF EN ISO 6506-2 | ISO 9717 |
| NF EN 583-1 + Amendment A1 | NF EN 10222-5 | NF EN ISO 6506-3 | IS US 319-21 |
| NF EN 583-2 | NF EN 10246-5 | NF EN ISO 6506-4 | MSS SP 43 |
| NF EN 583-5 + Amendment A1 | NF EN 10246-6 | NF EN ISO 6507-1 | Specifications for blasting by abrasives (O.N.H.G.P.I.) |
| NF EN 584-1 | NF EN 10246-7 | NF EN ISO 6507-2 | Rules for fire protection |
| NF EN 764-7 | NF EN 10250-1 | NF EN ISO 6507-3 | Recommendation 543.77 of I.I.S. Commission XII |
| NF EN 895 | NF EN 10250-2 | NF EN ISO 6507-4 | A.I.E.A. no. 50 C SG Q |

**Figure 5—List of Standards Used in the RCC-M Code (cont.)**

| Standard ID | Standard ID | Standard ID | Standard ID |
|---|---|---|---|
| NF EN 910 | NF EN 10250-3 | NF EN ISO 6508-1 | IIS/IIW 146.64 |
| NF EN 1043-1 | NF EN 10250-4 | NF EN ISO 6508-2 | ISC 319.20 |
| NF EN 1369 | NF EN 10263-1 | NF EN ISO 6508-3 | ISM 319.30 |
| NF EN 1371-1 | NF EN 10263-2 | NF EN ISO 6520-1 | Standard TEMA |
| NF EN 1418 | NF EN 10263-3 | NF EN ISO 6847 | |
| NF EN 1593 | NF EN 10263-4 | NF EN ISO 7438 | |
| NF EN 1597-1 | NF EN 10263-5 | NF EN ISO 7500-1 | |
| NF EN 1600 | NF EN 10269 + Amendment A1 | NF EN ISO 8492 | |
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**Figure 5—List of Standards Used in the RCC-M Code (cont.)**

## 2.3 Background Information on JSME

Historically, detailed technical rules and requirements on the design and construction activities for nuclear power plants in Japan were provided by the government as part of the government regulation system such as MITI Ordinance No. 62 and Notification No. 501. During the late 1990s, shortly after the WTO/TBT agreement came into in effect in 1994, there evolved discussions that the government regulation should be performance-based and that codes and standards of Standards Development Organizations (SDOs) should be applied as detailed technical codes (Reference [4]).

The Committee on Power Generation Facility Code was established within the Japan Society of Mechanical Engineers (JSME) in October 1997 to provide technically sound codes and standards to protect people's safety from industrial hazards and to promote industry development and competitiveness. Behind the scene, a consensus was reached between the regulator and the industry that the regulatory body would endorse and apply SDO codes and standards for their regulation of nuclear power plants in Japan.

Under the main committee, there are four subcommittees that include thermal power, nuclear power, fusion power and materials, as are shown in Figure 6. The subcommittee on nuclear power is responsible for developing, maintaining, and revising JSME nuclear codes and standards, and has in its under-tier 12 subgroups such as design and construction, materials, fitness for service, and so on. The organization of the subcommittee on nuclear power is shown in Figure 7. Each of these subgroups is responsible for a code book and many of these subgroups have several working groups.

As of today, a total of about 350 volunteers are actively committed to the JSME Codes and standards development and maintenance activities. These volunteers come from various sectors. These include industry (utilities, nuclear systems, component suppliers, and steel makers), laboratories and research institutes, university academia, government organizations, and regulatory agencies.

Since its foundation in 1997, the committee has issued a number of codes in the fields of thermal power, nuclear power, and fusion power. The latest editions of the JSME nuclear codes are listed in Figure 8 and the standards referenced in the JSME Code are listed in Figure 9. Note that the codes for spent fuel transport/storage casks and for spent fuel reprocessing facilities are included in JSME nuclear codes. Beside these code books, a number of code cases have been issued.

The first nuclear code published by JSME was JSME S NA1-2000, Rules on Fitness-for-Service for NPPs, which was a counterpart of ASME Section XI. The first edition of Rules on Design and Construction for NPPs, which is a counterpart of ASME Section III, was published in 2001. Since then, the JSME nuclear code editions have basically been published every three to five years. Between these editions, addenda have been issued generally on a yearly basis.

As was mentioned earlier, these JSME nuclear codes are subjected to technical evaluation conducted by the Japan Nuclear Energy Organization (JNES)[1], and then endorsed by the Nuclear and Industry Safety Agency (NISA).

Among these nuclear codes, JSME S NA1-2008, Rules on Fitness-for-Service for NPPs; JSME S NB1-2007, Rules on Welding for NPPs; and JSME S NC1-2007, Rules on Design and Construction for NPPs, Div. 1 LWRs, have been endorsed by NISA, the government regulatory body, and applied to the regulation of LWR nuclear activities of design, construction, maintenance, and repair.

[1]JNES is a Technical Support Organization (TSO) for NISA.

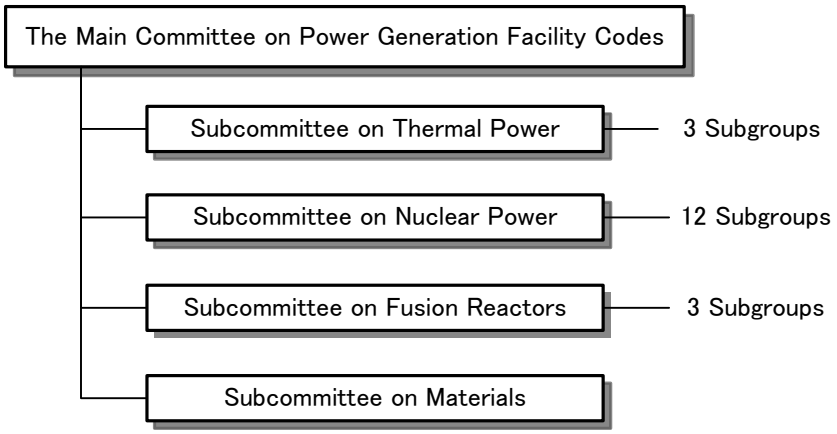


**Figure 6—Organization of JSME Main Committee**

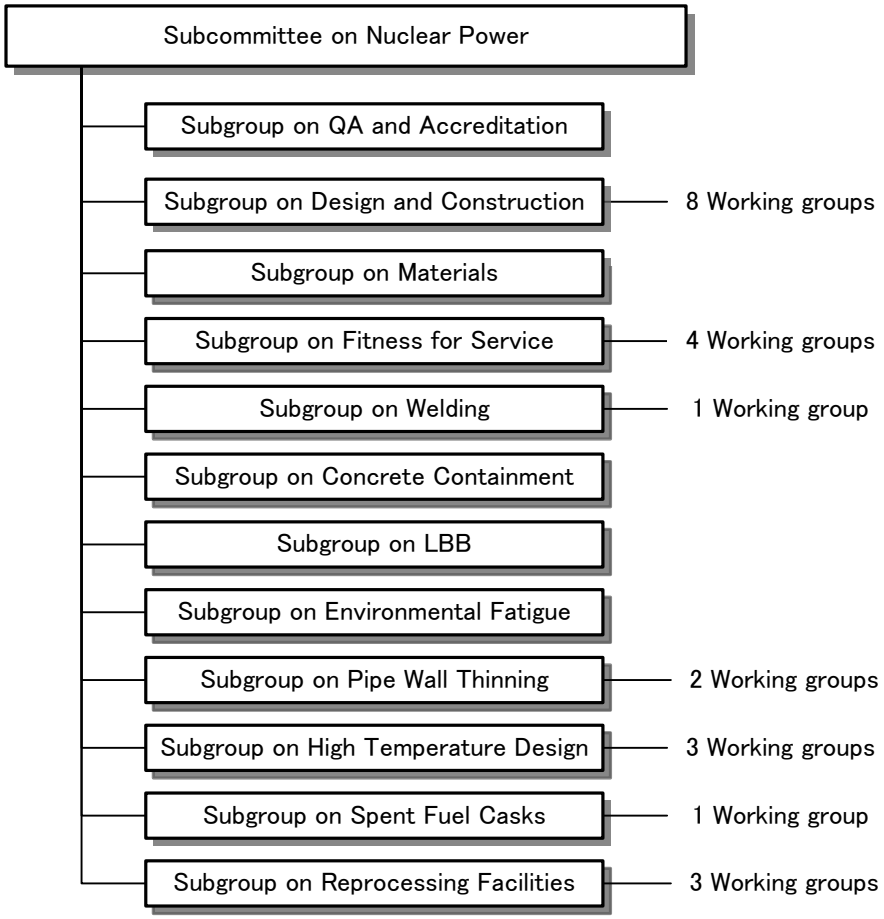


**Figure 7—Organization of JSME Subcommittee on Nuclear Power**

| Code No. | Title of Code | ASME BP&V Code Counterpart |
|---|---|---|
| JSME S NA1-2008 | Rules on Fitness-for-Service for NPPs | Section XI |
| JSME S NB1-2007 | Rules on Welding for NPPs | Section V |
| JSME S NC1-2008 | Rules on Design and Construction for NPPs, Div. 1 LWRs | Section III, Div.1 |
| JSME S NC2-2009 | Rules on Design and Construction for NPPs, Div. 2 FBRs | Section III, Div. I, Subsection NH |
| JSME S ND1-2002 | Rules on Protection Design against Postulated Pipe Rupture for NPPs (LBB) | |
| JSME S NE1-2003 | Rules on Concrete Containment Vessels for NPPs | Section III, Div. 2 |
| JSME S NF1-2009* | Environmental Fatigue Evaluation Method for Nuclear Power Plants | |
| JSME S NG1-2006 | Rules on Pipe Wall Thinning Management for PWR Power Plants | |
| JSME S NH1-2006 | Rules on Pipe Wall Thinning Management for BWR Power Plants | |
| JSME S NJ1-2011 | Rules on Materials for Nuclear Facilities (to be published) | Section II |
| JSME S RA1-2010 | Rules on Design for Reprocessing Facilities of Spent Nuclear Fuel | |
| JSME S FA1-2007 | Rules on Transport/Storage Packagings for Spent Nuclear Fuel | |
| JSME S FB1-2003 | Rules on Concrete Casks, Canister Transfer Machines and Canister Transport Casks for Spent Nuclear Fuel | |
| JSME S KA1-2008* | Rules on Superconducting Magnet Structure | |

* English translation version available.

**Figure 8—List of Latest JSME Nuclear Codes and Standards**

| JSME Rules on Design and Construction for NPP, Div.1 | | Used Codes & Standards |
|---|---|---|
| **Subsection** | **No.** | **Number and Title of Codes and Standards** |
| Subsection 1 General Requirements | GNR-1110 | JSME S NE1-2003 :Rules on Concrete Containment Vessels for Nuclear Power Plant |
| | GNR-1122 | JSME S NB1-2007: Rules on Welding for Nuclear Power Plant |
| | GNR-1122 | JSME S NJ1-2008: Rules on Materials for Nuclear Power Facilities |
| | GNR-1122 | JEAG 4601-Supplement-1984: Technical Guidelines for Aseismic Design of Nuclear Power Plant Part of Classification and Allowable Stress |
| | GNR-1122 | JEAG 4601-1987: Technical Guidelines for Aseismic Design of Nuclear Power Plant |
| | GNR-1122 | JEAG 4601-Supplement-1991: Technical Guidelines for Aseismic Design of Nuclear Power Plant |
| | GNR-1260 | JIS Z 8203: SI Units and Recommendations for the Use of Their Multiples and of Certain Other Units |
| Subsection 2 Mechanical Testing | GTM-1120 | JIS G 0202: Glossary of Terms Used in Iron and Steel (Testing) |
| | GTM-1120 | JIS G 0201:Glossary of Terms Used in Iron and Steel (Heat Treatment) |
| | GTM-1130 | JIS Z 2241: Method of Tensile Test for Metallic Materials |
| | GTM-1130 | JIS Z 2242: Method of Charpy Pendulum Impact Test of Metallic Materials |
| | GTM-2120 | JIS Z 2201: Test Pieces for Tensile Test for Metallic Materials |
| | GTM-3220 | JIS Z 2242: Method of Charpy Pendulum Impact Test of Metallic Materials |
| Subsection 3 Non-destructive Testing | GTN-1120 | JIS Z 2300: Terms and Definitions of Nondestructive Testing |
| | GTN-2212 | JIS Z 2352: Method for Assessing the Overall Performance Characteristics of Ultrasonic Pulse Echo Testing Instrument |
| | GTN-4141 | JIS Z 4606: Industrial X-ray Apparatus for Radiographic Testing |

**Figure 9—List of Standards Used in the JSME Code**

| JSME Rules on Design and Construction for NPP, Div.1 | | Used Codes & Standards |
|---|---|---|
| **Subsection** | **No.** | **Number and Title of Codes and Standards** |
| | GTN-4141 | JIS Z 4560: Industrial γ-ray Apparatus for Radiography |
| | GTN-4143 | JIS Z 2306: Radiographic Image Quality Indicators for Non-destructive Testing |
| | GTN-4145 | JIS Z 4561: Viewing Illuminators for Industrial Radiograph |
| Subsection 3 Non-destructive Testing | GTN-4231 | JIS G 0581: Methods of Radiographic Examination for Steel Castings |
| | GTN-6210 | JIS G 0565: Method for Magnetic Particle Testing of Ferromagnetic Materials and Classification of Magnetic Particle Indication |
| | GTN-7210 | JIS Z 2343-1: Non-destructive Testing-Penetrant Testing-Part 1: General Principles-Method for Liquid Penetrant Testing and Classification of the Penetrant Indication |
| | GTN-7260 | JIS Z 2343-3: Non-destructive Testing-Penetrant Testing-Part 3: Reference Test Blocks |
| Subsection 4 Vessels | Appendix 4-1 | JEAC 4206: Method of Verification Tests of the Fracture Toughness for Nuclear Power Plant Components |
| Subsection 5 Pipes | PPB-3414 | JIS B 2238: General Rules for Steel Pipe Flange |
| | PPB-3414 | JIS B 2239: General Rules for Cast Iron Pipe Flange |
| | PPB-3414 | JIS B 8265: Construction of Pressure Vessel-General Principles (Amendment-1) |
| | PPB-3415 | JIS B 2312: Steel Butt-welding Pipe Fittings (Amendment-1) |
| | PPB-3415 | JIS B 2313: Steel Plate Butt-welding Pipe Fittings (Amendment-1) |
| | PPB-3415 | JIS B 2316: Steel Socket-welding Pipe Fittings |
| | PPD-3415 | JIS B 2301: Screwed Type Malleable Cast Iron Pipe Fittings |
| | PPD-3415 | JIS B 2302: Screwed Type Steel Pipe Fittings |
| | PPD-3415 | JIS B 2303: Screwed Drainage Fittings |

**Figure 9 (cont.) —List of Standards Used in the JSME Code**

| JSME Rules on Design and Construction for NPP, Div.1 | | Used Codes & Standards |
|---|---|---|
| **Subsection** | **No.** | **Number and Title of Codes and Standards** |
| | PPD-3415 | JIS B 2311: Steel Butt-welding Pipe Fittings for Ordinary Use (Amendment-1) |
| | PPD-3415 | JIS G 3443-2: Coated Steel Pipes for Water Service-Part 2: Fittings |
| | PPD-3415 | JIS G 5527: Ductile Iron Fittings |
| | PPH-3040 | JIS B 2240: Copper Alloy Pipe Flanges |
| | Appendix 5-A | JSME S 012-1998: Guide Line for Evaluation of Flow-induced Vibration of a Cylindrical Structure in a Pipe |
| Subsection 5 Pipes | Appendix 5-B | JSME S 017-2003: Guide Line for Evaluation of High-cycle Thermal Fatigue of a Pipe |
| Subsection 10 Safety Valves | SRV-1120 | JIS B 8210: Steam Boilers and Pressure Vessels-Spring Loaded Safety Valves |
| | SRV-1120 | JIS B 0100: Glossary of Terms for Valves |
| | SRV-3113 | JIS B 8226: Bursting Discs and Bursting Disc Assemblies |
| Explanation Subsection 1 General Requirements | Table GNR-1220-1 | JEAC 4602-2004: Code for Defining Range of Reactor Coolant Pressure Boundary and Reactor Containment Vessel Boundary |
| | Table GNR-1220-2 | JEAC 4605-2004: Definition Code of Engineered Safety Features and Related Features for Nuclear Power Plants |
| Explanation Subsection 2 Mechanical Testing | GTM-3320 | JEAC 4202-1991: Drop-weight Test Method of Ferritic Steels |
| Explanation Subsection 3 Non-destructive Testing | GTN-2130 | JIS Z 2305: Non-destructive Testing-Qualification and Certification of Personnel |
| | GTN-2141 | JEAG 4207-1996: Ultrasonic Examination for Inservice Inspection of Light Water Cooled Nuclear Power Plant Components |
| | GTN-2142 | JEAC 4111-2003: Quality Assurance Code for Safety in Nuclear Power Plant |
| | GTN-3222 | JIS G 0582: Ultrasonic Examination for Steel Pipes and Tubes |

**Figure 9 (cont.) —List of Standards Used in the JSME Code**

| JSME Rules on Design and Construction for NPP, Div.1 | | Used Codes & Standards |
|---|---|---|
| **Subsection** | **No.** | **Number and Title of Codes and Standards** |
| | GTN-5151 | JIS G 0568: Eddy Current Testing Method for Steel Products by Encircling Coil Technique |
| | GTN-5151 | JIS G 0583: Eddy Current Examination of Steel Pipes and Tubes |
| | GTN-7141 | JIS Z 2343: Method for Liquid Penetrant Testing and Classification of the Indication |
| | GTN-8151 | NDIS 3414-1989: General Rules for Visual Testing Method |
| Explanation Subsection 4 Vessel | PVB-2221 | JIS G 0307: Steel Castings-General Technical Delivery Requirements |
| | PVC-3920 | JIS B 8501: Welded Steel Tanks for Oil Storage |
| | PVE-3710 | JIS B 8265: Construction of Pressure Vessel-General Principles (Amendment-1) |
| Explanation Subsection 5 Pipes | PPH-3020 | JIS A 4009: Components of Air Duct |
| Explanation Subsection 6 Pumps | PMB-3110 | JIS B 0131: Glossary of Terms for Turbopumps |
| Explanation Subsection 8 Support Structures | Figure SSB-3131-1 | Architectural Institute of Japan Design Standard for Steel Structures |
| Explanation Subsection 12 Surveillance Test | RST-1130 | JEAC 4201-2004: Method of Surveillance Tests for Structural Materials of Nuclear Reactors |
| | RST-1230 | JIS B 7722: Charpy Pendulum Impact Test-Verification of Testing Machines |

**Figure 9 (cont.) —List of Standards Used in the JSME Code**

## 2.4 Background Information on KEA

The Korea Electric Association is the sole organization in Korea that maintains and develops the technical standards in the power industry field. In 2001, KEA was registered as a private collective standards development organization at the ISO/IEC information center. The association pursues improved domestic technical power in Korea's power industry, continuously reflects power plant construction and operation experience, and advances the standardization technology by continuously maintaining and managing KEPIC.

KEPIC is an organization standard that was developed by industry bodies with the support of the government to secure the stability/reliability and quality of electric power industry facilities and equipment. It is the industry technology standard that comprehensively provides the technological guidelines for the overall stages from design, fabrication and installation to construction, testing, inspections, operation, etc.

KEPIC was developed by the KEPCO beginning in 1992, after the feasibility study of 1987 as part of the government's policy of self-reliant nuclear power technology, and the related works have been transferred to the nonprofit organization, the Korea Electric Association, in accordance with government policy of 1995. KEPIC committees were formed and the KEPIC 1995 edition was issued in the same year.

The KEPIC Technical Committee has been expanded and reorganized many times to form the current organization (Figure 10) with one Policy Committee, 8 Technical committees and 33 subcommittees, and approximately 400 specialists in related fields are now working, including the Regulatory Agency, Utilities, Industries, Academies, Research Institutes, Authorized Inspection Agencies, etc.

Originally, KEPIC was developed with a focus on the standards of nuclear power safety as related to pressurized light water reactors. However, it has been expanded through the 2000 edition, 2005 edition, and 2010 edition (338 types). Currently, as shown in Figure 11, standards related to nuclear and thermal power generation have been maintained and developed by each technical field.

KEPIC has been endorsed with the application of nuclear power plants in Korea through the government's public announcement, as shown in Figure 12, since the 1995 edition. In July 2010, KEPIC was endorsed by the United Arab Emirates (UAE) regulatory organization (FANR), for the application codes for nuclear power plants constructed in the UAE.

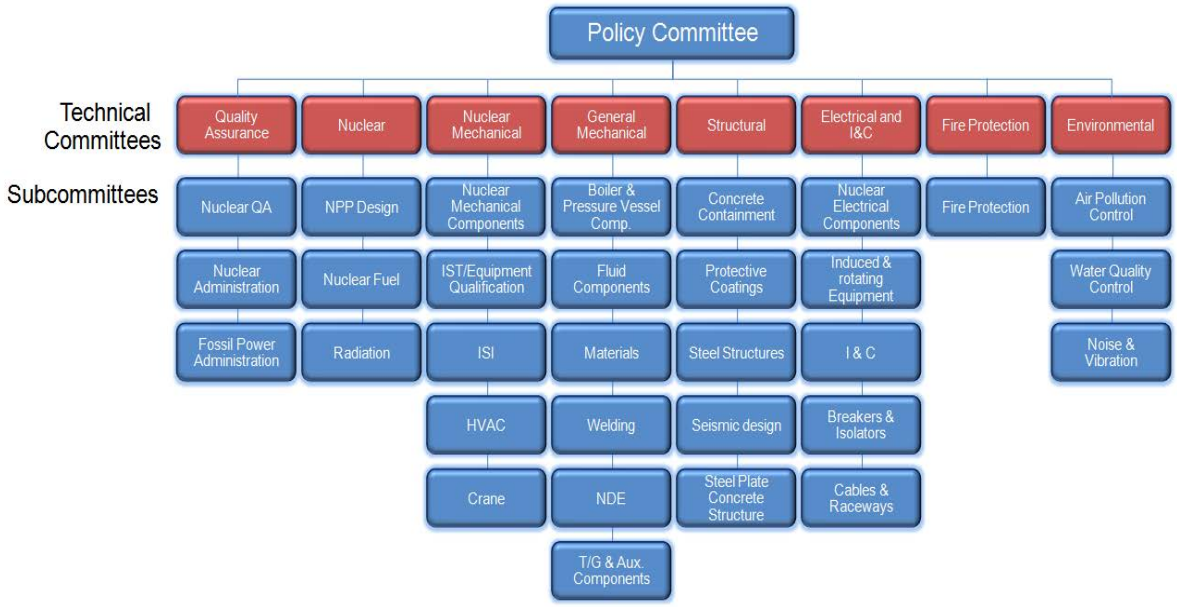


**Figure 10—KEPIC Committee Organization Chart**

| Part | Subpart | Reference Codes & Standards |
|---|---|---|
| Quality Assurance (KEPIC-Q) | QAP : Nuclear Quality Assurance<br>QAI : Authorized Inspection<br>QAR : Registered Professional Engineer | ASME NQA-1<br>ASME QAI-1<br>ASME Sec. III App. XXIII |
| Mechanical (KEPIC-M) | MN : Nuclear Mechanical Components<br>MG : Non-nuclear Mechanical Components<br>MC : Cranes<br>MH : HVAC<br>MD : Materials<br>ME : Non-destructive Examination<br>MQ : Welding &Brazing Qualification<br>MI : In-service Inspection<br>MO : In-service Testing<br>MF : Qualification of Mechanical Equipment<br>MB : Power Boilers<br>MT : Turbine &Generators<br>MP: Performance Tests | ASME Sec. III Div.1&3<br>ASME Sec. VIII, HEI, API<br>ASME NOG-1, CMAA 70<br>ASME AG-1<br>ASME Sec. II<br>ASME Sec. V<br>ASME Sec. IX<br>ASME Sec. XI<br>ASME OM<br>ASME QME-1<br>ASME Sec. I<br>Manufacturer's Spec.<br>ASME PTC Series |
| Electrical (KEPIC-E) | EN : Class 1E Equipment<br>EM: Measuring &Control Equipment<br>EE : Electric Equipment<br>EC : Cables &Raceways<br>ET : Transmission, Transformation and Distribution | IEEE, ANSI, ISA, etc.<br>IEEE, ISA, IEC, etc.<br>NEMA, IEC, ANSI, etc.<br>ASTM, NEMA, IEEE, etc.<br>IEC, IEEE, etc. |
| Structural (KEPIC-S) | SN : Nuclear Structures<br>SG : Non-nuclear Structures<br>ST : Extra-provisions for Structures<br>SW: Structural Welding | ASME Sec. III Div. 2, ACI 349, etc.<br>ACI 318, AISC, etc.<br>ASCE 4/7<br>AWS D1.1/D1.3 |
| Nuclear (KEPIC-N) | NF : Nuclear Fuels<br>ND : Design of Nuclear Power Plants<br>NR : Radiation Protection Facilities<br>NW : Radioactive Waste Processing System | ASTM, Manufacturer's Spec.<br>ANS 51.1 etc.<br>ANS 6.4, 18.1 etc.<br>ANS 55.1, 55.4, 40.35 etc. |
| Fire Protection (KEPIC-F) | FP : Fire Protection for Nuclear &Fossil Power Plants | NFPA 803/804/805, etc. |
| Environmental (KEPIC-G) | GG : Air Pollution Control<br>GS : Noise & Vibration<br>GW : Water Treatment | -<br>-<br>- |

**Figure 11—KEPIC Codes and Standards List (based on 2010 Edition)**

| Regulatory Body | Regulation No. (Notice) | Scope | Related KEPIC |
|---|---|---|---|
| MEST (Ministry of Education, Science and Technology) | 2010-28 | General Application of KEPIC for Nuclear Power Plants (2005 Ed. through 2006 2nd Add.) | QA, MN/MI/MO/MF, MH/MCN, EN/EM, SN/ST, FPN |
| | 2009-37 | Safety Valves and Relief Valves of Nuclear Reactor Facilities (Formerly 2008-15) | MD, MN |
| | | Detailed Requirements for Quality Assurance (Formerly 2008-11) | QAP |
| | | Safety Classification and Applicable Codes and Standards (Formerly 2008-13) | MN, EN, SN |
| | | In-service Inspection (Formerly 2009-23) | MI |
| | | In-service Testing (Formerly 2008-24) | MO |
| MKE (Ministry of Knowledge Economy) | 2009-35 | Substitutive Application of KEPIC for Fossil Power Plants | MB, MG, MT, MD, ME, MQ |

**Figure 12—KEPIC Endorsement Status by Korea Ministries**

## 2.5 Background Information on CSA

CSA is organized under an Executive Management Group known as the CSA Group. The Group has oversight over three major areas: CSA Standards, OnSpex, and CSA International.

The role of CSA Group is to foster operational excellence. The CSA Group harnesses the talents of people and the power of technology to create new products and services that respond to the needs of stakeholders and society at large. These efforts are supported by the effective management of financial and technological resources, risk and organizational change; legal and investigative support services; human resource recruitment and development; and a wide range of marketing activities designed to establish top-of-mind awareness of CSA among members, current and potential customers, and other key stakeholders.

If no standard exists, CSA provides a structure and a forum for developing the standard. A committee is created using a “balanced matrix” approach, which means that each committee is structured to capitalize on the combined strengths and expertise of its members — with no single group or matrix category dominating. The committee considers the views of all participants and develops the details of the standard by a consensus process. Substantial agreement among committee members, rather than a simple majority of votes, is necessary. When a draft standard has been agreed upon, it is submitted for public review, and amended if necessary. All CSA standards are regularly reviewed by committee members and updated to reflect current requirements. This inclusive approach results in standards that meet the needs and practical realities faced by diverse stakeholders. And because they have been developed by members from particular areas of expertise, they are readily accepted and applied by business, consumers, and regulators. By representing the interests of diverse members, CSA builds integrity into every standard published.

Many CSA standards are cited in legislation at federal, provincial, state and municipal levels across North America. Many are internationally or regionally harmonized. All are the result of the expertise and experiences of some 9000 members who develop the standards. CSA may take the initiative to develop a document, but more often the organization responds to requests from government, industry or consumers. If a standard is needed, CSA looks to its international counterparts to see whether an existing standard can be adopted.

CSA International offers testing and certification programs that correspond to about 40 percent of CSA standards. Sometimes, industry seeks certification because laws and regulations stipulate that certain products meet a standard before they are put on the market. Sometimes, an industry group or association requires its members to follow a certain standard. And sometimes, a company voluntarily seeks the mark because it conveys a meaningful message to consumers. The CSA mark, which appears on everything from DVD players to plumbing products…gas appliances to windows and doors… electrical goods to computer hardware, indicates that the product meets the requirements of the applicable standards. CSA marks are accepted by regulatory authorities in the occupational health and safety, electrical, gas, building, plumbing and many other fields in the U.S. and Canada.

CSA Group’s newest division, OnSpeX, provides a full range of product verification, testing, evaluation, inspection, and advisory services specifically designed to help clients accelerate supply chains, increase product sales, build customer satisfaction, and lower product return rates. At the product design stage, OnSpeX can help determine what relevant safety standards, regulations, and codes may be applicable — and evaluate compliance-critical factors. It can also provide detailed written specifications for existing products based on materials, physical characteristics, features, packaging attributes, and safety and regulatory requirements.

The Canadian Standards Association functions as a neutral third party, providing a structure and a forum for developing the standard. Its committees are created using a “balanced matrix” approach,

which means that each committee is structured to capitalize on the combined strengths and expertise of its members — with no single group dominating.

The committee considers the views of all participants and develops the details of the standard by a consensus process, which includes the principles of inclusive participation, and respect for diverse interest and transparency. Substantial agreement among committee members, rather than a simple majority of votes, is necessary. When a draft standard has been agreed upon, it is submitted for public review, and amended if necessary.

The committee's standards are living documents, continually revised and refreshed to address changing requirements and emerging technologies. Each standard is reviewed at least every five years as part of the process of continual improvement.

The governance of the CSA Standards development process is depicted Figure 13.

The standards development process under which CSA and other Standards Development Organizations operate is well developed and formally documented and controlled. This process includes eight distinct stages:

- Preliminary Stage: On receipt of a request for the development of a standard, an evaluation is conducted and the project is submitted for authorization.
- Proposal Stage: Public notice of intent to proceed is published and a Technical Committee is formed — or the project is assigned to an existing Technical Committee.
- Preparatory Stage: A working draft is prepared and a project schedule is established.
- Committee Stage: The Technical Committee or Technical Subcommittee — facilitated by CSA staff — develops the draft through an iterative process that typically involves a number of committee meetings.
- Enquiry Stage: The draft is offered to the public for review and comment, the Technical Committee reaches consensus, CSA staff conduct a quality review, and a pre-approval edit is completed.
- Approval Stage: The Technical Committee approves the technical content by letter ballot or recorded vote. A second-level review verifies that standards development procedures were followed.
- Publication Stage: CSA staff conducts a final edit to verify conformity with the applicable editorial and procedural requirements and then publishes and disseminates the standard.
- Maintenance Stage: The standard is maintained with the objective of keeping it up to date and technically valid. This may include the publication of amendments, the interpretation of a standard or clause, and the systematic (five-year) review of all standards.

Figure 14 delineates the standards development flow from the initial request to final publication and its ongoing maintenance.

The CSA Nuclear Standards Program promotes safe and reliable nuclear power industry in Canada and has a positive influence on the international nuclear power industry. While focusing on nuclear power plants, the program area provides guidance for other types of nuclear facilities for selected topics, such as radioactive waste management and environmental releases.

Specifically, the program is designed to:

- Address industry knowledge management challenges by embedding key historical knowledge in documents and exposing young technical personnel to seasoned experts.

- Provide an alternative to Regulatory Documents with consistent guidance to the industry.
- Provide a structure for interpretations of Standards by an "expert panel."
- Meet identified stakeholder needs for Standards on which to base future work.
- Provide standards and forums to support licensing and regulation.

Users of the Nuclear Standard are reminded that the design, fabrication, installation, commissioning, and operation of nuclear facilities in Canada are subject to the provisions of the Act and its Regulations. The Canadian Nuclear Safety Commission (CNSC) specifies regulatory and administrative requirements for pressure-retaining systems in their Regulations and regulatory documents. Where CNSC documents conflict with the requirements of this Standard, the CNSC documents take precedence. In this Standard, the CNSC is referred to as the regulatory authority.

The CSA Nuclear Strategic Steering Committee (NSSC) consists largely of senior executives and managers from the industry and regulators; it operates under the auspices of the CSA and its Board of Directors and Standards Policy Board. The NSSC's primary role is to set the long-term strategic direction for Canadian nuclear standards, and to provide guidance and support to the TC structure.

There are 10 TCs reporting to the NSSC, each covering distinct functional areas. Each TC is headed by a chair and consists of technical experts drawn from across the industry and relevant public interest groups. The TCs generate standards in the areas seen in Figure 15.

The various standards used can be found Figure 16.

The CSA N285 series consists of the following Standards:

- CSA N285.0 – General requirements for pressure-retaining systems and components in CANDU nuclear power plants.
- CAN/CSA-N285.1 – This Standard no longer exists as a separate publication; it was incorporated into CAN/CSA-N285.0-95.
- CAN/CSA-N285.2 – This Standard no longer exists as a separate publication; it is incorporated as Annex I of CSA N285.0-08.
- CAN/CSA-N285.3 – This Standard no longer exists as a separate publication; it is incorporated as Annex J of CSA N285.0-08.
- CSA N285.4 – Periodic inspection of CANDU nuclear power plant components.
- CAN/CSA-N285.5 – Periodic Inspection of CANDU Nuclear Power Plant Containment Components.
- CSA N285.6 Series – Material Standards for reactor components for CANDU nuclear power plants (published with CSA N285.0).
- CSA N285.8 – Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors.

The first edition of CSA Standard CAN3-N285.0, General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants, was issued in March 1981, and superseded the preliminary Standard N285.1 developed in the mid-1970s.

The second edition CSA Standard CAN/CSA-N285.0, General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants, supersedes the edition published in March 1981 and its amendments.

The third edition of the Standards was issued in November 2005, which also incorporated the CSA Standard CAN/CSA-N285.1-M91. Additionally, the fourth edition of CSA Standard CSA-N285.0-06, General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants, supersedes previous editions published in 1995, 1991, and 1981.

The latest edition of the CSA-N285.0 series of Standards was issued in June 2008. This is the first edition of CSA N285.0/N285.6 Series, General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants / Material Standards for Reactor Components for CANDU Nuclear Power Plants. It supersedes the previous editions of CSA N285.0 published in 2006, 1995, 1991 and 1981, and the previous editions of the CSA N285.6 Series published in 2005 and 1988.

The CSA N285 series of Standards specifies requirements applicable to nuclear power plants in Canada and references the applicable requirements of the ASME Boiler and Pressure Vessel Code (BPVC). The specific objectives of these Standards are as follows.

- To establish technical requirements for pressure boundary items of CANDU power reactors, in a format that regulatory authorities can reference.
- To establish requirements for each class of system, component or support, consistent with the Nuclear Safety and Control Act (Act) and its Regulations.
- To reference applicable requirements of the ASME BPVC where they are appropriate to CANDU power reactors.
- To specify rules and material requirements for the design, fabrication, installation, quality assurance, and inspection of those pressure-retaining components and supports for which the ASME BPVC does not specify requirements.
- To establish rules for the periodic inspection of pressure-retaining components in CANDU nuclear power plants.

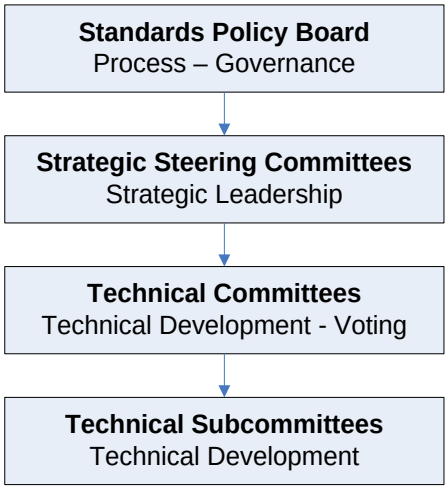


**Figure 13—Governance of the CSA Standards**

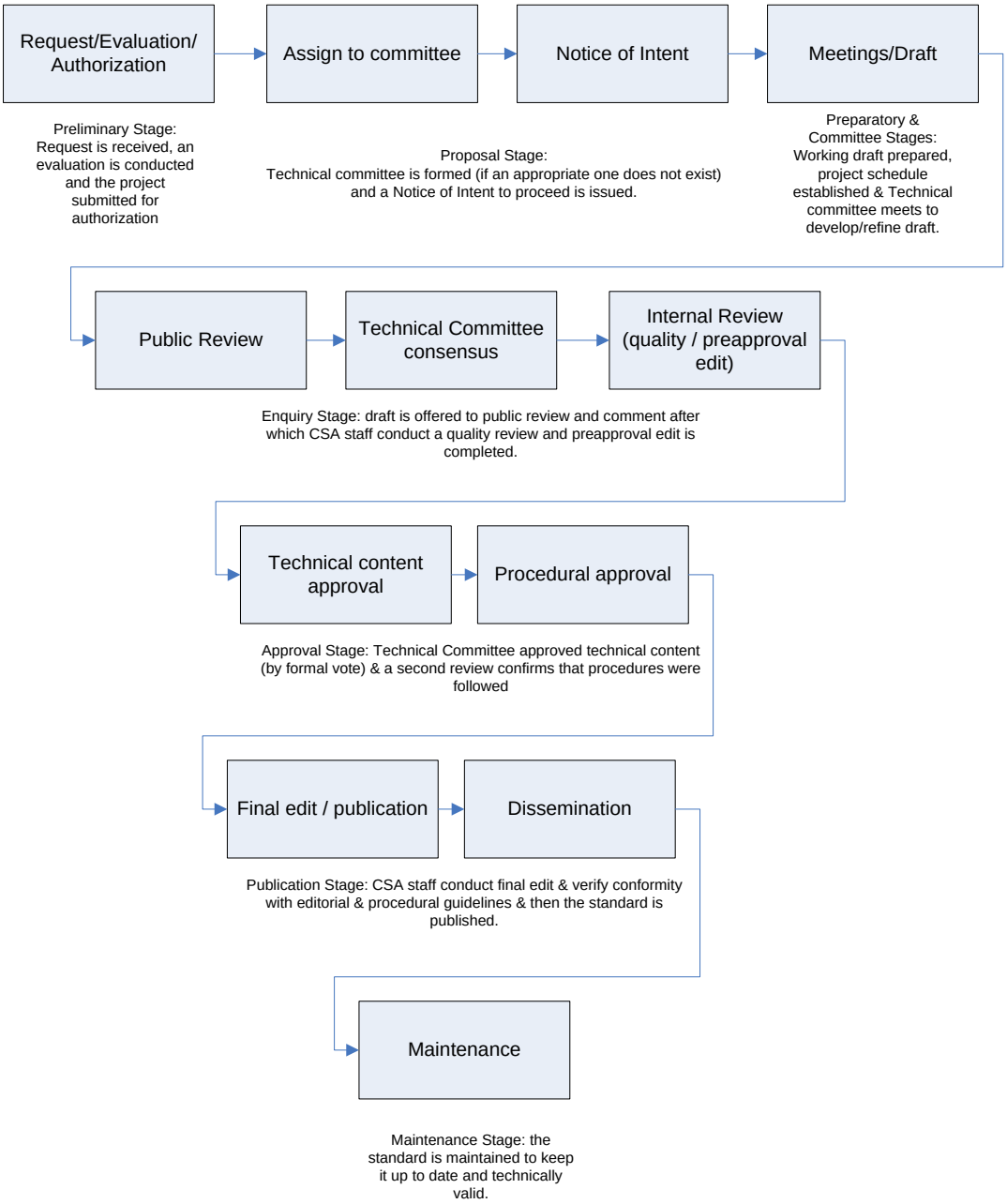


**Figure 14—CSA Standards Development Process**

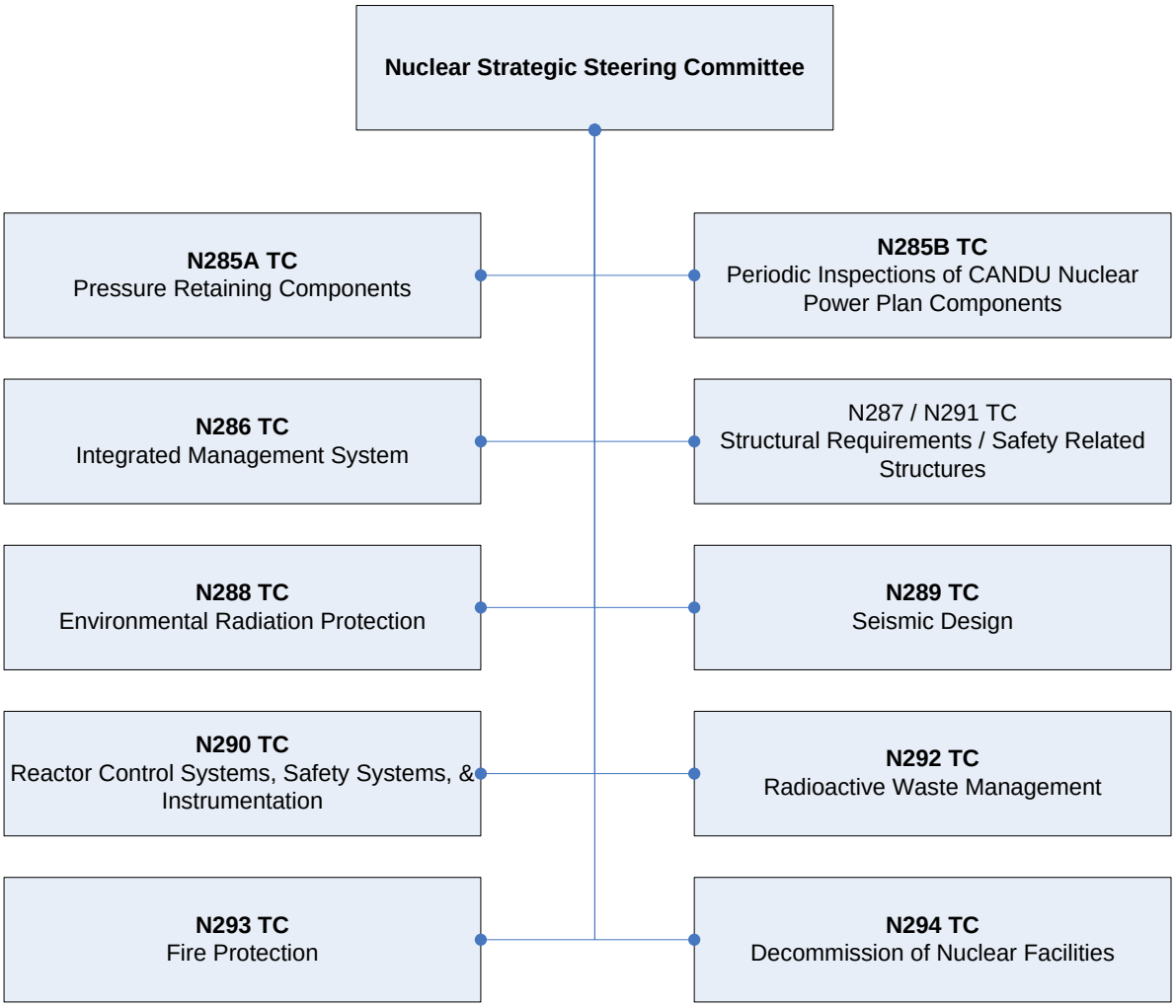


**Figure 15—NSSC and TC Organization Chart**

| Standard | Title of the Standard |
|---|---|
| N285.0/N285.6 | SERIES General Requirements for pressure-retaining systems and components in CANDU nuclear power plants/Material Standards for reactor components for CANDU nuclear power plants |
| N285.2 | Requirements for Class 1C, 2C, and 3C Pressure-Retaining Components and Supports in CANDU Nuclear Power Plants |
| N285.3 | Requirements for Containment System Components in CANDU Nuclear Power Plants |
| N285.4 | Periodic inspection of CANDU nuclear power plant components |
| N285.5 | Periodic inspection of CANDU nuclear power plant containment components |
| N285.8 | Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors |
| N286 | Management System Requirements for Nuclear Power Plants |
| N286.7 | Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants |
| N286.7.1 | Guideline for the application of N286.7-99, Quality assurance of analytical, scientific and design computer programs for nuclear power plants |
| N287.1 | General Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants |
| N287.2 | Material requirements for concrete containment structures for CANDU nuclear power plants |
| N287.3 | Design Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants |
| N287. | Construction, fabrication and installation requirements for concrete containment structures for CANDU nuclear power plants |
| N287.5 | Examination and Testing Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants |
| N287. | Pre-Operational Proof and Leakage Rate Testing Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants |
| N287.7 | In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants |
| N288.1 | Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities |
| N288.2 | Guidelines for Calculating Radiation Doses to the Public from a Release of Airborne Radioactive Material under Hypothetical Accident Conditions in Nuclear Reactors |
| N288.4 | Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills |

**Figure 16—List of Standards**

| Standard | Title of the Standard |
|---|---|
| N289.1 | General requirements for seismic design and qualification of CANDU nuclear power plants |
| N289.2 | Ground motion determination for seismic qualification of nuclear power plants |
| N289.3 | Design procedures for seismic qualification of nuclear power plants |
| N289.4 | Testing Procedures for Seismic Qualification of CANDU Nuclear Power Plants |
| N289.5 | Seismic Instrumentation Requirements for CANDU Nuclear Power Plants |
| N290.1 | Requirements for the Shutdown Systems of CANDU Nuclear Power Plants |
| N290.13 | Environmental Qualification of Equipment for CANDU Nuclear Power Plants |
| N290.14 | Qualification of Pre-Developed Software for Use in Safety-Related Instrumentation and Control Applications in Nuclear Power Plants |
| N290.15 | Requirements for the safe operating envelope of nuclear power plants |
| N290.4 | Requirements for the Reactor Regulating Systems of CANDU Nuclear Power Plants |
| N290.5 | Requirements for Electrical Power and Instrument Air Systems of CANDU Nuclear Power Plants |
| N290.6 | Requirements for monitoring and display of nuclear power plant safety functions in the event of an accident |
| N291 | Requirements for Safety-Related Structures for CANDU Nuclear Power Plants |
| N292.2 | Interim Dry Storage of Irradiated Fuel |
| N292.3 | Management of Low- and Intermediate-Level Radioactive Waste |
| N293 | Fire Protection for CANDU Nuclear Power Plants |
| N294 | Decommissioning of facilities containing nuclear substances |

**Figure 16 (cont.)—List of Standards**

## 2.6 Background information on NIKIET

Russian history relative to development of normative documents regulating design and service of pressure vessels begins on February 8, 1843, when the requirements for adherence to special rules and precautions when using steam boilers were first included in the "Charter on factory and plant industry" by Russian Empire Government decree. In December of the same year, an article pertaining to steam boiler inspections was added to the Charter.

The rules played an important part not only in organization of government supervision in Russia, but also in furthering industrial development, improving boiler design, and leading to creation of new materials.

The rules consisted of only 10 paragraphs, which are still in existence today. Requirements in these rules included maximum pressure in boilers; boiler design and materials; installation of water level gauges, manometers, and relief valves; and requirements for personnel and facility arrangement.

These initial rules were in force in Russia for the next 50 years, and only in 1893 were improved rules introduced. These rules were rather detailed, consisting of 27 paragraphs in 10 chapters, and included requirements for boiler design, reinforcement, boiler rooms, and defined the period and order of boiler inspection. The rules also established a system for obtaining permission for installation of steam boilers.

In 1911, the rules were revised again. Technical requirements of these rules were embodied in the first rules of the USSR in 1920, 1923, and 1929. Following the development of technology, new requirements for steam superheaters, economizers, feedwater, high-pressure boilers (above 2.2 MPa), and other requirements were also included in these rules.

In the mid-1930s, the Central Boiler and Turbine Institution (CKTI), named by Polzunov, began the development of code documents including requirements for design, choice of materials, strength analysis, welding, production control, testing, and maintenance of steam boilers. Documents included in this code were issued and reissued in 1950, 1956, and 1965.

The history of specialized normative acts in the nuclear power industry in the USSR began in 1970 with the establishment of the department of nuclear energy supervision in Gosgortechnadzor. In 1971, by the decree of the Council of Ministers of the USSR on the basis of NIKIET, a special division was founded that eventually would grow into ENES (ICP MAE). Carrying out research in the field of materials science and developing normative documents became its main tasks. During the period of 1970-1973, using specialists from NIKIET and IMASH, with help of experts from other nuclear power industry organizations in the USSR, the first code documents were issued, including "Strength analysis rules," "Rules for safety operation," "General welding regulations," and "Rules for welding control." Documents issued by the department of "Kotlonadzor" (State boilers' supervisor) as part of "Gosgortechnadzor" (Mining and Industrial regulation) that were in force at that time, were a basis for development of that code. The code was also based on documents issued by CKTI and ASME Code (1968) regulations. It was published in 1974.

Between 1975 and 1979, the code of normative documents for the USSR nuclear navy was developed.

In 1978, an interdepartmental commission headed by NIKIET was organized. Its main task was to revise the code of 1974 and create on the basis of code documents a new series, PNAE G-7 (Rules and Norms in nuclear energy). Experts from all nuclear power organizations of the USSR were involved. Specialists from CKTI and the Central Research Institute of Structural Materials (CRISM) "Prometey" made significant contributions to the development of the PNAE G-7 series of documents. Requirements of 1977 and 1980 editions of ASME Code were also taken into consideration.

Developed documents included:

- PNAE G-7-002-86, “Regulations of strength analysis of equipment and piping of nuclear power facilities”
- PNAE G-7-003-87, “Rules for certification of welders of equipment and piping of nuclear power facilities”
- PNAE G-7-008-89, “Rules for design and safe operation of equipment and piping of nuclear power facilities”
- PNAE G-7-009-89, “Equipment and piping of nuclear power facilities. Welding and Cladding. General rules”
- PNAE G-7-010-89, “Equipment and piping of nuclear power facilities. Welding and Cladding. Examination rules”
- PNAE G-7-013-89, “Rules on design and safe operation of actuators of reactivity control devices”
- PNAE G-7-014-89, “Standard Methods for Examination of Base Materials (Semiproducts), Welded Joints and Claddings of NPPs. Ultrasonic Examination. Examination of Base Materials (Semiproducts)”
- PNAE G-7-015-89, “Standard Methods for Examination of Base Materials (Semiproducts), Welded Joints and Claddings of NPPs. Magnetic Particle Examination”
- PNAE G-7-016-89, “Standard Methods for Examination of Base Materials (Semiproducts), Welded Joints and Claddings of NPPs. Visual and Measuring Examination”
- PNAE G-7-017-89, “Standard Methods for Examination of Base Materials (Semiproducts), Welded Joints and Claddings of NPPs. Radiographic Examination”
- PNAE G-7-018-89, “Standard Methods for Examination of Base Materials (Semiproducts), Welded Joints and Claddings of NPPs. Liquid Penetrant Examination”
- PNAE G-7-019-89, “Standard Methods for Examination of Base Materials (Semiproducts), Welded Joints and Claddings of NPPs. Leaktightness Examination. Gas and Liquids Methods”

The publication of PNAE G-7 documents was carried out in 1989.

In 1995, the new Federal Law, “On Nuclear Power Uses,” was issued in Russia. According to this law, only a part of the PNAE G-7 document series, namely PNAE G-7-002-86, PNAE G-7-008-86, PNAE G-7-009-86, and PNAE G-7-010-86, were added to the list of mandatory documents.

In 2003, the new Federal Law, “On Technical Regulation,” became operative in Russia. This law dramatically changed the system of standardization in Russia. This was done to satisfy the requirements for Russia to join the World Trade Organization (WTO). The law, “On Technical Regulation,” set two levels of normative documents: (1) mandatory normative legal level; and (2) national standards. At the same time, the law paved the way for future regulations in the field of nuclear energy with additional documents.

Today, in the field of nuclear energy in Russia, the only mandatory normative documents are those that fall under law “On Nuclear Power Uses,” particularly PNAE G-7-002-86, PNAE G-7-008-89, PNAE G-7-009-89, and PNAE G-7-010-89. In addition to these PNAE G-series documents, which focus on equipment/component design and analysis however, there are many Russian Federal rules

and regulations pertaining to General Safety Provisions; Site Design and Construction; Operation and Decommissioning; and requirements for Safety Analysis Reports.

At present, the role of codes in nuclear energy is being explored. Since 2005, development of codes for various purposes (for different types of reactors and related components) is proceeding.

In 2008, at the end of a three-year cycle of development (encompassing first edition, second edition, and final edition), code SPiR-O-2008, "Code of Rules and Manuals for supports of elements of NPPs with WWER," was prepared and published. Work was ordered by Rosatom (the Russian State Corporation dealing with nuclear energy) and carried out by specialists of ENES (ICP MAE), involving experts from leading organizations of nuclear and other related industry sectors in Russia. It should be noted that this was the first unified document for equipment supports and piping developed in Russia. During the development, some provisions of similar international documents – ASME Code, RCC-M Rules, KTA standard – were also considered.

As a result of activity on SPiR-O-2008, in 2009, a special organizational structure was established (Figure 17), and procedures for development of modern Russian nuclear codes were developed.

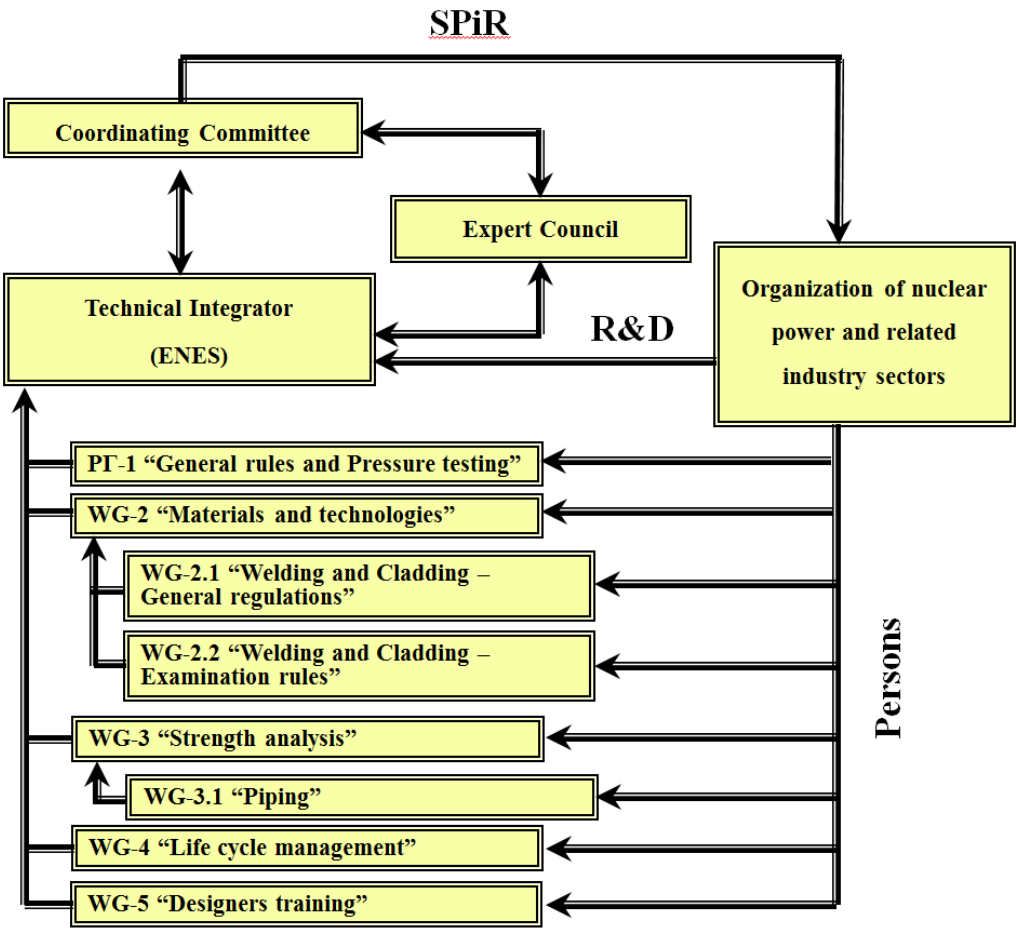


**Figure 17—Organizational Pattern of SPiR Codes Development**

In 2009 and 2010, the development of two modern codes (for high-temperature sodium reactors (SPiR-BN-2011) and WWER (water water energy reactor) type reactors (SPiR-WWER-2012)) was

started. The first of these works, SPiR-BN-2011, was completed in 2011, and completion of SPiR-BN-2011 is planned for 2013. In the future, it is planned to reissue these codes every 5 years.

The planned structure of codes SPiR-BN-2011 and SPiR-WWER-2012 is shown in Figure 18.

Given that codes SPiR-BN-2011 and SPiR-WWER-2010 are now under development, the current PNAE G-7 series documents will be used in an eventual code comparison project.

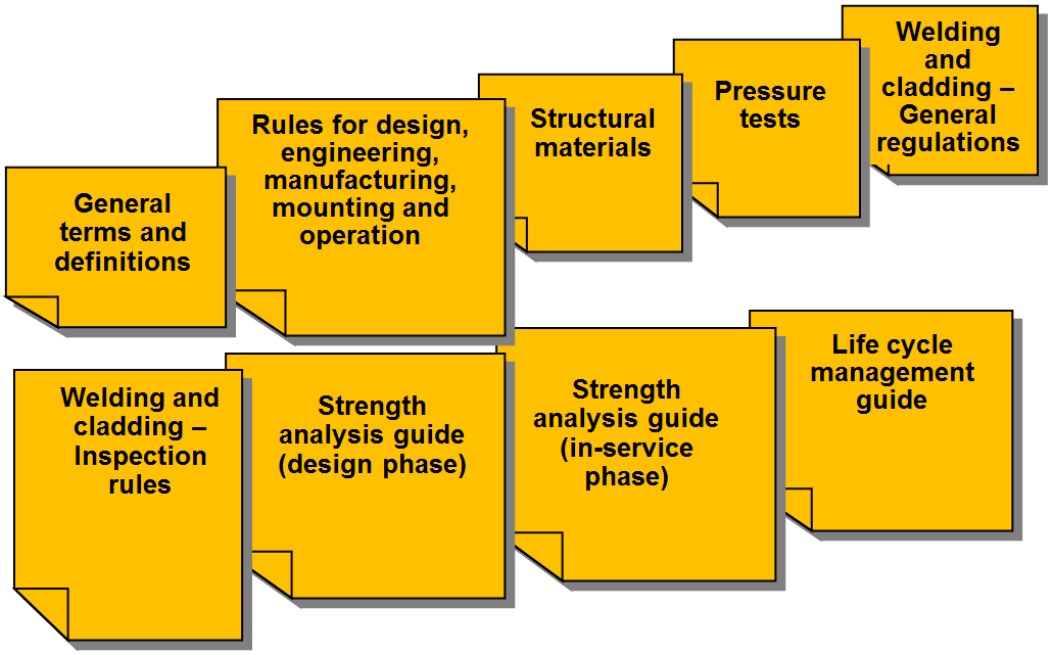


**Figure 18—Structure of the Developed Codes SPiR-BN-2011 and SPiR-WWER-2012**

# 3 GENERAL CODE LAYOUT COMPARISONS

## 3.1 RCC-M versus ASME General Layout Comparison

**Highlights**

- ASME information pertaining to nuclear components is presented in various sections, whereas the RCC-M is specific to PWR nuclear island components.
- While the RCC-M may not include certain information found in the ASME BPVC pertaining to the nuclear industry, these requirements are generally found in other AFCEN codes; for example, ASME Section XI versus the RSE-M.

The following paragraphs compare the general layout of the whole RCC-M and ASME BPVC and also the layout of the sections particular to nuclear island components, i.e., Section III Division 1 for the ASME BPVC and Section I for the RCC-M. A comparison of the two layouts and the information they contain can be found in Table 1. Table 2 provides a comparison of Section I of the RCC-M and ASME Section III Division 1, which both deal with nuclear island components.

These Volumes and Subsections were written with the same objective and this can be illustrated in practice in an overall quasi-identical numbering of the sections, as can be seen in Table 2. The similarities between these sections of the RCC-M and ASME are further evident in the respective Appendices, where Roman numerals indicate a mandatory appendix, while letters indicate non-mandatory appendices.

Finally, it is worth noting here that a detailed comparison of the structure of the two codes can be misleading as certain requirements integrated directly into the ASME BPVC are addressed in different codes published by AFCEN. For example, rules for in-service inspection of nuclear power plant components, which are defined in ASME Section XI, are not defined in the RCC-M but can be found in AFCEN's RSE-M, "*Règles de Surveillance en Exploitation des Matériels mécaniques des îlots nucléaires REP.*" Another example is that the ASME BPVC includes requirements for metal containments in Subsection NE for Class MC components, while it is the RCC-G that gives very detailed rules concerning concrete and metallic structures.

**Table 1—Codes General Layout Comparison**

| RCC-M | Section Title | ASME Equivalent | Section Title |
|---|---|---|---|
| Section I | *Matériel des îlots nucléaires* (Nuclear Island Components) | Section III | Rules for Construction of Nuclear Power Plants Components |
| Section II | *Matériaux* (Materials) | Section II and Section III | Materials |
| Section III | *Méthode de Contrôle* (Examination methods) | Section V and Section III | Nondestructive Examination |
| Section IV | *Soudage* (Welding) | Section IX and Section III | Qualification Standard for Welding and Brazing procedures, welders, brazers, and weld |
| Section V | *Fabrication* (Fabrication) | Included in Section III | Fabrication and Installation |

* The italic writing in the tables indicates that the text has been taken from the original text in French.

**Table 2—Nuclear Island Components Section Layout**

| RCC-M Section I | Section Title | ASME Section III | Section Title |
|---|---|---|---|
| Volume A | *Généralités* (General Comments) | Subsection NCA | General Requirements for Division 1 and Division 2 |
| Volume B | *Matériels de Niveau 1* (Level 1 Equipment) | Division 1 Subsection NB | Class 1 Components |
| | | Division 1 Subsection NH | Class 1 Components in Elevated Temperature Service |
| Volume C | *Matériels de Niveau 2* (Level 2 Equipment) | Division 1 Subsection NC | Class 2 Components |
| Volume D | *Matériels de Niveau 3* (Level 3 Equipment) | Division 1 Subsection ND | Class 3 Components |
| Volume E | *Petits Matériels* (Small Components) | Part of Division 1 Subsection NC-3900 | Zero psi to 15 psi (0 kPa to 100 kPa) Storage Tank Design |
| Volume G | *Equipements Internes du Réacteur* (Reactor Internals) | Division 1 Subsection NG | Components Core Support Structure |
| Volume H | *Supports* (Supports) | Division 1 Subsection NF | Components Supports |
| Volume J | *Réservoirs de Stockage* (Storage Tanks) | Division 1 Subsections NC and ND | |
| Volume P | *Traversées d'Enceinte* (Containment Penetration Components) | Part of Division 1 Subsection NE | Class MC Components |
| Volume Z | *Annexes Techniques* (Technical Appendices) | Division 1 Appendices | Appendices |

* The italic writing in the tables indicates that the text has been taken from the original text in French.

## 3.2 JSME versus ASME General Layout Comparison

**Highlights**

- ASME Section III information is divided among three JSME Codes.
- ASME BPVC Section III is organized per component class; JSME is organized per component type.

Among the JSME nuclear codes listed in Figure 8 of Section 2.3, the following three codes are the subject of comparison of Class 1 component rules.

- JSME S-NC1-2008: Rules on Design and Construction for NPPs, Div. 1 LWRs
- JSME S-NB1-2007: Rules on Welding for NPPs
- JSME S-NJ1-2008: Rules on Materials for Nuclear Facilities

The first one (NC-1, Design Code) covers the general aspects for the design and construction of nuclear components that include material, design, fabrication, examination, testing, and overpressure protection. In this sense, this code is the primary subject of the comparison. The latter two codes give specific requirements on welding and materials, respectively. These two codes are also included in the comparison because some requirements given in ASME Section III Subsection NB are specified in these JSME Codes. For example, some welding-related requirements given in the Article NB-4000 are provided in the Welding Code (S-NB-1) of JSME. Table 3 provides the contents of JSME Design Code.

Observing Table 3, first it is noted that the JSME Sections are structured in a component-oriented manner, while the ASME Sections III Subsections are laid out in a component class-oriented manner (NB for Class 1, NC for class 2 and so on). This comparison of organizational structure of ASME and JSME Codes is schematically illustrated in Figure 19.

Table 4 provides comparison of the structure of Class 1 vessel rules, i.e., Subsection NB of ASME and Subsection PVB of JSME.

**Table 3—JSME Design Code Organization and Section Titles**

| JSME Section Title | | | Remarks |
|---|---|---|---|
| Sec. 1 | GNR | General Requirements | See footnote 1 |
| Sec. 2 | GTM | Mechanical Testing | |
| Sec. 3 | GTN | Non-destructive Testing | |
| Sec. 4 | PVA, PVB, … | Vessels | See footnote 2 |
| Sec. 5 | PPA, PPB, … | Piping | See footnote 2 |
| Sec. 6 | PMA, PMB, … | Pumps | See footnote 2 |
| Sec. 7 | VVA, VVB, … | Valves | See footnote 2 |
| Sec. 8 | SSA | Support Structures | |
| Sec. 9 | CSS | Core Support Structures | |
| Sec. 10 | SRV | Safety Valves | |
| Sec. 11 | PHT | Pressure Testing | |
| Sec. 12 | RST | Surveillance Test | |

Notes:

1. As is discussed in this report, the general requirements in JSME Code do not cover QA and administration-related issues such as "Responsibilities and Duties," "Authorized Inspection," and "Certificates and Stamping."
2. For example, the Section 4 for Vessels is divided into some subsections including PVA (general), PVB (Class 1 vessels), PVC (class 2 vessels), and so on. This subdivision structure applies to some other sections such as piping, pumps, and valves.

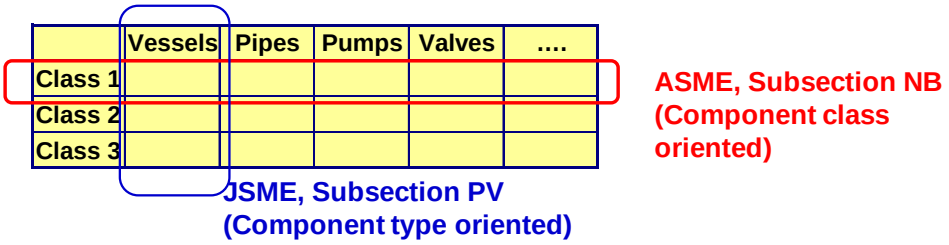


**Figure 19—Comparison ASME and JSME Code Organization**

**Table 4—Comparison of ASME NB and JSME Class 1 Rules**

| **Articles of ASME Subsection NB** | | **Subsections of JSME** | |
|---|---|---|---|
| NB-1000 | Introduction | PVB-1000 | Applicability |
| NB-2000 | Material | PVB-2000 | Material for Class 1 Vessels |
| NB-3000 | Design | PVB-3000 | Design of Class 1 Vessels |
| NB-4000 | Fabrication and Installation | PVB-4000 | Fabrication of Class 1 Vessels |
| NB-5000 | Examination | **JSME S-NB1 Welding Code** | |
| NB-6000 | Testing | PHT | Pressure Testing |
| NB-7000 | Overpressure Protection | NC-CC-001 (2006)[1] | |
| NB-8000 | Nameplates, Stamping and Reports | N.A. | |

Note:
1. Code Case NC-CC-001 (2006), Rules on Overpressure Protection.

## 3.3 KEPIC versus ASME General Layout Comparison

**Highlights**

- KEPIC was developed consistent with the ASME BPVC layout
- The English to SI unit conversion system adopted in KEPIC is different from that of ASME BPVC.

Basically, the composition of the machinery parts of KEPIC was developed to conform to ASME BPVC, as shown in Table 5. The technical contents and composition systems are also the same as those of ASME BPVC. However, in terms of the unit conversion of U.S. commercial units to SI, KEPIC adopted a soft conversion, different from ASME, which adopted a hard conversion. Table 5 shows the composition of KEPIC-MN corresponding to ASME BPVC Section III Div. 1 and Div. 3, and Table 6 shows the composition of KEPIC-MNB that corresponds to ASME BPVC Section III, Div. 1, subsection NB.

**Table 5—Composition of KEPIC-MN and Reference Standards**

| KEPIC | ASME BPVC | Title | Remarks |
|---|---|---|---|
| MNA | Sec. III NCA & Div. 3 WA | General Requirements | Equivalent |
| MNB | Sec. III Div. 1 Subsec. NB | Class 1 Component | Identical |
| MNC | Sec. III Div. 1 Subsec. NC | Class 2 Component | Identical |
| MND | Sec. III Div. 1 Subsec. ND | Class 3 Component | Identical |
| MNE | Sec. III Div. 1 Subsec. NE | Metal Containment | Identical |
| MNF | Sec. III Div. 1 Subsec. NF | Support | Identical |
| MNG | Sec. III Div. 1 Subsec. NG | Core Support Structure | Identical |
| MNS | Sec. III Div. 3 Subsec. WC | Class TC Transportation Containment | Identical |
| MNT | Sec. III Div. 3 Subsec. WB | Class SC Storage Containment | Identical |
| MNZ | Sec. III Div. 1 Appendices | Appendices | Identical |

NOTE: Compatibility with the reference standards is in accordance with ISO/IEC Guide 21.

**Table 6—Composition of KEPIC-MNB and ASME NB**

| KEPIC-MNB | Contents | ASME NB |
|---|---|---|
| MNB 1000 | Introduction | NB-1000 |
| MNB 2000 | Material | NB-2000 |
| MNB 3000 | Design | NB-3000 |
| MNB 4000 | Fabrication and Installation | NB-4000 |
| MNB 5000 | Examination | NB-5000 |
| MNB 6000 | Testing | NB-6000 |
| MNB 7000 | Overpressure Protection | NB-7000 |
| MNB 8000 | Nameplates, Stamping and Reports | NB-8000 |

## 3.4 CSA versus ASME General Layout Comparison

**Highlights**

- ASME BPVC is used in various Canadian provinces and N285.0 written to define how ASME BPVC Section III is adopted to fit the Canadian laws.
- N285.0 provides rules for classification of the various components; once classification is done, the relevant ASME BPVC Section III part is used.

The relationship between the ASME Boiler and Pressure Vessel Code and CSA Standards started with non-nuclear areas over 75 years ago. The Canadian Jurisdictions adopted the technical requirements of the ASME Boiler and Pressure Vessel Code as the basis for their acceptance of pressure boundary construction and began participation in their development. This was done mainly through their relationship with the organization known today as the National Board of Boiler and Pressure Vessel Inspectors, of which all Provinces and Territories of Canada participate as members. This not only provided them an entry into the U.S. markets, but also mitigated the need to develop a similar document in Canada.

Regulation of safety is a provincial responsibility and each Province has its own laws and processes through which the construction of the pressure boundary is controlled. It was apparent that there was a need to develop interfacing documents that allowed the application of the ASME Boiler and Pressure Vessel Code in the various Provinces and Territories and to provide some consistency in approach throughout Canada. The CSA Standard B51 was the vehicle that was developed to provide this consistency. It defined how the ASME BPVC is adopted in Canada. This approach has proven to be very successful over the years.

With introduction of nuclear power and the development of the CANDU concept as Canada's contribution to the industry, it became obvious that a document similar to B51 would provide similar benefits. This was particularly true for nuclear power because the CANDU concept introduced materials, components, and methods of construction that were not part of the ASME BPVC that was developing. The Section III Code was being written to facilitate the development and use of the U.S. concepts and with the heavy influence of the USA Regulatory Authority, the U.S. NRC, some of the CANDU requirements could not be met at that time. In was in this milieu that the Canadian Standard N285.1 was developed in the mid-1970s. Starting in 1980, a new Standard CSA N285.0 was written and this became the upper-tier document in a series of Standards.

N285.0 has evolved over the years but essentially it filled the same purpose as the B51 document; it provided the approach for adopting the ASME BPVC for use in the construction of the CANDU pressure boundary. Besides providing this intermediate document, others in the Series provided requirements for the use of materials and components that were unique to the CANDU concept. However, even in these cases, the technical requirements of Section III have been adopted when they are applicable.

N285.0 provides rules for classification of the process and special safety systems and, by default, the classification of the components in those systems or sections of systems. Once the classification of a component has been defined, the requirements for the construction of the ASME BPVC can be used to construct the component. Only those items that are unique to the CANDU concept use the other CSA Standards and, even in these cases, they are referenced directly to a section of the Section III Code for technical requirements.

**Table 7—List of the N285.0**

| Sections | Title |
|---|---|
| **Main Body** | |
| 1 | Scope |
| 2 | Reference publications |
| 3 | Definition |
| 4 | Effective date for standards |
| 5 | Classification |
| 6 | Registration |
| 7 | Design |
| 8 | Materials |
| 9 | Fabrication and installation |
| 10 | General requirements for quality assurance |
| 11 | Examination and pressure testing |
| 12 | Documentation |
| 13 | In-service requirements |
| 14 | Repairs, replacements and modifications |
| **Annex** | |
| A (normative) | Classification |
| B (informative) | Registration numbers |
| C (informative) | Registration procedures |
| D(informative) | Design documentation |
| E (informative) | Implementation of quality assurance programs |
| F (normative) | Registration exemptions |
| G (informative) | Servicing Class 6 overpressure protection devices |
| H (informative) | Qualification of licensee's verifiers |
| I (normative) | Requirements for Class 1C, 2C and 3C pressure-retaining components and supports in nuclear power plants |
| J (normative) | Design rules for containment boundary components |
| K (informative) | In-service plugging by fusion welding of Class 1, 2 and 3 heat-exchanger tube or tube sheet holes with a one-inch maximum diameter |
| L (normative) | Reconciliation of modifications and as-built changes |
| M(informative) | Alternative requirements for pressure testing of Class 1, 2, 3 and 6 systems after repairs, replacements and modifications |

## 3.5 PNAE G-7 vs. ASME Code General Layout Comparison

**Highlights**

- The structures of the PNAE G-7 series of documents and the ASME Code differ significantly. This aspect makes it very difficult, if not virtually impossible, to assess and determine full compliance between the PNEG-7 series and the ASME Code.
- Along with the PNAE G-7 series of documents, additional government and industry standards are typically applied in the Russian nuclear industry as approved by the Owner and Regulatory Body. The number of governing documents from various Russian State and industry organizations, such as GOST and OST, is expanding and, in some cases, updating regulations included in the PNAE G-7 series for specific equipment at various stages of its life cycle (design, fabrication, etc.).

The PNAE G-7 series documents addresses only the components of the nuclear island, i.e., equipment safety groups A, B, and C according to PNAE G-7-008-89 classification. Other NPP equipment and piping is not covered by requirements of PNAE G-7-008-89, yet must satisfy the requirements of other standards, including appropriate standards of the GOST and OST series Russian State and industry standards, respectively.

The structure of the PNAE G-7 series of documents substantially differs from the structure of the ASME Code. In most cases, it is difficult to define a clear correspondence between the ASME Code and the documents within the PNAE G-7 series. Approximate correspondence between the PNAE G-7 documents and the ASME Code is shown in Table 8.

**Table 8—Codes General Layout Comparison**

| PNAE G-7 | ASME Code |
|---|---|
| PNAE G-7-008-89 | ASME Code II<br>ASME Code III (NCA, NB, NC, ND)<br>ASME Code V<br>ASME Code XI |
| PNAE G-7-009-89 | ASME Code III (NB, NC, ND)<br>ASME Code IX |
| PNAE G-7-010-89 | ASME Code III (NB, NC, ND)<br>ASME Code V<br>ASME Code IX |
| PNAE G-7-002-86 | ASME Code II<br>ASME Code III (NCA, NB, NC, ND, Appendices) |

For additional demonstration of differences in layout, the reverse correspondence of NB chapters to the PNAE G-7 chapters is shown in the Table 9.

**Table 9—ASME Code NB and PNAE G-7 Layouts Comparison**

| ASME Code NB | PNAE G-7 |
|---|---|
| NB-1000 | PNAE G-7-008-89 |
| NB-2000 | PNAE G-7-008-89<br>PNAE G-7-002-86<br>PNAE G-7-014-89<br>PNAE G-7-015-89<br>PNAE G-7-017-89<br>PNAE G-7-018-89<br>PNAE G-7-025-90, “Steel cast products. Examination” |
| NB-3000 | PNAE G-7-002-86 |
| NB-4000 | PNAE G-7-008-89<br>PNAE G-7-009-89<br>PNAE G-7-010-89 |
| NB-5000 | PNAE G-7-008-89<br>PNAE G-7-009-89<br>PNAE G-7-010-89<br>PNAE G-7-014-89<br>PNAE G-7-015-89<br>PNAE G-7-016-89<br>PNAE G-7-017-89<br>PNAE G-7-018-89 |
| NB-6000 | PNAE G-7-008-89 |
| NB-7000 | PNAE G-7-008-89 |
| NB-8000 | PNAE G-7-008-89 |

In general, the scope of the PNAE G-7 series is narrower than the scope of the ASME Section III. In particular, the PNAE G-7 series does not include specific requirements for supporting structures, in-core components, metal facing of concrete containments, or containers for transportation of fuel and waste. It uses the same approach for these NPP elements as for equipment and pipelines, for which separate Russian State and industry standards are applied.

Another specific difference related to Russian Federation nuclear standardization is applicability of a large number of guidance documents issued by individual standards organizations. These documents are not mandatory but are typically applied by the Owner or Regulator. Usually, these documents specify the general requirements of PNAE G-7 series for a specific type of equipment or piping at a particular stage of its life cycle; for example, requirements for examination of tube sheets at

manufacturing. Guidance documents satisfy the basic requirements of PNAE G-7 series of documents. While these guidance documents may not be mandatory, they are typically applied to cover topics not addressed by the PNAE G-7 series.

It is also worth noting that PNAE G-7 series of documents is not divided into sections depending on the equipment safety classification as is the case relative to ASME Section III. The same PNAE G-7 design requirements are generally applied regardless of safety classification; however, different examination and testing requirements are applied relative to safety classification.

Work is currently underway relative to a modern set of SPiR documents that will replace the PNAE G-7 series. While the SPiR series of documents will, in general, maintain the structure of the PNAE G-7, the SPiR series will integrate many of the applicable requirements that are currently found in non-mandatory guidance documents. The SPiR documents highlight some of sections in separate documents (see Figure 18).

Thus, some harmonization of the SPiR structure will be reached with major international documents, such as the ASME and RCC-M codes.

# 4 RCC-M VERSUS ASME BPVC SECTION III COMPARISON

## 4.1 Abstract

The American and French nuclear industries are among the two largest in the world. In these two countries though, the evolution of two different codes has developed, the RCC-M Code in France and the ASME BPVC in the U.S., and although the RCC-M Code has its roots based on Section III of the ASME BPVC, they have diverged over the years. With the globalization of the markets today, the different existing codes can lead to a barrier for manufacturers used to working with one code and then switching to another.

As of today, there exists a set of practical examples as well as various documents that have been drafted to compare the codes, but no report reflecting mutual agreement and effort from French and American parties exists. This part of the report is an attempt to fill this gap.

The sections compared here are based on Section III from the ASME BPVC versus the RCC-M Code. Starting from a line-by-line comparison of the two codes, each paragraph of the codes was ranked in four categories, varying from “same” to “technically different.” The main body of this section was then built based on the identified main differences from the line-by-line comparison.

The first conclusion is that the two codes are dissimilar in many aspects. However, most differences can be classified in two categories: differences due to technical requirements and differences due to regulatory requirements. A reconciliation of the technical differences is manageable, provided additional work is carried out, while the regulatory differences would require political and regulatory effort.

This part has identified the main differences between the codes, technical and regulatory. For the technical part, this section constitutes a tool for an owner (manufacturer, designer, etc.) wanting to assess the differences between the two codes. It will enable the individual to highlight the areas where in-depth technical knowledge is required to bridge the gap between the codes. Concerning the regulatory requirements, they are dependent on the politics and cultural background of the countries, so would be more resistant to modification.

## 4.2 Introduction

The objective of this section is to summarize the major differences identified in the specific comparison of the two codes, ASME BPVC and RCC-M Code. This specific comparison is presented as an attachment (Appendix A) of this report. Indications between brackets will be given when a paragraph from this text relates directly to the table in Appendix A. In the case that certain sections of either of the two codes are not mentioned in this summary, this implies that there are no significant differences between the two codes in this area. While the detailed comparison provided in Appendix A may identify some specific differences, these were considered to have no real impact in practice.

For Class 1 vessels, the RCC-M is generally more prescriptive than ASME Section III; ASME has a larger scope than RCC-M while RCC-M focuses specifically on PWR components.

RCC-M and ASME Section III are used with a different QA organization.

Many differences are reported and will lead to nonconformances with existing regulator practices, but many of these differences can be solved by the manufacturer through complementary requirements.

Again, it is necessary to bear in mind that the main idea is to provide a general overview of any significant dissimilarity between the codes and permit an assessment of how these differences might impact various regulatory and licensing requirements.

As a clarification, the two codes that will be compared here are the ASME 2007 Edition and the RCC-M 2007 Edition without any consulting of the additional Addenda published after 2007, generally without consideration of appendices or code cases.

The ASME BPVC has today become an international standard for design pressure and mechanical equipment as a whole. On the other hand, the RCC-M has grown to become an internationally recognized code in the nuclear industry, being also used worldwide in countries such as, among others, Korea, China, South Africa, and Finland. Nevertheless, when assessing the differences between the RCC-M and ASME BPVC, the original basis for development of these respective codes should be kept in mind.

The ASME BPVC aims at laying down rules for nuclear components as a whole, as its title indicates for multiple types of nuclear power plant designs. On the other hand, the RCC-M Code is focused mainly on the rules for construction of mechanical equipment for PWR reactors. This difference implies having information in the ASME BPVC relating to the nuclear industry scattered in different sections. This last point is particularly important when comparing the codes section to section, as is done in the rest of this Section.

The first subsection compares the NB-1000 preliminary paragraphs from the ASME BPVC to their equivalents from the RCC-M Code. The second subsection addresses the NB-2000 paragraphs about materials and the third one deals with the NB-3000 paragraphs about design. The NB-4000 about fabrication and installation is discussed in the subsection named Fabrication and Welding. Examination from the NB-5000 is dealt with in the subsection with the same name. The NB-6000 paragraphs about testing are partially covered in the subsection named Pressure Tests. NB-7000, about overpressure protection, is addressed in the last subsection before a short overview on quality aspects in the codes, and the Conclusion.

## 4.3 Preliminary Paragraphs and Scope Presentation

**Highlights**

- No stamping and no certificate holder in RCC-M
- No boundaries of jurisdiction consideration in RCC-M.

This section aims at describing the differences between the preliminary paragraphs Section III Division 1 NB-1000 of the ASME BPVC and their equivalent in the RCC-M Code.

In the American code, these paragraphs give an introduction to the contents of the Section III Division 1 NB paragraphs and, more importantly, define the scope of the section. Conversely, in the closest section in the RCC-M, which is Section I B-1000, the route taken is different: this paragraph goes over the documents that are required and should be kept at the disposition of the surveillance agents as well as the identification to be used. These differences in the layouts are best summarized in Tables 10 and 11. But beyond these line-by-line comparison discrepancies, more important differences in the two codes should be commented on here.

The rest of this section is organized in three paragraphs. The first provides comments on the differences between the two codes as regards the practices used, such as stamping and certificate holders, as well as the Design Specification. A second part describes deterioration aspects and, finally, a third paragraph deals with the jurisdictional boundary definition and penetration assemblies.

A first comment about the two codes pertains to stamping and certificate holders. In the ASME BPVC, it is specified in Section III Division 1 NB-1110 (a) that the "*Subsection NB contains rules for the material, […], stamping, and preparation reports by the Certificate Holder […].*" The RCC-M does not have any stamping or certificate holders (Appendix A – line NB-1110). This point will be developed more in detail in the paragraph about overview of quality aspects. Moreover, the term

"Design Specification" appears in the paragraph NB-1131 of the ASME BPVC, but is not identified as such in the RCC-M Code (design requirements are included in equipment specification in RCC-M). This also is a major difference: where the RCC-M is in most cases self-supported, the ASME BPVC, on the other hand, states that a Design Specification issued by the owner should be used. In particular, it is mentioned here as having to define the boundary of components.

Moreover, the ASME BPVC mentions clearly in the paragraph NB-1110 that the scope of this code will not cover any deterioration of material in-service. The RCC-M does not specify it will in the introduction, but deterioration is partially covered in the French code in various sections about fatigue, fracture, and so on (Appendix A – line NB-1110).

Finally, the definition of the jurisdictional boundary is not clearly specified in the RCC-M. In Section III H-1220 and P-1100 paragraphs, a description of the scope of these sections, pertaining respectively to supports and containment penetration, is briefly done. Conversely, the ASME BPVC chose to make this topic a whole paragraph, the NB-1130. In the latter, a full description is made of the equipment for which Section III Division 1 subsection NB applies (Appendix A – line NB-1130).

One last difference is the electrical and mechanical penetration assemblies that are considered in RCC-M in Section III, subsection P, and not in the ASME BPVC (Appendix A – line NB-1140).

**Table 10—Location in RCC-M of Paragraphs Equivalent to ASME Section III Division 1 NB-1000**

| ASME Section III NB-1000 | Section Title | RCC-M Equivalent Section(s) | Section Title |
|---|---|---|---|
| NB-1110 | Aspects of construction covered by these rules | Section I A-1000 | *Objectifs et structure du recueil* (Objectives and structure of the code) |
| NB-1120 | Temperature limits | Section II | Various material specifications |
| NB 1130 | Boundaries of jurisdiction applicable to this subsection | Section I H-1220 | *Domaine d'application du volume H* (Jurisdictional Boundaries of subsection H) |
| | | Section I P-1100 | *Introduction* |
| NB 1140 | Electrical and mechanical penetration assemblies | Section I Volume P | *Traversées d'enceinte* (Containments penetration) |

**Table 11—Location in ASME BPVC of Paragraphs Equivalent to RCC-M Section III B-1000 Paragraphs**

| RCC-M Section III B-1000 | Section Title | ASME Equivalent Section(s) | Section Title |
|---|---|---|---|
| B-1100 | *Introduction* | N/A | N/A |
| B-1200 | *Documents à établir* (Required documents) | Section III Division 1 NB-8000 | Nameplate, Stampings and Reports |
| B-1300 | *Identification* | Section III Division 1 NB-8000 | Nameplate, Stampings and Reports |

## 4.4 Materials

**Highlights**

- ASME allows numerous materials in Section II, whereas RCC-M limits the number to the materials described in B-2000 (PPS/STR).
- Implementation of the PPS/STR requires fewer supplements in RCC-M than in ASME; RCC-M is more prescriptive, in particular relative to application of materials for specific PWR components.
- For procurement, tensile tests are required to be done at room temperature and high temperature in RCC-M; ASME relies on trend curves for high temperature without additional tensile test.
- Homogeneity of the material properties should be evaluated for certain material applications in RCC-M (for Class 1 equipment).
- Deterioration of material in service: owner responsibility in ASME (Section III NB 2160); AFCEN partially covers deterioration of material in Section I B-2200 (PPS).
- Standards to determine characteristics of material properties are different in the two codes, including the location of the test samples.

This section relates to the code requirements dealing with materials of the ASME BPVC Section III, Division 1 as well as their characteristics and is organized in four paragraphs, the first recalling the standards used in each of the codes, the second dealing with material procurement, the third highlighting an important difference regarding material testing and, finally, the fourth comparing the material composition and properties using illustrative examples. Specific comparison details relative to NB-2000 requirements are provided in Appendix A of this report.

Section II of the ASME BPVC also contains information relating to materials and their chemical composition and relies also on complementary information from the ASTM Standards. In addition, the materials stress and yield limits necessary for the design of components may be found in Section II Part D, Properties. Section II of the RCC-M contains the chemical composition of the materials, but unlike the ASME, the material characteristics and properties are collected in Section I, Appendix Z.

The ASME and the RCC-M both include requirements pertaining to materials for use in Section III Division 1 2000 paragraphs of ASME and Section I 2000 paragraphs of RCC-M. This is summarized in Tables 12 and 13, herein.

A first general comment is that neither code refers to the same material reference (example in Appendix A – lines NB-2320): the ASME uses its own specification system (based on the ASTM), whereas the RCC-M uses the European AFNOR norm as well as its own *Spécification Technique de Référence*. This does not make the comparison any easier as there is no clear correspondence between the standards used, although an approximate equivalent of a material in one code can nevertheless be found in the other code. The material properties comparison Tables 14 and 15 as well as Figure 20 provide a tangible and quantifiable illustration of what is meant by “approximate” in the previous sentence. It should be noted here that the RCC-M Code includes all the information about the materials for the nuclear industry in the code itself, whereas the ASME BPVC requires identification of some of the information in the ASTM standards. The codes are also dissimilar in many aspects relative to material procurement, as is illustrated in Table 17.

Taking first the 2000 paragraphs of Section I of the RCC-M, it is possible to see that the material is prescribed for each component to be built. The Table B-2200 is a summary of the various equipment of the Nuclear Island and a material STR number to be used is associated with each piece of equipment (Appendix A – first lines of NB-2000, Material). The methodology in RCC-M is to

impose a material (or to select one from a list of materials) according to the level and nature of the product or part. For example, the aforementioned Table B-2200 imposes PPS (STR) M2115 for the material of tube plate of steam generators, to which the ASME BPVC Section II equivalent would be the SA-508/SA-508 M. Note that, in addition, the PPS (STR) in Section II of RCC-M also defines associated tests and NDE, which are not required as mandatory for SA-508/SA-508 M. The scope of RCC-M is therefore not identical to that of ASME Section II for material specification: the ASME BPVC gives a selection of different alternatives, with one to be retained in the purchase order with associated procurement specification.

On the other hand, looking at Section III Division 1 of the ASME and the 2000 paragraphs, these include general requirements on the materials that should be used for each component. An example of such a paragraph is Section III Division 1, Section NB-2120 relating to pressure-retaining material. The paragraph gives general requirements but leaves freedom to the designer to select the material. The idea in ASME Section III is that the owner has not to completely define and choose the material in the design specification. Nevertheless, the design report issued by the designer and certified by a Registered Professional Engineer (RPE) must allow the N-certificate holder to issue the material specification that will be used, within adequately defined conditions, by the material manufacturer. Only with this process, optional parts of ASME Section III like Appendix W, which is never called in the body of the Section III, can become mandatory. This should, in this case, be specified by the owner or the designer. Each actor in the decision process has a responsibility that will, in the end, guarantee a material selection equivalent to the RCC-M (such as the M2115 versus SA-508/SA-508 M mentioned above).

To end this discussion, it should be highlighted that if materials are selected from Section II of the ASME BPVC, used along with Appendix II only, and that in addition the selection is done by a designer without an RPE and/or by a material producer without any quality management certification, it is impossible to guarantee a final material equivalent to the RCC-M one.

Another discrepancy lies in the material testing and more specifically the tensile tests (Appendix A – line NB-2340). Considering two materials of very similar chemical composition, the SA-508 Grade 3 in the ASME and the 16MND5 in the RCC-M, which can respectively be found in Section II SA-508/SA-508M and in Section II Section M2111, it can be seen that:

- In Part 6.0 of the section of the ASME mentioned above, there is no need for a high-temperature tensile test and only a room temperature one.
- In the section of the RCC-M specified above, it is mentioned clearly in part 4.3 a requirement for "*tension testing at room temperature and at high temperature*."

Similar requirements can be found in different parts of the two codes when assessing the mechanical requirements for other materials. Among other parts of the RCC-M, a high-temperature tensile test is also required for filler material acceptance (Section IV, Section S-2536).

The discussion from the previous paragraph about material procurement explains this difference. These tests are justified in RCC-M to ascertain the characteristics at ambient temperature of the material ordered and/or supplied. ASME, on the other hand, considers that the attentive survey of the Third Party will ascertain that the required characteristics, ordered with the appropriate documentation (see previous paragraph) and with the adequate testing requirements, meet the actual characteristics of the material supplied. The absence of a Third Party in the RCC-M Code is compensated by a series of additional tests.

Moreover, the ASME BPVC relies on other design factors to account for uncertainties in the material properties given in Section II. As an example, looking at Figure 21 and at the ultimate strength of the SA-336 Cl F316LN and of the Z2CND18-12, it can be seen that the allowable of the former is much lower than that of the latter.

A last set of differences to mention in this subsection is the tests to be performed: RCC-M uses Charpy V-notch test, drop weight test, or calculates $RT_{NDT}$ with ISO standard as a basis, whereas ASME uses U.S. standards, as mentioned in the paragraph NB-2300 of the ASME BPVC (Appendix A – line NB-2320). The discrepancies in the values used can be seen in Table 16. The same comments could be made for examination and repair (NB-2500) and material organization quality system programs (NB-2600).

Concerning the material composition and using as an example the SA-508 Grade 3 in the ASME and the 16MND5 in the RCC-M, which can respectively be found in Section II SA-508/SA-508M and in Section II Section M-2111, it can be seen that the prescriptions in chemical compositions are different as regards the contents, as can be seen in Table 14. For example, cobalt content is 0.03% in M-2111 in RCC-M and not mentioned in SA-508. When working with the ASME BPVC, the designer may recall and/or impose these limits in the technical specifications based on the experience gathered through the years. In practice, two materials produced as per ASME requirements and RCC-M requirements will potentially have differences in their chemical composition, but it is the responsibility of the owner or designer to add extra requirements that ensure adequate quality.

For example, designer will have to address:

- The need to minimize intergranular attack in austenitic stainless steels as in Section I B-2300 of RCC-M
- The need for material cleanliness for long-term service as in B-3176 of RCC-M
- Lamellar tearing as in B-3177 of RCC-M.

Multiple other differences could be found concerning the material composition and selection, but this discussion will be ended here. See Appendix A for other differences. All the examples given above lead indeed to one conclusion: the ASME leaves much more responsibility and/or freedom to the owner or designer. It is not self-supporting and relies on additional specifications. The RCC-M gives a very detailed listing of the steps that should be followed and the materials allowed. Finally, regarding the Class 1 material properties, two illustrative examples will be taken with the SA-508 Grade 3 Class 2 in the ASME and the 16MND5 (M2111) in the RCC-M, already selected above, and the SA-336 Cl F316LN and Z2CND18-12 (M3301, diameter bigger than 150 mm). As can be seen in Figures 20 and 21, the compared properties as regards design stress, yield strength, and ultimate strength are very similar. As mentioned above, the ultimate strength allowable is sometimes lower for the materials in the ASME to compensate for the fact of not carrying out tensile tests at high temperatures. The comparison between the 16MND5 and the SA-508 Grade 3 Class 2 is more extensive and can be seen in Tables 14 to 16.

An additional requirement found in the RCC-M regarding the properties is the assessment of the latter within the material. Concerning main components (M140) and new material qualification, in RCC-M Section M-143.6, it is stated that when qualifying a component or part, the fabricator should assess the homogeneity of the material (Appendix A – lines NB-2221 and NB-2223). No such requirement can be found in the ASME. A dedicated requirement for main parts is the technical qualification M 140 for forged parts and M160 for main castings. This is explained in the section on Fabrication – Welding.

To conclude, the main differences for this section stem from the responsibility that the ASME leaves to the ordering chain (owner, designer, Third Party, and/or supplier), whereas the RCC-M is typically more prescriptive.

**Table 12—Location in RCC-M of Paragraphs Equivalent to ASME Section III Division 1 NB-2000**

| ASME Section III NB-2000 | Section Title | RCC-M Equivalent Section(s) | Section Title |
|---|---|---|---|
| NB-2100 | General requirements for material | Section I B-1000, B-2000, B-4000 and Appendix Z V | |
| | | Section II M-1000 to 6000 | Material Procurement Specification |
| NB-2200 | Material test coupons and specimens for ferritic steel material | Section II M-1000 to 6000 | Material Procurement Specification |
| | | Section II M-150 | *Traitements thermiques* (Heat Treatment) |
| NB 2300 | Fracture toughness requirements for material | Section II M-1000 to 6000 | Material Procurement Specification |
| | | Section III MC-1200 | *Essais Mécaniques* (Mechanical tests) |
| NB 2400 | Welding material | Section IV S-2000 | *Recettes des produits d'apport* (Acceptance of filler material) |
| NB 2500 | Examination and repair of pressure-retaining material | Various paragraphs of Section II | |
| NB 2600 | Material organizations' quality system programs | Section I A-5000 | *Assurance de la qualité* (Quality Assurance) |
| NB 2700 | Dimensional standards | Section I A-1300 | *Liste des normes et de leur édition applicable* (List of Standards and applicable editions) |

* The italic writing in the tables indicates that the text has been taken from the original text in French.

**Table 13—Location in ASME BPVC of Paragraphs Equivalent to RCC-M Paragraphs about Materials from Sections I and II**

| RCC-M Section II | Section Title | ASME Section II | Section Title |
|---|---|---|---|
| M 000 | *Généralités* (General Provisions) | Part A | Material Specifications – Ferrous |
| M 1000 | *Aciers non alliés* (Carbon steels) | | |
| M 2000 | *Aciers Alliés* (Alloy Steels) | | |
| M 3000 | *Aciers Inoxydables* (Stainless steels) | | |
| M 4000 | *Alliages Spéciaux* (Special alloys) | Part B | Material Specifications – Non-Ferrous |
| M 5000 | *Divers* (Miscellaneous) | | |
| M 6000 | *Fontes* (Iron Castings) | Part C | Material Specifications – Welding Rods, Electrodes and filler Metals |
| **RCC-M Section I** | **Section Title** | **ASME Section II** | **Section Title** |
| 2000 paragraphs | *Matériaux* (Materials) | 2000 paragraphs | Material |
| Section Z-ZI | *Caractéristiques des matériaux à utiliser pour la conception* (Properties of materials to be used in Design) | Part D | Properties |

* The italic writing in the tables indicates that the text has been taken from the original text in French.

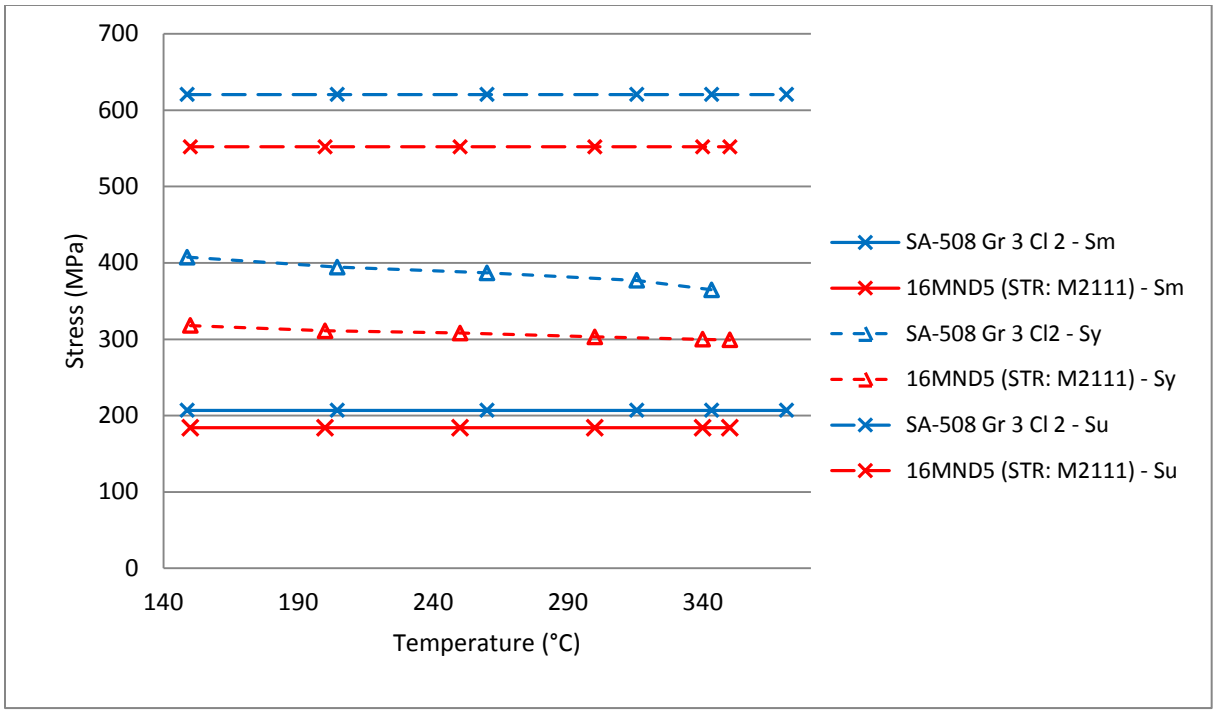


**Figure 20—Design Stress ($S_m$), Yield Stength ($S_y$) and Ultimate Strength ($S_u$) Comparison of Two Carbon Steels, SA-508 Gr 3 Cl2 and 16MND5 (M2111)**

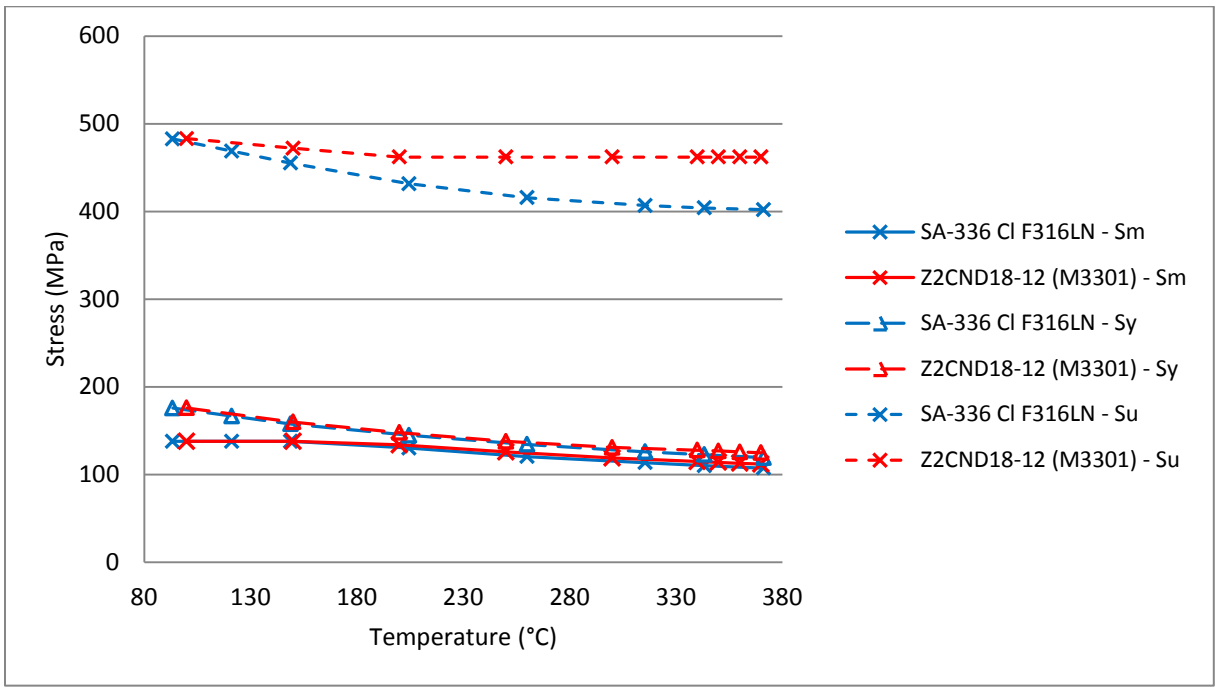


**Figure 21—Design Stress ($S_m$), Yield Stength ($S_y$), and Ultimate Strength ($S_u$) Comparison of Two Carbon Steels, SA-336 Cl F316LN and Z2CND18-12 (M3301)**

**Table 14—AFNOR 16MND5 (STR: M2111) as per RCC-M and SA-508 Grade 3 as per ASME – Specification for Quenched and Tempered Vacuum-Treated Carbon and Alloy Steel Forgings for Pressure Vessels**

| | Ladle analysis % | | Product analysis % | |
|---|---|---|---|---|
| | 16MND5 | | SA-508 Grade 3 Class 1 | |
| **Element** | **M2111** | **SA508** | **M2111** | **SA-508+SA-788** |
| Max. Carbon | 0.20 | 0.25 | 0.22 | 0.25 |
| Manganese | 1.15-1.55 | 1.20-1.50 | 1.15-1.60 | 1.20-1.50<br>Variation 0.03 ~ 0.09 |
| Max. Phosphorus | 0.008 | 0.025 | 0.008 | 0.025 |
| Max. Sulphur | 0.005 | 0.025 | 0.005 | 0.025 |
| Silicon | 0.10-0.30 | 0.40<br>0.15 when required | 0.10-0.30 | 0.40<br>0.15 when required |
| Nickel | 0.50-0.80 | 0.40-1.00 | 0.50-0.80 | 0.40-1.00<br>Variation 0.03 |
| Max. Chromium | 0.25 | 0.25 | 0.25 | 0.25<br>Variation 0.03 ~ 0.06 |
| Molybdenum | 0.45-0.55 | 0.45-0.60 | 0.43-0.57 | 0.45-0.60<br>Variation 0.03 ~ 0.08 |
| Max. Vanadium | 0.01 | 0.05 | 0.01 | 0.05<br>Variation 0.01 |
| Max. Columbium | – | 0.01 | – | 0.01 |
| Max. Copper | 0.08 | 0.20 | 0.08 | 0.20 |
| Max. Calcium | – | 0.015 | – | 0.015 |
| Max. Boron | – | 0.003 | – | 0.003 |
| Max. Titanium | – | 0.015 | – | 0.015 |
| Aluminum Max.<br>Preferred Max. | –<br>0.04 | 0.025<br>– | 0.04<br>– | 0.025<br>– |
| Max. Cobalt | 0.03 | – | 0.03 | – |

**Table 15—Comparison of Chemical Composition Requirements in M2111 for 16MND5 through the Years, and in SA-508 and SA-788 for SA-508 Grade 3 Class 1**

| Elément (% massique) | 1,2MDO7 SENA 1961 | SA 508 Cl3 CPFC 1974 | 16MND5 RCC.M 1980 | 1983 | 1985 | 1988 |
|---|---|---|---|---|---|---|
| Carbone max. | 0,23 | 0,20 | 0,20 | 0,20 | 0,20 | 0,20 |
| Manganèse | 1,0/1,5 | 1,2/1,5 | 1,15/1,55 | 1,15/1,55 | 1,15/1,55 | 1,15/1,55 |
| Phosphore max. | 0,025 | 0,012 | 0,012 | 0,008 | 0,008 | 0,008 |
| Soufre max. | 0,025 | 0,015 | 0,010 | 0,008 | 0,008 | 0,008 |
| Silicium | 0,15/0,35 | 0,15/0,35 | 0,10/0,30 | 0,10/0,30 | 0,10/0,30 | 0,10/0,30 |
| Nickel | 0,30/0,70 | 0,40/0,80 | 0,50/0,80 | 0,50/0,80 | 0,50/0,80 | 0,50/0,80 |
| Chrome max. | 0,20 | 0,25 | 0,30 | 0,25 | 0,25 | 0,25 |
| Molybdène | 0,35/0,55 | 0,45/0,60 | 0,45/0,55 | 0,45/0,55 | 0,45/0,55 | 0,45/0,55 |
| Vanadium max. | | 0,01 | 0,01 | 0,01 | 0,01 | 0,01 |
| Cuivre max. | 0,25 | 0,10 | 0,10 | 0,08 | 0,08 | 0,08 |
| Cobalt max. | 0,02 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 |

**Table 16—Charpy Impact Test Values for AFNOR 16MND5 (STR: M2111) as per RCC-M and SA-508 Grade 3 as per ASME**

| | Test Temperature | Properties | Required Value | |
|---|---|---|---|---|
| | | | Axial Direction | Circumferential Direction |
| M2111 | 0°C | Min. average value | 80J | 80J |
| | | Min. individual value | 60J | 60J |
| | -20°C | Min. average value | 40J | 56J |
| | | Min. individual value | 28J | 40J |
| | +20°C | Min. individual value | 104J | 120J |
| SA-508 | 4.4°C | Min. average value | 41J | |
| | | Min. individual value | 34J | |

**Table 17—Typical Material Specification Comparison for the RCC-M (left) and ASME (right)**

| RCC-M Typical Material Specification (Section II – Part 1 & 2) | | ASME Typical Specification (Section II – Part A) | |
|---|---|---|---|
| M 2111 | PART PROCUREMENT SPECIFICATION - MANGANESE-NICKEL-MOLYBDENUM ALLOY STEEL FORGINGS FOR PRESSURIZED WATER NUCLEAR REACTOR SHELLS IN THE BELTLINE REGION | SA-508/ SA-508M | SPECIFICATION FOR QUENCHED AND TEMPERED VACUUM6TREATED CARBON AND ALLOY STEEL FORGINGS FOR PRESSURE VESSEL |
| 0 | SCOPE | 1 | SCOPE |
| 1 | MELTING PROCESS | 2 | REFERENCED DOCUMENTS |
| 2 | CHEMICAL REQUIREMENTS | 2.1 | ASTM Standards |
| 2.1 | REQUIRED VALUES | 2.2 | ASME Standard |
| 2.2 | CHEMICAL ANALYSES | 3 | ORDERING INFORMATION |
| 3 | MANUFACTURE | 4 | MATERIALS AND MANUFACTURE |
| 3.1 | MANUFACTURING PROGRAMME | 4.1 | MELTING PROCESS |
| 3.2 | FORGING | 4.2 | HEAT TREATMENT |
| 3.3 | MACHINING | 4.3 | AUSTENITIZING PROCEDURE |
| 3.4 | DELIVERY CONDITION - HEAT TREATMENT | 5 | CHEMICAL COMPOSITION |
| 3.5 | STRUCTURE | 5.1 | HEAT ANALYSIS |
| 4 | MECHANICAL PROPERTIES | 5.2 | PRODUCT ANALYSIS |
| 4.1 | REQUIRED VALUES | | |
| 4.2 | SAMPLING | 6 | MECHANICAL PROPERTIES |
| 4.3 | TESTING OF REPRESENTATIVE AS-DELIVERED PART SAMPLES | 6.1 | TENSION TEST |
| 4.3.1 | Number and content of tests | 6.2 | IMPACT TEST |
| 4.3.2 | Additional impact tests | 7 | WORKMANSHIP AND QUALITY LEVEL REQUIREMENTS |
| 4.3.3 | Test procedure | 8 | NONDESTRUCTIVE INSPECTION REQUIREMENTS |
| 4.4 | RETREATMENT | 8.1 | GENERAL REQUIREMENTS |
| 4.5 | TESTING OF SAMPLES SUBJECTED TO SIMULATED STRESS-RELIEVING TREATMENT | 8.2 | MAGNETIC PARTICLE INSPECTION |
| | | 8.3 | ULTRASONIC INSPECTION |

**Table 15—Typical Material Specification Comparison for the RCC-M (left) and ASME (right) (cont.)**

| RCC-M Typical Material Specification (Section II – Part 1 & 2) | |
|---|---|
| 5 | BASE MATERIAL TEST COUPONS |
| 6 | SURFACE EXAMINATION - SURFACE DEFECTS |
| 7 | VOLUMETRIC EXAMINATION |
| 7.1 | TIME OF EXAMINATION |
| 7.2 | PROCEDURES |
| 7.3 | SCANNING PLAN AND DEGREE OF EXAMINATION |
| 7.4 | EVALUATION OF INDICATIONS |
| 7.5 | RECORDABLE CONDITIONS AND EXAMINATION CRITERIA |
| 8 | REMOVAL AND REPAIR OF UNACCEPTABLE AREAS |
| 9 | DIMENSIONAL CHECK |
| 10 | MARKING |
| 11 | CLEANLINESS - PACKAGING - TRANSPORTATION |
| 12 | TEST REPORTS |
| ANNEX 1 TO SPECIFICATION M 2111 | |
| DETERMINATION OF $RT_{NDT}$ TEMPERATURE | |

| ASME Typical Specification (Section II – Part A) | |
|---|---|
| 9 | REPAIR WELDING |
| 10 | CERTIFICATION AND REPORTS |
| 11 | PRODUCT MARKING |
| 12 | KEYWORDS |
| | |
| SUPPLEMENTARY REQUIREMENTS | |
| S1 | Simulated Post-Weld Heat Treatment of Mechanical Test Samples |
| S2 | Ultrasonic Testing-Reference Block Calibration |
| S3 | Charpy V-Notch Impact Transition Curve |
| S4 | Additional Charpy Data |
| S5 | Alternative Impact Test |
| S6 | Drop-Weight Test |
| S7 | Restrictive Chemistry for Grades 4N and 5 |
| S8 | Additional Vanadium |
| S9 | Restrictive Chemistry for Grades 2, 3 or 4N |
| S10 | Alternative Fracture Toughness Requirements |
| S11 | Vacuum Carbon-Deoxidized Steels |
| S13 | Minimum Tempering Temperature |
| S14 | Cooling from the Tempering Temperature |
| S15 | Product Analysis |
| S16 | Silicon Content |

## 4.5 Design

**Highlights**

- Different limits and rules of reinforcement approach for vessel openings in RCC-M (RCC-M Appendix ZA and through finite element analysis).
- RCC-M requirements for additional justification for Class 1 vessel Stress Classification; generally, RCC-M C 3000 table can be used.
- Some differences in allowable stresses, in particular associated with nonlinear analysis.
- Differences in fatigue analysis, such as differences in strain correction factor $K_e$ or crack-like defect analysis.
- Differences in rupture analysis, larger scope and more detail analysis in RCC-M (in accordance with RCC-M Appendix ZG, more prescriptive than ASME III Appendix G).

This part covers the sections on design of the two codes: Section 3000 of the Volume B in Tome I of the RCC-M Code and the Chapter 3000 of Section III Division 1, Subsection NB of the ASME Code.

RCC-M has a specific volume for small components (vessels, piping, pumps, and valves under a certain pressure, and certain sizes): Volume E. There is no similar Chapter in ASME III.

These parts covering design are overall quite comparable as far as the restrictions, stress limits, and even wording of the paragraphs. Table 18 draws a parallel between the organizations of these two codes and this makes the comparison relatively straightforward.

As far as the contents are concerned, some similarities are obvious. For instance, the general stress analysis philosophy is the same: both are based on stresses calculated using elastic calculations and the Tresca Stress Intensity as a yield criterion. Both codes also require the issuance of a stress report to demonstrate the compliance of the design to the requirements. But the part of interest for this report, and the rest of this section, is the differences between the codes.

The first difference that will be addressed here is the reinforcement of openings. A second part will then present how the stresses are classified in both codes and a third section will make a comparison between the categories dealt with. Finally, a deeper insight of fatigue analysis will be given in a fourth subsection.

First, concerning the openings in the vessel wall, the approach between the two codes is quite different. As stated in the ASME Code, there are clear mandatory rules to follow when it comes to design openings in vessels and especially how to reinforce them to facilitate the stress analysis. A reinforced opening as per ASME Section III, Division 1, NB-3334 will typically not require a detailed calculation of the stresses outside a so-called limit of reinforcement. This limit defines a zone where a sufficient amount of material that was taken away from the vessel when punching the opening has been compensated for on either side of the opening. In practice, calculations using the classic continuum mechanics equations will be sufficient to demonstrate the compliance of the opening with ASME rules for all or simple nozzle designs. It is not fully adapted for modern nozzle designs that are more “progressive” and “smoother” than previous designs.

Conversely, in the RCC-M Code, these rules are stated in the nonmandatory appendices (Appendix ZA). The reinforcement of openings for design is an indication that may or not be followed. In practice, this will translate to an additional effort in analysis and calculations to obtain a more optimized design.

It is important to note at this point that with modern types of nozzles; for instance, with the smooth transition profiled nozzles fabricated with an extrusion process versus the former welding of the

nozzle on the vessel, it has become more and more difficult to apply the limit of reinforcement rules from the ASME. The RCC-M Code, by shifting the limit of reinforcement method to the nonmandatory appendix, demonstrates an evolution to incorporate rules for this modern type of nozzle, which offers better design.

In addition, although the general design philosophy is comparable, another difference lies in the stress classification. In both codes, the calculated stresses are first organized in various categories depending on the nature of the stress. As an example, a stress due to a pressure inside a recipient will not be of the same nature as a stress due to temperature effects and, hence, requires a classification system. The ASME BPVC is very instructive about this classification and gives numerous examples and even tables illustrating this classification (Section III Division 1, paragraphs NB-3217-1 and NB-3217-2).

The RCC-M Code is much less explicit and even states that "*In case of doubt, the damage mechanisms must be considered when resolving the practical problems presented by these operations.*" (RCC-M Tome I, Section B-3231.1). In practical applications, the RCC-M C 3000 table can be used (not mentioned in the 2007 Code Edition). What can seem like a minor discrepancy may have a significant impact in practice: when presenting the stress analysis work, the analyst will be expected to present at least a short explanation of the stress classification methodology used. This will force the analyst to fully master and comprehend the analysis techniques retained. (This last point is required by QA; the analyst has to be familiar with the Code background, in particular for Class 1 components.)

Concerning the levels of analysis and the criteria to be applied for each service level, see

Table 19. The first difference is that the acceptance criterion for Level B is equivalent to that for the Level 0 criterion in the RCC-M 2007, which is more conservative. It should be noted here that Level B has been added in versions of the RCC-M issued from 2007 onward.

The ASME Code gives slightly more stringent criteria for the Design Limits, especially concerning the membrane plus bending stress limits, as can be read in ASME Section III Division 1 NB-3221.3.

Concerning the Collapse Load analysis found in ASME Section III Division 1, NB-3228.1 and NB-3228.2, and RCC-M Tome I Sections B-3241 and B-324, both codes permit the use of limit (elastic-perfectly plastic) analysis or experimentation to determine the lower-bound collapse load, as an alternate method to satisfying the requirements for some primary stress limits. The ASME Code, being more restrictive, requires the use of $1.5S_m$ for the yield strength in an analysis, while the RCC-M permits the use of the yield strength. The ASME Code permits the use of two-thirds collapse load as an alternative for satisfying the Design Condition stress limits for General Primary Membrane Stress, $P_m$ (NB-3221.1), Local Primary Membrane Stress, $P_L$ (NB-3221.2) and Primary Membrane ($P_L$ or $P_m$) plus Bending Stress ($P_b$) (NB-3221.3). The RCC-M allows the use of two-thirds collapse load as determined by alternate analysis or testing in place of satisfying only Level 0 $P_L$ (B-3233.2) and $P_L$ or $P_m + P_b$ (B-3233.3) stress limits. Both codes allow similar use of collapse load limits for Level C, Level D, and Test, for external pressure.

Both the ASME and RCC-M permit the use of alternative analysis using actual material stress-strain relationships (plastic) analysis or experimentation to determine the plastic analysis collapse load, as an alternate method to satisfying the requirements for some primary stress limits ($P_L$ or $P_m + P_b$). For the Design Condition, ASME Section III Division 1, NB-3228.3 allows use of two-thirds the plastic collapse load, while the RCC-M Tome I, Section B-3243 limits the Level 0 loading to 0.4 times the instability load. The Level C limit is 120% (0.5 times the instability load) of Level 0 or the Design Condition, and Level D and Test limits are similar.

Turning to Level A Service Loadings and fatigue analysis, a first significant difference is the definition of the $K_e$ factor (see detailed table in appendix, line NB 3222). When the stress range in

fatigue analysis exceeds the given allowable ($3S_m$, as given in ASME Section III Division 1, NB-3228.5 and RCC-M Tome I Section B-3234.3), both codes permit the calculation of a strain correction factor $K_e$ in consideration of a simplified elastic-plastic analysis (NB-3228.5 and B 3234.6), but the formulae to calculate this factor are different.

For austenitic steels as well as the nickel-chromium-iron alloys, the RCC-M has separate expressions for the calculation of $K_e$ for the mechanical contribution to the stress range and the thermal contribution to the stress range. The ASME, more conservativly, uses the same expression for the combined mechanical and thermal stress range. This implies a noticeable difference in practice for fatigue results for austenitic steels as well as the nickel-chromium-iron alloys. Figure 22 shows the corresponding curves for the $K_e$ values. See Figure 22 for illustration of these differences.

Still concerning Level A criteria, the RCC-M Tome I Section B-3234.7 gives advice about any geometrical discontinuity and indicates special finite element modeling requirements in Appendix ZD. The latter contains a method on how to analyze geometrical singularities.

The ASME, on the other hand, specifies Strength Reduction Factors, defined in NB-3213.17, to address fatigue crack initiation: ASME NB-3352.4 (d-5) indicates, for instance, that a Strength Reduction Factor of no less than 4 should be used. If no factor is specified in the Owner Design Specification, the ASME leaves it to the analyst's discretion to make the decision with the associated justifications. See Table 20 for factor of safety comparison between the two codes.

Turning to fracture analysis, both the ASME Code (NB-3211, Appendix G) and RCC-M (B 3260, Appendix ZG) require an evaluation of the vessel design for protection against fracture. The ASME Code focuses on non-ductile failure of ferritic materials, while the RCC-M examines both ductile and non-ductile fracture, for austenitic or austenitic-ferritic materials, and ferritic materials, respectively.

Except for Class 1 reactor pressure shells, the RCC-M provides exemptions from evaluation based on material properties.

The second level is based on large reference defects. Postulated flaws applied in the evaluations are similar between the two codes (except for RCC-M, where the maximum flaw depth is 20 mm instead of 1/4 t in ASME, including thick wall). For thick vessels, 1/4 wall thickness with a width-to-length ratio of 1/6 is used, except near nozzle corners for the RCC-M, where the width-to-length ratio of 1/2 is prescribed. The RCC-M requires the crack center, as well as the ends, to be evaluated. Examinations for the ASME Code are based on crack tip stress intensity, $K_I$, while the RCC-M requires examination of either crack tip stress intensity, $K_{cp}$ (elastic KI plus plasticity effect correction factor), or crack extension force, J, for the ductile evaluation. All the detailed formulae for elastic $K_e$ evaluation of all locations are attached to RCC-M through RSE-M Appendix 5; nothing similar is available in ASME III Code. Particular attention is required on dissimilar-metal welds in RCC-M (methods and data are analyst responsibilities); nothing similar is available in ASME III Code.

Both codes allow for a conservative simple calculation method and a more detailed calculation method, when the simple evaluation is too conservative.

The detailed methods are similar to some extent, but more detailed for the RCC-M. RCC-M provides simple, conservative rules for consideration of the plastic zone at the crack tip.

If exemption rules and reference large defect criteria cannot exceptionally be fulfilled, RCC-M permits the detailed methods of determining flaw size based on in-service crack monitoring (RSE-M, Appendix 5.4) with an associated pre-service inspection of the location.

The ASME allows the use of the Welding Research Council Bulletin WRCB-175 for determination of the critical flaw size, which also considers the effect of the plastic zone at the crack tip, but only when WRCB-175 is to be applied.

The critical stress intensity factor, $K_{IC}$, used as an acceptance criterion for flaw size, is based on static initiation fracture toughness obtained under slow loading conditions for both codes.

Factors of Safety to be applied for Level A-B service levels are nearly the same but the ASME Code does not require any factors for Level C and D. Both codes require the effects of irradiation on the fracture toughness to be considered, but the RCC-M also prescribes methods for consideration, as well as consideration of thermal aging and strain aging (that are mainly used during periodic safety review of existing plants).

Overall, the ASME Code has a limited scope, based on simple assumptions (some are conservative, some are not, some are based on very old data, and so on) with respect to design, while the RCC-M is more prescriptive and detailed with respect to analytical requirements and provides an increased understanding of margins.

Both codes use their design methods for pressure-temperature limits of PWRs in operation.

RSE-M uses the reference defect analysis and margins to define its In-Service-Inspection program; this justifies the need for “realistic and conservative” methods and data to reach an understanding of margins. Today, analyses of all Class 1vessel welds and cast materials are systematically required by different regulators or different owner design specifications. RCC-M answers to these latest requirements; ASME BPVC Section III needs more investment of the analyst in terms of methods and material properties. Many important decisions on this “rupture” topic have to be made quite early in the design of new plants to ensure safety and optimum operation.

Finally, both the ASME and RCC-M permit the use of alternative analysis using actual material stress-strain relationships (plastic) analysis to evaluate for progressive deformation under cyclic loading, as an alternate method to satisfying the requirements for thermal stress ratchet (NB-3222.5 or B 3234.8) and progressive distortion of non-integral connections (NB-3227.3 or B 3238.3). Either code allows plastic analysis strain range results to be applied in the fatigue analysis, in determining the alternating stress. The ASME Code is less restrictive as it allows exemptions from shakedown analysis for ductile materials.

To sum up, one main conclusion is that the requirements from the two codes are similar with respect to both the methods for primary stress evaluation as well as specification of allowable limits.

The RCC-M nevertheless includes more experience feedback for the analysis related to two major failure modes, fatigue and fracture, that need more state-of-the-art methods and data, to reach a better understanding of margins and make decisions early in the design process of new plants or components. This detailed understanding of margins is also important for the definition of an optimum In-Service Inspection program.

### 4.5.1 Piping, Valves, and Pumps

**Highlights:**

- Major differences for pumps, valves and piping are associated with design rules; the principles for material selection, fabrication-welding, and control are extremely similar between vessel and piping, pumps, and valves.
- RCC-M proposes to use B 3300 and B 3200 to design piping, pumps, and valves; ASME III proposes to use only NB 3300.
- No fatigue exemption rules in RCC-M, but optimized fatigue analysis rules as for vessels, supplemented by a particular piping fatigue analysis appendix (Appendix ZE).
- For pumps, the RCC-M scope is more limited than ASME III in pump types.

- For valves, particular body shape rules for internal radius are proposed by RCC-M for fatigue-sensitive valves
- For piping, the level A criteria (equation 10), the stress indices, and the seismic criteria are different between RCC-M B 3600 and ASME III NB 36000.

#### 4.5.1.1 Pumps

For pumps, the scopes of RCC-M B 3400 and ASME III NB 3400 are very similar.

Small pumps less than 165 kW are covered by subsection E in RCC-M, whereas no small pumps (DN < 100) are considered in ASME III.

The RCC-M scope is limited to centrifugal/single-volute casing pumps and ASME III considers more different types of pumps.

The design requirements are similar for both codes: ASME III NB 3350 or RCC M B 3350, RCC-M accept the use of B 3200 instead of B 3300; more severe requirements in RCC-M to consider external loads ($P_{eb}$) than in ASME III; same differences with vessels for fatigue analysis ($K_e$ optimization and crack-like defects) and rupture analysis.

For bolting, the rules are similar.

For supports, ASME III proposes subsection NF and RCC-M subsection H, which are similar.

A design report is required for DN 100 or over in ASME III, and DI 25 mm in RCC-M

#### 4.5.1.2 Valves

The scope is similar but, the RCC-M does not cover bellows, springs, and diaphragms and there are no particular rules for pressure relief valves in RCC-M. The ratings are limited in RCC-M to PWR operating conditions, larger number of ratings in ASME III; same as for pumps.

One difference in body shape rules for valves sensitive to thermal fatigue: r3 is limited to $0.05t_m$ (fig. NB 3544.1(c)-1) in ASME III NB 3500 and 0.1 $T_r$ (fig. B 3544.1.b) in RCC-M B 3500.

The same differences exist as for vessels for fatigue analysis ($K_e$ optimization and crack-like defects) and rupture analysis.

#### 4.5.1.3 Piping

The scope is similar and the differences very similar to those for pumps and valves (no miters and no non-welded piping joints permitted in RCC-M).

The complementary differences are:

- In level C, the ASME III NB 3600 criterion is $2.25S_m$ instead of $1.9S_m$ in RCC-M B 3600.
- In level A, $\Delta T_1$ is included in RCC-M equation (10) but not in ASME III 2007 (it was in earlier ASME editions but was removed); $K_e$ is more realistic in RCC-M than in ASME III for fatigue analysis (see Figure 22).
- No fatigue analysis exemption rules exist for Class 1 piping in RCC-M.
- Class 2 design rules for non-fatigue-sensitive piping are not accepted in RCC-M.
- A particular appendix is proposed in RCC-M for piping system fatigue analysis (Appendix ZE); less severe than basic rules.
- The stress indices are also different between ASME III and RCC-M.

**Table 18—Location in ASME BPVC of Paragraphs Equivalent to RCC-M Paragraphs About Design**

| RCC-M Tome I Section B-3000 | Section Title | ASME Section III Division I NB-3000 | Section Title |
|---|---|---|---|
| B-3100 | *Règles générales de conception* (General Design Rules) | NB-3100 | General Design |
| B-3200 | *Règles générales d'analyse du comportement des matériels* (General Rules for analyzing components behaviour) | NB-3200 | Design by analysis |
| B-3300 | *Conception générale des recipients* (General Vessel Design) | NB-3300 | Vessel Design |
| B-3400 | *Conception générale des pompes* (Pump Design) | NB-3400 | Pump Design |
| B-3500 | *Conception générale des organs de robinetterie* (General Design of Valves) | NB-3500 | Valve Design |
| B-3600 | *Conception des tuyauteries* (Piping Design) | NB-3600 | Piping Design |

**Table 19—ASME and RCC-M Loading Category and Applied Criteria**

| RCC-M Loading Categories | | RCC-M Applied Criteria | ASME Loading Categories | ASME Applied Criteria |
|---|---|---|---|---|
| *Situation de Référence* (Design Case) | | *Niveau* 0 (Level 0) | Design Loadings | Design Limits |
| *Situation de deuxième catégorie* (Second category situations) | *Situations normales* (Normal situations) | *Niveau A* (Level A) | Service Loadings | Level A Service Limits |
| | – | – | | Level B Service Limits |
| *Situation de troisième catégorie* (Third category situations) | | *Niveau C* (Level C) | Level C Loads | Level C Limits |
| *Situation de quatrième catégorie* (Fourth category situations) | | *Niveau D* (Level D) | Level D Loads | Level D Limits |
| *Situations d'essai* (Test situation) | | *Niveau T* (Level T) | Test Loadings | Test Limits |

**Table 20—Factors of Safety for Ferritic Materials**

| | ASME | RCC-M | ASME | RCC-M | ASME | RCC-M |
|---|---|---|---|---|---|---|
| **Service Level** | **Primary Membrane Stress** | | **Primary Membrane + Bending Stress** | | **Primary and Secondary Membrane + Bending Stress** | |
| Level A and B | 3.0 | 2.0(1) | 3.0 | 2.0(1) | 1.0 | 2.0(1) |
| Level C | (2) | 1.6(3) | (2) | 1.6(3) | (2) | 1.6(3) |
| Level D | 1.5 | 1.2(4) | 1.5 | 1.2(4) | (2) | 1.2(4) |
| Test | 1.5 | 1.0 | 1.5 | 1.0 | 1.0 | 1.0 |

Notes:

1. Except above the transition temperature range, where 1.6 can be used.
2. Not Applicable
3. Except above the transition temperature range, where 1.3 can be used.
4. Except above the transition temperature range, where 1.0 can be used.

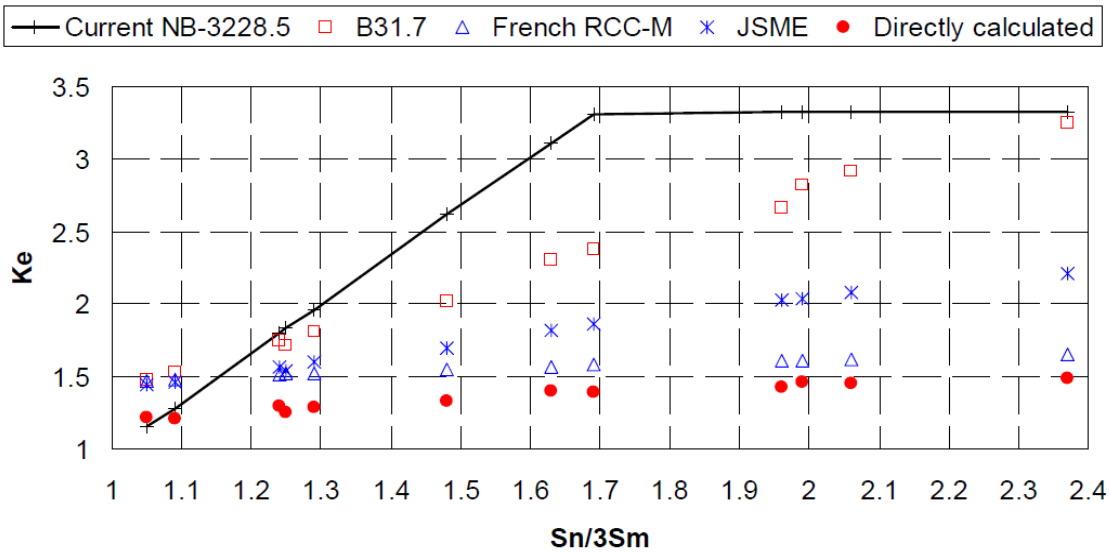


**Figure 22—$K_e$ vs. $S_n/S_m$ Curves per ASME, RCC-M, JSME and Direct Calculation (Gurdal and Xu, PVP 2008)**

## 4.6 Fabrication – Welding

**Highlights**

- To qualify a material manufacturer process per RCC-M, a qualification piece is required before fabrication for components listed in M 141 and M 160 in Section II.
- Test coupons are required even after welding qualification in the RCC-M.
- Brazing is not covered in RCC-M, nor is capacitor discharge welding.
- Attachments and appurtenances for welding are dealt with in detail in ASME.
- Friction welding is not covered in ASME.
- Hubbed flanges are not covered in RCC-M for Class 1 equipment.
- Cleanliness requirements during fabrication and assembly are covered in RCC-M Section III F-6000 and are under owner responsibility in ASME.
- The differences of format and documentation requirements can lead to deviation in front of each national authority, although the manufacturing processes are similar in the two codes.

Welding is included in Section IV of the RCC-M Code and the equivalent provisions can be found in parts of Section III Division 1 NB paragraphs and parts of Section IX of the ASME BPVC.

This part begins with differences in welding qualifications. A second paragraph then highlights how different the weld processes are, and finally, a third section analyzes the weld examination methods.

Concerning the weld and welding process qualification, the RCC-M stipulates that the ISO norms should be followed. Turning to Section IV Section S-3200 for instance, a foreword indicates that the rest of the section will be in accordance with the prescriptions from the norm NF EN ISO 15614-1. In the following paragraphs, the numbering is virtually the same as in the norm. It should nevertheless be noted here that additional requirements exist in the RCC-M that may not be found in the norm. In the ASME, the welds and welding process qualification should be done as per Section IX and additional provisions specific to the nuclear industry in Section III.

ASME and RCC-M have a similar approach of Procedure of Qualification Record (PQR) and Welding Procedures (WP). The manufacturer or contractor, as stated respectively in Section IX QW 200.2 in ASME or in quality assurance management requirements in Section I A-5000 in RCC-M, reviews and certifies the PQR and WP. The RCC-M requires in Section I, Sections ZZ-400 and ZY-400 that a Notified Body review the WP or PQR (Appendix A – line NB-4310).

Finally, to conclude this paragraph, and concerning documentation for welding in general, it has to be noted that the format of documentation is different in ASME and RCC-M for PQR and Weld Procedure Specification (WPS), even if the process is identical in itself and differs only by a few parameters. As an example, first taking the RCC-M Section IV S-3150, there is a list of reports to provide to approve the welding procedure qualification. One of these relates to the acceptance of filler material. The code then refers to Section IV S-2000 and gives in S-2800 and S-2900 reference data sheets for filler material. This reference is interesting because, although it appears not to be compulsory to strictly follow this layout, it provides an example of a typical data sheet in the RCC-M Code philosophy. An example of this sheet necessary in the Welding Procedure Qualification can be seen in Figure 23.

On the other hand, the Welding Qualification Procedure is provided in detail in the ASME BPVC Section IX QW 200.2. In this part, it refers to a series of reference nonmandatory documents located in Section IX Nonmandatory Appendix B. An example of one sheet is given Figure 24.

Both codes include welding techniques that the other code does not deal with and/or designates as prohibited. The first example is friction welding: it is excluded from use for pipes in the ASME BPVC Section III Division 1 NB-4311.4 but allowed in the RCC-M Code (Appendix A – line NB-4311). An interesting account of a practical example of how the gap was bridged to qualify friction welding in the U.S. is given in Reference [3]. This consists of a practical example of a component manufactured in France but destined for the American market.

On the other hand, the ASME BPVC mentions capacitor discharge welding in Section III Division 1 NB-4311.2, whereas this process is not mentioned anywhere in the RCC-M (Appendix A – line NB-4311).

The ASME BPVC has dedicated a whole paragraph to brazing, Section III Division 1 NB-4500. This process can essentially be used, as specified by the ASME BPVC, for attachment of cladding to the base material and of tubes to tubesheets. Appurtenances and piping filling specific criteria may be brazed also (Appendix A – line NB-5000). This process is not dealt with in the RCC-M and for the previous example, the manufacturing processes used are described in Section IV S-3600 and S-3700.

Finally, RCC-M can be more conservative when it comes to examination of the weld. A first example is for volumetric examination of ferritic welds in Class 1 components: RCC-M Section IV Section S-7713.2 specifies that such examination requires the use of both radiographic and ultrasonic techniques while the ASME Section III Division 1 Section NB 4400 does not include this same requirement (Appendix A – line NB-4400). Nevertheless, in practice, this requirement is typically applied based on design specification requirements.

Furthermore, and comparing the preparation of the test coupons and specimens dealt with in ASME Section III Division 1 Section NB 4334 and in the RCC-M Section IV S-3000, it can be seen that the tests are different. First, the $RT_{NDT}$ is not required for all materials in RCC-M, whereas it is required for all materials in ASME. On the other hand, chemical analysis is required in RCC-M but not in ASME (Appendix A – line NB 4334).

In addition, RCC-M permits no undercut as can be seen in RCC-M Section IV, Sections S-7460 and S-7714 for Class 1 and 2 welds. On the other hand, ASME Section III, Section NB-4424.1 permits 1/32 inch (1 mm). This stems from the fact that the French authorities have identified undercuts as being a potential cause for weld failure (Appendix A – line NB-4334).

Moreover, multiple test coupons are to be taken as instructed in RCC-M Section IV, Section S-7800. For the most part of the equipment manufactured, test coupons will be necessary to demonstrate the know-how of welders but also necessary for every WPS and component, even after a welding procedure has been qualified. On the other hand, the ASME does not require so many test coupons after the qualification of the welding procedure. ASME will typically rely in practice on manufacturer work under survey of a third party (either ANI or AIA).

Fabrication is mentioned in Section I of the RCC-M but most of the instructions related to fabrication are included in Section V. It should also be noted that Section II Section M-100 includes some requirements related to prequalification of equipment before “mass production.” The Fabrication and Installation paragraphs can all be found in Section III of the ASME.

Both codes contain a first section on the pre-fabrication stage. The next paragraph lists in more detail the discrepancies related to the fabrication part itself.

The RCC-M states in Section II M-140 that a qualification is necessary for material or part supplier of a component in the list M-141, thereby requiring the workshop to forge the first piece to demonstrate its capability to complete the task, monitoring all parameters of forging while doing so. For future pieces, it is not necessary to demonstrate the monitoring of all the same parameters if the manufacturer has already been qualified as per the RCC-M to produce parts and can demonstrate

continuity in competencies. This process philosophy from the RCC-M is based on evidence of monitoring the right production parameters by the part manufacturer. After the successful completion of the qualification piece, the batch of equipment can be produced, but only within the limits defined by the qualification piece. Overall, RCC-M aims at providing evidence on actual material for the qualification piece. It should be noted that, depending of the country of regulation, a third party will be mandatory, in addition to RCC-M requirements. Concerning the so-called qualification piece or "prototype," it should be highlighted here that it should be treated as a first-of-a-kind type part, does not have to be scrapped, and can be used industrially as long as it shows the adequate level of quality.

On the other hand, the ASME BPVC considers that a qualified supplier has knowledge that allows manufacture of parts, validated through the following approach.

- Qualification program and certification (NCA 3800, for example) of the material producer
- Mandatory procurement specification taking into account owner and designer requirements
- Acceptance by third party (ANI or AIA) of final forged part for integration in equipment

If the Designer orders a part correctly, a third party (ANI or AIA) will check that the performance specified for the part manufacturing is adequate, with the right implementation of the know-how of the manufacturer.

Concerning the Fabrication itself, the RCC-M is, overall, more prescriptive than the ASME and this can be illustrated by the following examples.

First, the RCC-M lays down very stringent steps to follow concerning forming, bending, and cutting. Documentation is necessary (Section V F-4112), the qualification process and tests follow a very detailed process (Section V F-4120), and the results of the qualification can be subject to examination by Inspectors (Section V F-4126).

The RCC-M has grouped all experience feedback related to cleanliness in a dedicated section of the code, Section V Section F-6000. The ASME BPVC does not have an equivalent section pertaining to cleanliness requirements. Part of basic cleanliness requirements can be found in various sections of the ASME BPVC, such as Section III Division 1 NB-4412, pertaining to Cleanliness and Protection of Welding Surfaces (Appendix A – line NB-4412). The RCC-M Code is particularly stringent on this aspect and it forces the workshop to have an irreproachable cleanliness to manufacture components for the nuclear industry. The ASME BPVC tends to consider implicitly this aspect as the responsibility of the owner.

Finally, Section V F-5000 of the RCC-M deals with surface treatment as a whole. It encompasses various domains ranging from cladding to painting. The ASME BPVC has, for instance, information pertaining to cladding in Section III Division 1 NB-4000 and in Section IX. However, no section dedicated specially to surface treatment can be found in the ASME BPVC.

While the ASME permits the use of fabricated hubbed flanges as specified in Section III Section NB-2125, they are excluded from use for Class 1 equipment in the RCC-M, as specified in Section I Appendix Z-V (Appendix A – line NB-2125).

**Table 21—Location in RCC-M of Paragraphs Equivalent to ASME Section III Division 1 NB-4000**

| ASME Section III NB-4000 | Section Title | RCC-M Equivalent Section(s) | Section Title |
|---|---|---|---|
| NB-4100 | General requirements | Section I B-4100 | *Généralités* (General) |
| | | Section I B-2000 | *Matériaux* (Materials) |
| | | Section IV S-7600 | *Réparation par soudage* (Repair by welding) |
| NB-4200 | Forming, fitting and aligning | Section V F-4000 | *Formage et tolérances dimensionnelles* (Forming and dimensional tolerances) |
| NB-4300 | Welding qualification | Section IV S-3000 | *Qualification de mode opératoire de soudage* (Welding procedure qualification) |
| | | Section I B-4231 | *Soudage* (Welding) |
| NB-4400 | Rules for governing making, examining and repairing welds | Section I B-4400 | *Soudages et techniques connexes* (Welding and associated techniques) |
| | | Section IV S-7000 | *Soudures de production* (Production welds) |
| NB-4500 | Brazing | Not covered | |
| NB-4600 | Heat treatment | Section IV S-1300 | *Généralités sur les traitements thermiques* (General remarks on heat treatments) |
| | | Section V F-8000 | *Traitements thermiques* (pièces et matériels) (Heat treatment (parts and components)) |
| NB-4700 | Mechanical joints | Section V F-7000 | *Assemblages mécaniques vissés* (Screwed joints) |

**Table 22—Location in ASME BPVC of Paragraphs Equivalent to RCC-M Paragraphs about Welding from Section IV**

| RCC-M Section IV | Section Title | ASME | Section Title |
|---|---|---|---|
| S 1000 | *Généralités* (General) | Section IX Part QW Article I | Welding General Requirements |
| S 2000 | *Recette des produits d'apports* (Acceptance of Filler Material) | | |
| S 3000 | *Qualification de mode opératoire de soudage* (Welding procedure qualification) | Section IX Part QW Article II | Welding Procedure Qualification |
| S 4000 | *Qualification des soudeurs en opérateurs* (Qualification of welders and operators) | Section IX Part QW Article III | Welding Performance Qualification |
| S 5000 | *Qualification des produits d'apports* (Qualification of filler materials) | Section III Division 1 Section NB-4300 | Welding Qualifications |
| S 6000 | *Qualification technique des ateliers de fabrication* (Technical qualification of production workshop) | Section IX Part QW Article III | Welding Performance Qualification |
| S 7000 | *Soudures de production* (Production welds) | Various parts of Section IX | |
| S 8000 | *Rechargements dûrs par fusion sur aciers non-alliés, faiblements alliés ou alliés* (Weld-deposited hardfacing on carbon, low-alloy or alloy steels) | Parts of Section IX | |
| **RCC-M Section I** | **Section Title** | **ASME Section I** | **Section Title** |
| Section B-4000 | *Fabrication et contrôles associés* (Fabrication and associated examination) | Section III Division 1 Section NB-4300 | Welding Qualifications |

**Table 23—Location in ASME BPVC of Paragraphs Equivalent to RCC-M Paragraphs about Fabrication from Section V**

| RCC-M Section V | Section Title | ASME | Section Title |
|---|---|---|---|
| F 1000 | *Introduction* (Introduction) | | |
| F 2000 | *Procédés de marquage* (Marking Procedure) | Section III Division 1 NB-8000 | Nameplates, Stamping and Reports |
| F 3000 | *Découpage réparation sans soudage* (Cutting repair without welding) | Section III Division 1 Section NB-4120 | Cutting, Forming and Bending |
| F 4000 | *Formage et tolérances dimensionnelles* (Forming and dimensional tolerances) | Section III Division 1 Section NB-4220 | Forming tolerances |
| F 5000 | *Traitements de surface* (Surface treatment) | Parts of Section III Division 1 Section NB-4000 cover cladding only | |
| F 6000 | *Propreté* (Cleanliness) | Parts of Section III Division 1 Section NB-4000 (ex : NB-4412) | NB-4412 – Cleanliness and protection of welding surfaces |
| F 7000 | *Assemblages Mécaniques Vissés* (Screwed joints) | Section III Division 1 Section NB-7000 | Mechanical Joints |
| F 8000 | *Traitements Thermiques (pièces et matériels)* (Heat treatment (parts and components)) | Section III Division 1 Section NB-6000 | Heat Treatment |
| **RCC-M Section I** | **Section Title** | **ASME Section I** | **Section Title** |
| Section B-4000 | *Fabrication et contrôles associés* (Fabrication and associated examination) | Parts of Section III Division 1 Section NB-4000 | |

| | | |
|---|---|---|
| **CLASSIFICATION** : E 7018 - E 380 B<br>E 420 B<br>**STANDARD** : AWS A5.1<br>NF EN ISO 2560<br>**GRADE** : Carbon steel | **PROCESS**: Manual arc<br>**TYPE OF PRODUCT**: Covered electrode | **DATA SHEET**<br>No. S 2810 |

**1) CHEMICAL ANALYSIS**

| % | C | Si | Mn | P | S | Ni | Cr | Mo | Co | Cu | V | Fe | $N_2$ | Ta Nb | Calcu-lated δ ferrite |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| In welding material | | | | | | | | | | | | | | | |
| In de-posited metal | ≤ 0.100 | ≤ 0.90 | ≤ 1.40 | ≤ 0.025(1) 0.030(2) | ≤ 0.025 | ≤ 0.30* | ≤ 0.20* | ≤ 0.30 | | ≤ 0.25 (1) | ≤ 0.04* | | | | |

**2) MECHANICAL PROPERTIES**

a) TENSILE STRENGTH

| CHARACTE-RISTICS / DEP'D METAL COND. | TENSILE STRENGTH AT ROOM TEMPERATURE | | | | TENSILE STRENGTH AT °C | | | | TENSILE AT °C | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | in MPa | | in % | | in MPa | | in % | | in MPa | | in % | |
| | $R_{p0.2}$ | $R_m$ | A | Z | $R_{p0.2}$ | $R_m$ | A | Z | $R_{p0.2}$ | $R_m$ | A | Z |
| As welded or after simulated stress relieving heat treatment in accordance with S 2534** | min. | | min. | min. | min. | | min. | min. | min. | | min. | min. |
| | Varies according to the base metal see S 2540 | | | | | | | | | | | |

b) IMPACT STRENGTH

| CHARACTE-RISTICS / DEP'D METAL COND. | KV room temperature | | KV 0°C | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | J | | J | | J | | J | | °C |
| | mean | min. | mean | min. | mean | min. | mean | min. | |
| Same as above | | | ≥ 60 | ≥ 42 | (1) | | | | |
| | | | ≥ 40 | ≥ 28 | (2) | | | | |

**3) BASE METAL - TYPE OF WELD:**

1 = Strength welds and buttering
2 = TIG root pass and seal welds
3 = Cladding

| BASE METAL | WELD 1 | WELD 2 | WELD 3 | BASE METAL | WELD 1 | WELD 2 | WELD 3 |
|---|---|---|---|---|---|---|---|
| Steels as per NF EN 10028-2 | X | | | | | | |
| Steels as per NF EN 10025-2 | X | | | | | | |
| 16 MND 5 - 18 MND 5 | X | | | | | | |
| | | | | | | | |
| | | | | | | | |

**4) COMMENTS**

* If analysis is required elsewhere (1) for class 1 components (2) for components outside class 1

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**Figure 23—Filler Material Reference Data Sheet Example for Filler Material Acceptance from RCC-M Section IV S-2800**

A08

**QW-482 SUGGESTED FORMAT FOR WELDING PROCEDURE SPECIFICATIONS (WPS)**
**(See QW-200.1, Section IX, ASME Boiler and Pressure Vessel Code)**

Company Name _____ By _____
Welding Procedure Specification No. _____ Date _____ Supporting PQR No.(s) _____
Revision No. _____ Date _____

Welding Process(es) _____ Type(s) _____
(Automatic, Manual, Machine, or Semi-Automatic)

JOINTS (QW-402) Details

Joint Design _____
Root Spacing _____
Backing: Yes _____ No _____
Backing Material (Type) _____
(Refer to both backing and retainers)

☐ Metal ☐ Nonfusing Metal
☐ Nonmetallic ☐ Other

Sketches, Production Drawings, Weld Symbols, or Written Description should show the general arrangement of the parts to be welded. Where applicable, the details of weld groove may be specified.

[At the option of the manufacturer, sketches may be attached to illustrate joint design, weld layers, and bead sequence (e.g., for notch toughness procedures, for multiple process procedures, etc.)]

*BASE METALS (QW-403)
P-No. _____ Group No. _____ to P-No. _____ Group No. _____
OR
Specification and type/grade or UNS Number _____
to Specification and type/grade or UNS Number _____
OR
Chem. Analysis and Mech. Prop. _____
to Chem. Analysis and Mech. Prop. _____
Thickness Range:
Base Metal: Groove _____ Fillet _____
Maximum Pass Thickness ≤ $^1/_2$ in. (13 mm) (Yes) _____ (No) _____
Other _____

| *FILLER METALS (QW-404) | 1 | 2 |
|---|---|---|
| Spec. No. (SFA) | | |
| AWS No. (Class) | | |
| F-No. | | |
| A-No. | | |
| Size of Filler Metals | | |
| Filler Metal Product Form | | |
| Supplemental Filler Metal | | |
| Weld Metal | | |
| Thickness Range: | | |
| Groove | | |
| Fillet | | |
| Electrode-Flux (Class) | | |
| Flux Type | | |
| Flux Trade Name | | |
| Consumable Insert | | |
| Other | | |

*Each base metal-filler metal combination should be recorded individually.

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**Figure 24—Example of Documentation Sheets to Give for Welding Procedure Specification from ASME Section IX Nonmandatory Appendix B**

A08

**QW-482 (Back)**

WPS No. _____ Rev. _____

POSITIONS (QW-405)
Position(s) of Groove _____
Welding Progression: Up _____ Down _____
Position(s) of Fillet _____
Other _____

POSTWELD HEAT TREATMENT (QW-407)
Temperature Range _____
Time Range _____
Other _____

PREHEAT (QW-406)
Preheat Temperature, Minimum _____
Interpass Temperature, Maximim _____
Preheat Maintenance _____
Other _____
(Continuous or special heating, where applicable, should be recorded)

GAS (QW-408)

| | Percent Composition | | |
|---|---|---|---|
| | Gas(es) | (Mixture) | Flow Rate |
| Shielding | | | |
| Trailing | | | |
| Backing | | | |
| Other | | | |

ELECTRICAL CHARACTERISTICS (QW-409)

| Weld Pass(es) | Process | Filler Metal | | Current | | Volts (Range) | Travel Speed (Range) | Other (e.g., Remarks, Comments, Hot Wire Addition, Technique, Torch Angle, etc.) |
|---|---|---|---|---|---|---|---|---|
| | | Classification | Diameter | Type and Polarity | Amps (Range) | | | |
| | | | | | | | | |

Amps and volts range should be recorded for each electrode size, position, and thickness, etc.

Pulsing Current _____ Heat Input (max.) _____

Tungsten Electrode Size and Type _____
(Pure Tungsten, 2% Thoriated, etc.)

Mode of Metal Transfer for GMAW (FCAW) _____
(Spray Arc, Short Circuiting Arc, etc.)

Electrode Wire Feed Speed Range _____

Other _____

TECHNIQUE (QW-410)
String or Weave Bead _____
Orifice, Nozzle, or Gas Cup Size _____
Initial and Interpass Cleaning (Brushing, Grinding, etc.) _____

Method of Back Gouging _____
Oscillation _____
Contact Tube to Work Distance _____
Multiple or Single Pass (Per Side) _____
Multiple or Single Electrodes _____
Electrode Spacing _____
Peening _____
Other _____

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**Figure 24—Example of Documentation Sheets to Give for Welding Procedure Specification from ASME Section IX Nonmandatory Appendix B (cont.)**

## 4.7 Examination

**Highlights**

- RCC-M personnel qualification must preferably follow European Standard but any equivalent specification can be admitted; ASME refers to U.S. standards (SNT-TC-1A).
- Differences exist in examination techniques and methods between ASME and RCC-M.
- ASME Section III considers pre-service examinations in accordance with Section XI requirements, while RCC-M allows owners requirements for pre-service examination.

Examination methods are addressed Section III of the RCC-M and Section V of the ASME BPVC. The RCC-M refers to examination in its Section I, but in Subsection A, essentially refers and instructs the user to look into Section III for the documentation relating to examination. The other Subsections of Section I (B, C, and D) refer to Section IV, Welding, for the examinations associated with manufacturing.

ASME Section III includes in its Division 1 Section NB-5000 requirements that are unique to the nuclear industry, including specification of limits for acceptance after examination. A significant part of the information on nondestructive examination (NDE) is nevertheless concentrated in a different section (Section V), as in the RCC-M.

It should be mentioned that both RCC-M and ASME also include provisions for NDE in their Material sections, Section II in both codes, especially about the extent, the time (stage) and acceptance criteria for the examination. Special examination requirements for welding are also included in Section IV of the RCC-M and Section IX of the ASME.

This section first describes the differences in practice for NDE personnel qualification and then, in a second paragraph, focuses on the differences between the techniques and methods used.

NDE personnel qualification is done per SNT-TC-1A according to the ASME Section III Division 1 NB-5510. In paragraph Section III Division 1 NB-5522, it is stated that the employer has the responsibility of the adequacy of the qualification program as well as the certification of Level I, II, and III NDE personnel. This is sufficient in the U.S. to become certified by the American Society of Nondestructive Testing or ASNT.

RCC-M Section III Section MC-8000 invites the user to comply with the European norm NF EN 473. Numerous common points between the two certifications can be highlighted: three levels of certification, experience, and practical examination are required to progress to upper levels; certificate expires every 5 years. The certification in Europe requires the intervention of a third party to qualify the NDE personnel. This third party must be accredited by NF EN ISO/IEC 17024 to deliver certification according to the NF EN 473 performs qualification. Outside Europe, RCC-M accepts a certification granted by an independent organization following an equivalent standard after approval by The Contractor (MC 8000). A qualification from the employer as in the U.S. is not fully equivalent in process, but the technical result is level equivalent provided the employer is fully reliable.

In addition, it should be highlighted here that the qualification from the employer in ASME BPVC is not fully equivalent to certification EN 473 delivered by a third party in Europe in the process itself, despite the fact that the levels of competencies are similar (Appendix A – line NB-5520).

To conclude this discussion, in practice, despite the difference highlighted above, this certification issue can be overcome. The detailed comparison work was done in Reference [3] and the conclusion was that the requirements for Inspector Certification per SNT-TC-1A and per EN 473 offer the same guarantees.

The following discussion focuses on the differences between the techniques and methods presented in each of the codes.

First, in RCC-M Section IV S-7363, it is mentioned that liquid penetrant examination is required for Class 1 and 2 welds before starting any welding. In ASME Section III NB-4400, no such provision can be found. Looking at this method of examination in the two codes, it can be seen that the ASME Code is very descriptive as regards the liquid penetrant examination (ASME BPVC Section V, Article 6). Moreover, the penetrant removal technique is different as well as the drying method. But as analyzed in Reference [3], this gives equivalent results in practice.

The ASME Section III Division 1 NB-5410 requires examination of the weld joints by liquid penetrant or magnetic particle in addition to carrying out all pre-service volumetric examinations (Appendix A – line NB-5410). The RCC-M Section I B-5240 does not call for such stringent examination after the hydrotest. The philosophy is different: instead of asking for more stringent check after the test, there exists other testing, as specified Section I B-5300, that will make any problem visible. The RCC-M requires visual examination in the case of tracking gross plasticity distortion, as per RCC-M Section I B-5520. RCC-M Section IV S-7460 requires also visual examination of Class 1 and 2 welded joints.

The RCC-M requires removal and liquid penetrant examination of all arc strikes. This examination is not required by ASME. However, in practice, arc strikes are generally examined using liquid penetrant following removal and blending.

For ultrasonic examination of welds, the classification of defects as planar or non-planar is essential as a planar defect is unacceptable. For this classification, the RCC-M refers to a European standard. The ASME leaves this responsibility to the NDE personnel.

The ASME BPVC includes also a paragraph about pre-service examination, Section III Division 1 NB-5332. Conversely, it should be noted here that for the PSI, it is the AFCEN RSE-M Code that covers this and that no paragraph about this topic can be found in the RCC-M (Appendix A – lines NB-5280 and NB-5332). At this stage though, it is also interesting to mention that the RCC-M Code allows the use of ASME BPVC Section IX for pre-service and in-service inspection. Using the RCC-M Code does not mean that the RSE-M Code should be used exclusively for these types of inspections. For the ASME BPVC, if the component is manufactured per the ASME BPVC, it is often more challenging to switch to another code for pre-service and in-service inspection.

It should also be noted that all that relates to brazing cannot be found in the RCC-M: this includes ASME BPVC Section III Division 1 NB-5274 and NB-5370 (Appendix A – lines NB-5274 and NB-5370).

Finally, a last point of comparison between the codes is the acceptance criteria. Taking first the radiographic examination, it can be seen first in ASME BPVC Section III Division 1 NB-5320 that the term “indication” is used. It can refer to a gas cavity as well as an inclusion. The RCC-M distinguishes the two and provides acceptance criteria depending on the nature of the indication (Appendix A – line NB-5320). Table 26 gives an example of the acceptance criteria for the radiographic examination from the two codes.

Turning to the ultrasonic examination, it is possible to see that the criteria given in Section III Division 1 NB- 5330 are more or less identical to the radiographic examination criteria (Appendix A – line 5330). On the other hand, the RCC-M is particularly extensive about this examination as can be seen in Section IV S-7714.4.

From the two previous examples, it can be seen that the RCC-M offers a more detailed and prescriptive set of requirements. One final example deals with the magnetic particle examination. In

this case, it is not as easy to conclude which of the two codes is really more restrictive. The comparison can be seen in Table 27 (Appendix A – line 5340).

Other examples of criteria and method differences for this paragraph could be found, but instead of going into more detail, a general conclusion on examination is given here. As can be seen in the description made here, overall, examination methods and procedures are often more detailed in the RCC-M than the ASME BPVC. One counterexample of this point is for the hydrotest, where the ASME BPVC requires more than visual inspection after its completion, whereas visual inspection is sufficient in RCC-M, but with an additional amount of tests. This demonstrates a difference in the philosophy of the two codes, more stringent inspection after test versus increased number of tests required.

**Table 24—Location in RCC-M of Paragraphs Equivalent to ASME Section III Division 1 NB-5000**

| ASME Section III NB-5000 | Section Title | RCC-M Equivalent Section(s) | Section Title |
|---|---|---|---|
| NB-5100 | General requirements for examination | Section III MC-2000 MC-3000 and MC-4000 | |
| | | Section IV S-7700 | *Examens non destructifs des soudures de production* (Nondestructive examination of production welds) |
| NB-5200 | Required examination of welds for fabrication and preservice baseline | Section IV S-7700 | *Examens non destructifs des soudures de production* (Nondestructive examination of production welds) |
| NB-5300 | Acceptance standards | Section IV S-7700 | *Examens non destructifs des soudures de production* (Nondestructive examination of production welds) |
| NB-5400 | Final examination of vessels | Part of Section III MC-7100 | *Examens visuels* (Visual examination) |
| NB-5500 | Qualification and certification of nondestructive examination personnel | Section IV MC-8000 | *Qualification et certification des agents de contrôles non destructifs* (Qualification and certification of nondestructive control examination personnel) |

**Table 25—Location in ASME BPVC of Paragraphs Equivalent to RCC-M Paragraphs about Fabrication from Section IV**

| RCC-M Section IV | Section Title | ASME | Section Title |
|---|---|---|---|
| MC-1000 | *Essais Mécaniques, Physiques, Physico-Chimiques et Chimiques* (Mechanical, Physical, Physico-chemical and chemical tests) | Section V Subsection A Section V A-1 | General Requirements |
| MC-2000 | *Examen par Ultrasons* (Ultrasonic examination) | Section V Subsection A Section V A-5 | Ultrasonic examination methods for materials and fabrication |
| MC-3000 | *Examen par radiographie* (Radiographic examination) | Section V Subsection A Section V A-2 | Radiographic examination |
| MC-4000 | *Examen par ressuage* (Liquid penetrant examination) | Section V Subsection A Section V A-6 | Liquid penetrant examination |
| MC-5000 | *Examen par magnetoscopie* (Magnetic particle examination) | Section V Subsection A Section V A-7 | Magnetic particle examination |
| MC-6000 | *Examen par courants de Foucault des produits tubulaires* (Eddy current examination of tubular products) | Section V Subsection A Section V A-8 | Eddy current examination of tubular products |
| MC-7000 | *Autres méthodes d'examen* (Other examinations methods) | Parts of Section V Subsection A | |
| MC-8000 | *Qualification et certification des agents de contrôle destructif* (Qualification and certification of nondestructive personnel) | Section III Division 1 NB-5500 | Qualifications and certification of nondestructive examination personnel |

**Table 26—Radiographic Examination Acceptance Criteria for RCC-M and ASME BPVC**

| RCC-M Section IV S-7114.3 | | | ASME BPVC Section III Division 1 NB-5320 | |
|---|---|---|---|---|
| **Wall thickness e (mm)** | **Gas cavity size (mm)** | **Isolated inclusion size (mm)** | **Thickness of the thinner portion of the weld t (mm)** | **Indication size (mm)** |
| e ≤ 4.5 | e/3 | 1.5 | t ≤ 19 | 6 |
| 4.5 < e ≤ 6 | 1.5 | 1.5 | | |
| 6 < e ≤ 10 | 2 | 3 | 19 < t ≤ 57 | t/3 |
| 10 < e ≤ 25 | 2.5 | e/3 | | |
| 25 < e ≤ 50 | 3 | e/3 | | |
| 50 < e ≤ 60 | 4 | e/3 | 57 < t | 19 |
| 50 < e | 4 | 20 | | |

**Table 27—Magnetic Particle Examination Acceptance Criteria for RCC-M and ASME BPVC**

| | **RCC-M Section IV S-7114.2** | **ASME BPVC Section III Division 1 NB-5340** |
|---|---|---|
| Size of recordable indication (mm) | >2 mm | >1.5 mm |
| Unacceptable indication size (mm) | >4 mm | >5 mm |
| Unacceptable in line indications criteria | 3 or more indications in line, less than 3 mm apart edge to edge or extending more than 20 mm, if this distance is between 3 and 6 mm | 4 or more rounded indications in a line separated by 1.5 mm or less edge to edge |
| Unacceptable surface indications | – | Ten or more rounded indication in any 4000 $mm^2$ of surface with the major dimension of this area not to exceed 150 mm […] |

## 4.8 Pressure Tests

**Highlights**

- Higher hydrotest pressure in the RCC-M (B-5000) than in ASME NB-6200
- No pneumatic testing in the RCC-M

This paragraph presents the pressures that should be chosen for the tests. These pressures can be found in RCC-M Section I B-5000, while it is Section III Division 1 NB-6220 that includes these provisions. Table 28 presents the layout in ASME BPVC and indicates where the equivalent paragraphs are located in the RCC-M Code. In this paragraph, only one table is proposed because no other section from the RCC-M covers pressure tests than the one specified in the Table 28, so unlike the other sections, there was no need to create a second table.

The ASME states that the hydrostatic test pressure should only be 1.25 times the design pressure.

The RCC-M gives another formula in the RCC-M Section I Z-Z720 to determine the factor to scale up the design pressure by a factor k, which is:

$$k = \max(1.43\ ;\ 1.25\ \mathrm{x}\frac{\mathrm{SmHT}}{\mathrm{SmD}})k = \max(1.43\ ;\ 1.25\ \mathrm{x}\ \frac{\mathrm{S_{MHT}}}{\mathrm{S_{MD}}})$$

where $S_{MHT}$SmHT is the maximum load withstood by the component at the hydrotest temperature and the SmD$S_{MD}$ is the maximum load withstood by the component at design temperature.

If more than one material is used, then the minimal value of the ratio of the maximum loads should be used.

This factor is provided by the European Directive 97/23/CE (RCC-M Appendix A paragraph 7.4) and, in practice, exceeds the factor given by the ASME. This can render the test and also the design and analysis of the component more delicate with the use of RCC-M (Appendix A – line NB-6200 and after).

As a practical example, it is possible to consider the primary side of a steam generator with the primary nozzle on its bottom. The nozzle will typically have a safe-end or piece to link the pipe and nozzle together. The material of the safe-end will typically be different of that of the channel head bowl of the steam generator. If a common carbon steel is used for the channel head, such as the 18 MND 5 (STR: M2143), and the hydrotest and design temperatures are respectively 50°C and 350°C, then SmHT/SmD is equal to 1 ($S_m$ versus temperature is constant), so k is equal to 1.43. If an austenitic stainless steel is selected for the safe-end, such as the Z6 CN 18.10, then SmTH/SmD is equal to 1.24 and so k becomes equal to 1.55. In this case, the hydrotest pressure for the channel head bowl and the primary nozzle, including its safe-end, shall therefore be 1.55 times the design pressure if the RCC-M Code is followed. Conversely, the hydrotest pressure will be only 1.25 times the design pressure as per the ASME BPVC.

Nevertheless, the practical implementation of this requirement is somewhat moderated by the European harmonized standard EN 13445, which considers that the pressure test value should not govern the design of pressure equipment (Edition 2002 and reinforced by amendment October 2009). This is accepted by European Authorities and therefore integrated in modification 2008 of RCC-M.

Apart from this significant difference, it should be also mentioned that no pneumatic test is covered in the RCC-M Code (Appendix A – line NB-6300).

The test procedures regarding the hydrostatic test are comparable overall as stated and checked in Reference [3].

**Table 28—Location in RCC-M of Paragraphs Equivalent to ASME Section III Division 1 NB-6000**

| ASME Section III NB-6000 | Section Title | RCC-M Equivalent Section(s) | Section Title |
|---|---|---|---|
| NB-6100 | General requirements | Section I B-5100 | *Généralités* (General) |
| | | Parts of Section I B-5200 | *Essais hydrostatiques* (Hydrostatic tests) |
| NB-6200 | Hydrostatic tests | Section I B-5200 | *Essais hydrostatiques* (Hydrostatic tests) |
| NB-6300 | Pneumatic tests | Not covered | |
| NB-6400 | Pressure test gages | Section I B-5240 | *Exécution de l'essai* (Hydrostatic test) |
| NB-6500 | N/A | N/A | N/A |
| NB-6600 | Special test pressure situations | Section I Appendix Z IV | *Règles de calculs des matériels soumis à la pression extérieure* (Design rules for components subjected to external pressure) |

## 4.9 Overpressure Protection

**Highlights**

- Two different certifications of pressure relief equipment in the RCC-M.

This paragraph highlights the differences between the two codes that relate to overpressure of the equipment. The prescriptions are given RCC-M Section I B-6000 and ASME Section III Division 1 NB-7000. A comparison of the layouts of the two sections is given Table 29.

These two sections are essentially equivalent, including even the layout of both sections in Table 29. The RCC-M Code essentially differs from the ASME BPVC because it refers to other European and French regulations, such as EN 764-7 (Appendix A – line NB-7314).

The RCC-M Section I Section B-6700 indicates how to certify pressure relief equipment and offers a possibility to comply with one of two different standards to do so. The first Standard given is the ASME while the second is the EN IS 4126 parts 1 to 5 European Norm. The European Norm does not require any Authorized Observer to validate the test and deliver the certification.

It is worth mentioning, though, that additional requirements are attached in France and in Europe to the European Pressure Equipment Directive (PED) requirements, and especially justification for paragraph 2.11.1 of the PED Appendix A, "Fail-safe modes, redundancy, diversity and self-diagnosis."

On the other hand, the ASME Section III Division 1 Section NB-7738 states clearly that laboratory acceptance of the pressure-relieving capacity test is required under the presence of an Authorized Observer. The Authorized Observer is accepted by the ASME Committee and has to fulfill the requirements of ASME PTC-1994 (Appendix A – line NB-7700 and after).

Despite these differences in the reference made to different standards and norms, the provisions are equivalent for this section.

**Table 29—Location in RCC-M of Paragraphs Equivalent to ASME Section III Division 1 NB-7000**

| ASME Section III NB-7000 | Section Title | RCC-M Equivalent Section(s) | Section Title |
|---|---|---|---|
| NB-7100 | General requirements | Section I B-6100 | *Généralités* (General) |
| NB-7200 | Overpressure protection report | Section I B-6200 | *Dossier de protection contre les surpressions* (Overpressure protection report) |
| NB-7300 | Relieving capacity | Section I B-6300 | *Capacité de décharges* (Relief capacity requirements) |
| NB-7400 | Set pressures of pressure relief devices | Section I B-6400 | *Pression de tarage des dispositifs pour la limitation directe de la pression* (Set pressure for direct pressure limitation devices) |
| NB-7500 | Operating and design requirements for pressure relief valves | Section I B-6500 | *Spécifications de conception et de fonctionnement pour les robinets de décharge de pression* (Design and operating specifications for pressure relief valves) |
| NB-7600 | Nonreclosing pressure relief devices | Section I B-6600 | *Dispositifs de décharge de pression non refermables* (Non-reclosing pressure relief devices) |
| NB-7700 | Certification | Section I B-6700 | *Détermination de la capacité de débit* (Determination of flow capacity) |
| NB-7800 | Marking, stamping and data reports | Section I A-3800 | *Documents de programmation, de suivi et de compte-rendu final* (Technical preparation, follow-up and final report documents) |
| | | Section I B-1300 | *Identification* |

## 4.10 Overview of Quality Aspects

**Highlights**

- QA in the RCC-M Code is based on international standards and recommendations.
- ASME uses NQA-1; RCC-M uses ISO-9001 and IAEA 50 C/SG.
- Professional Engineer certification only exists in ASME Code.

While outside the scope of this report, a brief discussion is provided herein to identify some basic differences regarding Quality Assurance and Engineer Certification aspects of the codes.

On the request of the American National Standards Institute (ANSI), the ASME brought together the Committee on Nuclear Quality Assurance, which in 1979 issued the Nuclear Quality Assurance (NQA-1) report. This report provides quality assurance program requirements for Nuclear Type or N-Type Certificate Holders. The ASME refers to this Standard, in its Section III Division 1 NCA-4000.

The RCC-M refers in Section I A-5000 to a combination of the 50 C/SG Quality Standard written by the International Atomic Energy Agency (IAEA) and the ISO-9001/9002 Standard, first implemented in the late 1980s. The first objective of these ISO standards is customer satisfaction while the ASME Code relies on a very technical and nuclear industry oriented standard.

Moreover, the ASME specifies, in its Section III Division 1, Section NCA-4000, the existence of an Authorized Inspection Agency (AIA) and Authorized Nuclear Inspectors (ANI). The ASME had assembled, in 1973, a Committee on Qualifications for Authorized Inspection (QAI), which issued the QAI-1 standard to qualify Authorities for Inspection. Even before that, the National Board of Boiler and Pressure Vessel Inspectors (NBBPVI) was created in 1919 to make sure that pressure vessels were built according to an acceptable standard and qualify inspectors capable of verifying the implementation of the standard. The NBBPVI nowadays qualifies the inspectors per the QAI-1 to enable them to perform third-party verification of nuclear pressurized components.

The ASME developed Subsection NCA, which provides the general rules for ASME N-Type certification program for construction of Division 1 and 2 components, including Class 1 pressure vessels. The ASME N-Type certification program provides rules and requirements for designers, component owners, authorized inspection, professional engineers, material suppliers, qualification documents, and the application of the N-stamp, quality assurance, and registration with the ASME.

In contrast, the RCC-M gives more responsibility or freedom to the owners. Owners may here be the contractor, manufacturer, or supplier, as specified in Section I A-5100. It is the responsibility of the owner to prepare and implement a quality system that is compliant with the code, to notify the various contractors, suppliers, and manufacturers that it interfaces with of the quality system used and, finally, verify that they all are compliant with the defined quality system.

These are, in essence, two different ways of achieving the same objective.

There are also differences between the two codes as far as Personnel Qualification is concerned, especially in the area of Engineering Qualification. The ASME requires a Registered Professional Engineer to certify the component, the design specification, the overpressure protection report, design report, and/or construction report.

For Engineering Qualification, the requirements of the ASME Code may be found in Section III Division 1, Appendix XXIII. It is described how to qualify a Professional Engineer, i.e., personnel able to certify Designs and Equipment. In practice, a Professional Engineer has to start the process after graduating with a Bachelor’s degree from an accredited university (accreditation by the Accreditation Board of Engineering and Technology [ABET]) by taking the Fundamentals in Engineering (FE) exam.

After gaining experience in one specialty field as well as in regulation and licensure requirements (4 years), the final step is then to take the final Professional Engineering exam.

In the RCC-M, there is no such equivalent accreditation. The code does not address this certification, but every company has a QA program and internal requirements to assign engineers to particular tasks. The tools that can be used to assess the technical ability of an individual or an engineering organization are numerous. They range from simply looking at the résumés to looking at the scientific publications of an individual. It should also be noted that the IAEA 50 SG/Q, ISO 9001 and also, when applied, the nonmandatory Appendices ZZ and ZY, all require adequate competence of personnel. As for the manufacturer certification above, it is the owner responsibility to ensure this last point.

To conclude, it should be remembered that the RCC-M is a set of guidelines that is almost compulsory to follow in practice, but the French ASN does not enforce the use of any code. The AFCEN is, nevertheless, in close contact with the ASN to periodically collect its comments about the code. Moreover, an external document measuring the adequacy of the RCC-M provisions to the directives can be found (RM 09012, “File regarding the assessment of RCC-M Ed.2007 requirements versus ESPN Order of December, 12th 2005”). Nevertheless, on the European and French markets, the European directives and French laws are above the code and should be the first point of entry when manufacturing equipment for these markets.

For a strict consideration of QA, it must be noted that countries such as France, Finland, and the United Kingdom have specific regulations that supersede any Code requirements.

## 4.11 Conclusion

A preliminary remark is that this conclusion does not include the results of Section 4.10, “Overview of Quality Aspects,” as this paragraph is clearly out of the scope of the report as defined in the Introduction.

Charts summarizing the differences based on Appendix A are provided as Figure 25 through Figure 26. These diagrams provide a good general overview of the nature and number of differences between the two codes.

To summarize the preceding, the first point concerns the prescriptive nature of the RCC-M Code compared to the ASME. The RCC-M dictates the specific design of a respective component to a greater degree than ASME Section III, which, due to the broader scope, leaves more responsibility to the owner (designer and/or manufacturer). As defined in the foreword, the ASME BPVC is intended to apply broadly to the mechanical equipment industry, while the RCC-M focuses on PWR components and is derived from the industrial experience in France. The ASME BPVC is intended to apply more generally and does not attempt to represent the specific experience of a single industry, as is the case regarding the RCC-M Code. In practice, the owners (individual utilities, designers and/or manufacturers) define the additional experience-based requirements used in conjunction with the requirements defined in the ASME BPVC to achieve an end result.

The second point concerns the evolutionary nature of the RCC-M, which tends to include more experience feedback, as can be illustrated by the part of the code on cleanliness, stemming directly from practical cases. Since its first edition in 1984, materials have been added, paragraphs have evolved, and new results from R&D have been integrated.

These are two different approaches. The RCC-M approach, being more prescriptive, will guide the user to attain the desired end result, whereas, although a similar end will likely result through implementation of the ASME Section III rules by an experienced designer, the ASME does not provide the same level of direction. This difference is particularly apparent with respect to selection of materials. While, except for a few instances particularly based on French experience, the materials

applied to address either RCC-M or ASME Section III requirements are very similar for like components, the RCC-M typically explicitly defines the material to be applied for a particular component while the selection in the case of the ASME component is generally based on design/manufacturing experience.

The comparison between the RCC-M Code and ASME Section III indicates that two types of differences can be identified: purely technical differences and differences resulting due to regulatory requirements. The former can be identified based on the work presented in this report with the responsibility left to the owner (designer and/or manufacturer) to address these differences. Concerning the latter, those differences resulting due to regulatory requirements are therefore related to some degree to cultural and political decisions resulting from the interpretation of industry developments. Addressing these kinds of differences requires discussion and reconciliation between the regulatory authorities of the respective countries.

One last positive note to end this part is the example given in Reference [3], which illustrates that in practice, adaptation of components from one code to the other is a challenge that can be overcome, even as regards regulatory aspects.

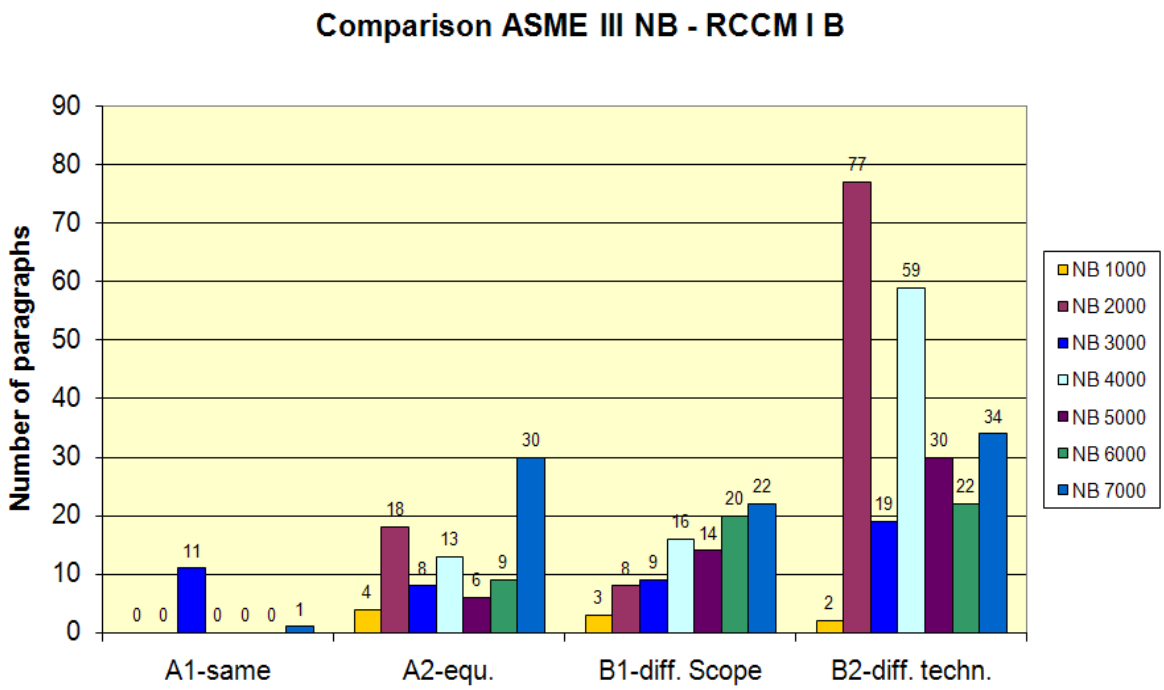



**Figure 25—Detailed Section-by-Section Comparison Between ASME BPVC Section III NB Paragraphs and RCC-M Section I B Paragraphs**

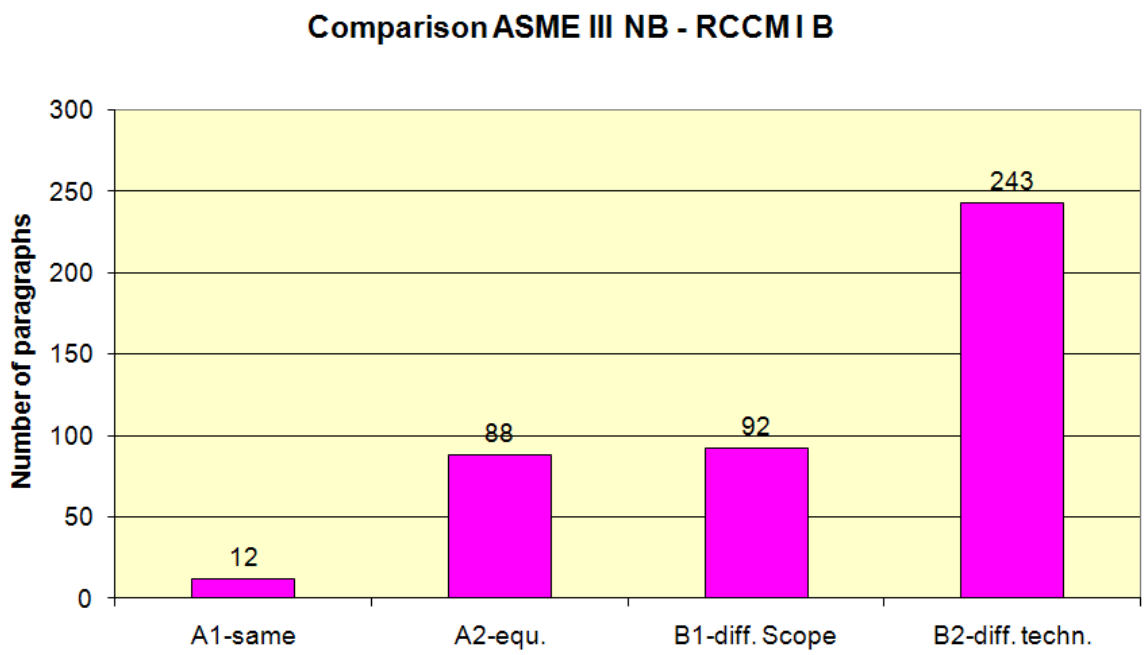



**Figure 26—General Comparison Between ASME BPVC Section III NB Paragraphs and RCC-M Section I B Paragraphs**

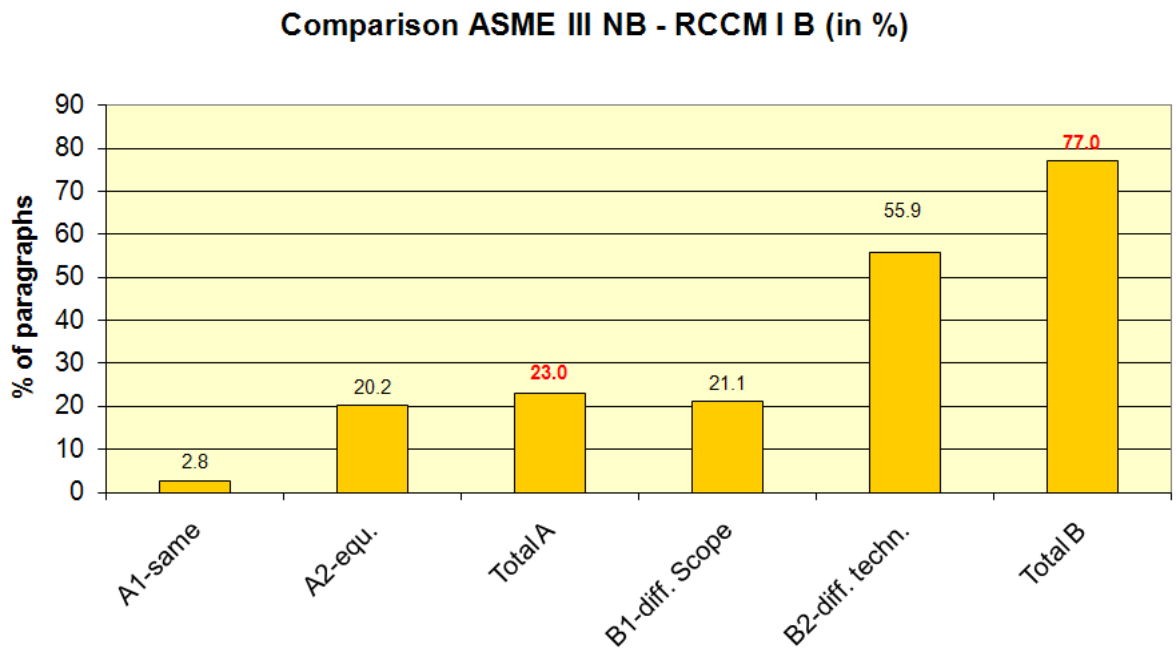



**Figure 27—General Comparison Between ASME BPVC Section III NB Paragraphs and RCC-M Section I B Paragraphs in Percentages**

# 5 JSME VERSUS ASME BPVC SECTION III COMPARISON

## 5.1 Abstract

The JSME nuclear code (JSME S-NC-1 2008: Rules on Design and Construction for NPPs, Division 1, LWRs) is currently primarily applied to domestic plants in Japan.

Considering globalization of the nuclear industry, it is considered beneficial for the industry in general that the similarities and differences of the codes and standards of various countries be identified and clarified to support possible future harmonization of these codes and standards. From this perspective, a comprehensive line-by-line comparison was made between JSME S-NC-1 and ASME BPVC Section III for Class 1 component rules. This part of the report describes the main result of the comparison.

As a result of the comparison, it was found that the very basic technical requirements are the same between ASME BPVC Section III and JSME S-NC-1. In particular, the basic design allowable limits for the failure modes that should be considered in design and operating conditions are fundamentally identical. This similarity comes from the fact that the origin of the JSME Code is based on a repealed government regulation, METI Notification 501, which essentially relied on ASME BPVC Section III.

There are, of course, a number of minor differences in the requirements of JSME and ASME Codes. A large part of these differences fall into a category of ASME requirements that are not addressed or addressed in less detail in JSME.

It should be also noted that the Quality Assurance (QA) related and administrative requirements are quite different between JSME and ASME, reflecting the difference of regulatory environment and industry practice between Japan and the U.S.

## 5.2 Introduction

The comparison of JSME and ASME Codes on the rules of Class 1 components (vessels, piping, pumps, and valves) is described in this section. First, a description of the comparison scope and strategy is provided, and then the comparison results are given, where the major differences are summarized. Appendix B which provides summary tables that identify the major differences between JSME and ASME Code rules on the Class 1 vessel and Class 1 components (piping, pumps, and valves), respectively.

As was agreed upon among the participating SDOs, the first comparison was made on the rules for Class 1 components (vessels, piping, pumps, and valves), and JSME made comparison between JSME and ASME Codes. Along with the comparison of the technical requirements, the QA and related administrative requirements were also included in the comparison.

A detailed, line-by-line comparison was made of the JSME Code technical requirements with corresponding ASME requirements, and the comparison results were summarized in a tabular format. Sources or causes of the major differences were identified and classified, which are discussed in the latter sections of this report.

As for the QA requirements, contrary to the technical requirements, comparison was made on the whole, since the code organization and contents of the QA requirements are significantly different between Japan and the U.S.

For the technical part of the design and construction rules for Class 1 vessels, the following ASME and JSME Codes were subjected to comparison.

*(a)* For ASME,

*(1)* ASME B&PV Code Section III 2007 Edition, Subsection NB, Class 1 Components: Articles NB-1000 through NB-7000

*(2)* Related Appendices

For JSME Nuclear Power Generation Facility Codes,

*(3)* JSME Nuclear Power Generation Facility Codes

*(4)* JSME S-NC1-2008: Rules on Design and Construction for NPPs, Div. 1 LWRs

*(5)* JSME S-NB1-2007: Rules on Welding for NPPs

*(6)* JSME S-NJ1-2008: Rules on Materials for Nuclear Facilities.

For the general and QA-related requirements, the following ASME and JSME Codes were subjected to comparison.

*(a)* For ASME,

*(1)* ASME B&PV Code Section III 2007 Edition, Subsection NCA

*(2)* ASME NQA-1-1994

For JSME and Japanese Electric Association (JEA[2]),

*(3)* JSME S-NC1-2008: Rules on Design and Construction for NPPs, Div. 1 LWRs

*(4)* JEAC 4111-2003: Code of Quality Assurance for Nuclear Power Plant Safety[3].

The comparison results were classified into the following four categories.

| | |
|---|---|
| 1. Equivalent | Code requirements of ASME and JSME are practically the same. |
| 2. Not Equivalent | Requirements in JSME are different from those in ASME. |
| 3. Not Addressed in JSME | No rules in JSME corresponding to ASME requirement. |
| 4. JSME Unique | Rules unique to JSME and not addressed in ASME. |

[2]JEA: Japan Electric Association, one of three major SDOs for nuclear codes and standards of Japan.
[3]Unofficial translation of the code title.

## 5.3 Preliminary Paragraphs and Scope Presentation

**Highlights**

- No stamping and no certificate holder in JSME S-NC1
- No detailed boundaries of jurisdiction consideration in JSME S-NC1

This section summarizes the major differences between the introductory paragraphs of ASME BPVC Section III Division 1, NB 1000 and JSME S-NC1 section GNR.

One of the most significant differences is that marking, stamping, and preparation of reports by the Certificate Holder of items are not required in JSME. The scope of JSME S-NC1 is limited to material, design, fabrication, examination, testing, and overpressure relief. This difference is closely related to the significant differences of QA/QC requirements between ASME and JSME, which is overviewed in Section 5.11 of this report. Behind these differences lies the historical background of JSME S-NC1 development. JSME S-NC1 was first developed, by policy, mainly based on MITI Notification No. 501, which contained the detailed technical rules for structural design of nuclear components established by the regulatory authority. In developing MITI Notification No. 501, JSME sifted through ASME Section III and adopted provisions therein that were judged necessary from the regulator's point of view. With this background, there are number of provisions that exist in ASME Section III but not in JSME Code.

Differences are also found in the boundary of jurisdiction. The boundaries of components and jurisdiction are described clearly and in detail in ASME NB-1130, while JSME S-NC1 has limited descriptions. First, while ASME NB-1131 mandates the Design Specification to define the boundary of a component to which piping or another component is attached, JSME S-NC1 does not. In JSME S-NC1, descriptions are only given that correspond to NB-1132.2 (a) through (e). In JSME, there are no explicit distinctions between pressure-retaining and non-pressure-retaining attachments, or structural or nonstructural attachments (NB-1132.1) either.

The last major difference in this section is component classification definitions. While, in ASME, the component classification is entrusted to the Design Specification, component classification definitions are given in JSME S-NC1, such as, "Class 1 components are those components that constitute the reactor coolant pressure boundary." Lists of major systems and components that belong to each class (Classes 1, 2, 3, MC, etc.) are given in the explanatory part of JSME S-NC1 (which is not the code itself). This comes also from the historical background of JSME S-NC1.

## 5.4 Materials

**Highlights**

- JSME does not specify welding materials.

Generally, the requirements for test coupons, fracture toughness test, and nondestructive examinations (NDE) for base material and repair activities (NB-2000 in ASME) are almost the same between JSME and ASME. However, there are some differences between JSME and ASME that are listed below.

First, JSME does not define nomenclatures in detail as ASME NB-2110, e.g., JSME does not define "pressure-retaining material" or "nominal thickness."

Second, JSME does not specify welding materials, NB-2121. Manufacture qualifies applicable welding material based on the welding procedure qualification test conducted in accordance with the performance requirement of Part 2 of JSME S NB1-2007, "Rules on Welding for Nuclear Power

Plants." JSME requires welding materials to have strength equal to or greater than that of base material in N-1040 of JSME S NB1-2007.

In addition, JSME does not specify requirements for Certified Material Testing Report (CMTR), NB-2130. Japan Industrial Standards (JIS) are applied for it.

Moreover, ASME specifies QA requirements such as material identification, NB-2150, and heat treatment procedure, NB-2180, whereas JSME does not. ISO 9001 is applied as QA requirements in Japan.

It should also be noted that detailed requirements of NDE are partly different. This can be seen in Figure 28.

ASME also specifies requirements for qualification of welding procedures and welders (NB-2539.2, NB-2573.3), and NDE procedure requirements (NB-2575.4). JIS requirements are applied in Japan.

Finally, ASME specifies requirements for a material organization's quality system programs, NB-2600. QA programs based on ISO 9001 are applied in Japan.

| | ASME | JSME |
|---|---|---|
| UT requirements for plate | Angle UT for 2 in. thickness and below; straight UT for over 2 in. thickness, and all vessel material, NB-2531 | Straight UT for all materials, PVB-2411 |
| Time of examination | After heat treatment, NB-2537(a) | Not related to heat treatment, PVB-2413 |

**Figure 28—Comparison of Detailed Requirements for NDE in ASME and JSME Codes**

## 5.5 Design

**Highlights**

- $K_e$ factor in JSME is formulated based on the elastic follow-up model for local plasticity.

Generally, the requirements for the design rules for Class 1 vessels (NB-3000 in ASME) are almost the same. Especially, the basic design allowable limits for the failure modes that should be considered in design and for every operating condition are identical. However, there are some differences between JSME and ASME and those are listed here.

First, concerning the plastic analysis, the ASME BPVC, NB-3228, specifies limit analysis, experimental analysis and plastic analysis as primary stress evaluation methods. Shakedown analysis is also specified in ASME. JSME PVB-3160, meanwhile, only specifies limit analysis as a primary stress evaluation method. Instead, JSME has a Code Case specifying evaluations for primary stress, primary plus secondary stress, and shakedown assessment by direct use of inelastic finite element (FE) analysis results, NC-CC-005. The JSME Code Case has clear methodologies for those evaluations, while the ASME provisions specify only requirements as shown in Table 30.

Concerning the $K_e$ factor, ASME NB-3228.5, JSME PVB-3300 specifies original $K_e$ factors that are formulated based on the elastic follow-up model for local plasticity, reflecting Japanese R&D results. The $K_e$ factors are compared for some typical cases between ASME (NB-3328.5) and JSME (PVB-3315) in Figure 29. It is noted that JSME gives less conservative values.

For openings and reinforcement, the ASME Code (NB-3339) specifies alternative rules for nozzles in cylindrical shells, spherical shells, and formed heads, while JSME PVB-3551 only specifies nozzles

for cylindrical shells. JSME PVB-3552 generally requires more area reinforcement for values of $d/\sqrt{(Rt_r)}$ between 0.2 and 0.4 than does NB-3339.3, based on use of the formula in Welding Research Council (WRC) Bulletin 133.

The following formulae produce nearly identical results.

*a.* ASME ─ $A_r = [4.05(d/\sqrt{(Rt_r)})^{1/2}-1.81]dt_r$

*b.* JSME ─ $Ar = [3.75(d/\sqrt{(Rtr)}-0.75]dtr$

It should also be mentioned here that reflection of plant operating experiences in Japan is integrated in the code. The following JSME unique appendices are established reflecting operating experiences in Japanese plants.

*a.* Nonmandatory Appendix 4-B: Fluid-elastic Vibration Evaluation of U-bend Tubes in Steam Generators

*b.* Nonmandatory Appendix 5-A: Evaluation of Flow-Induced Vibration

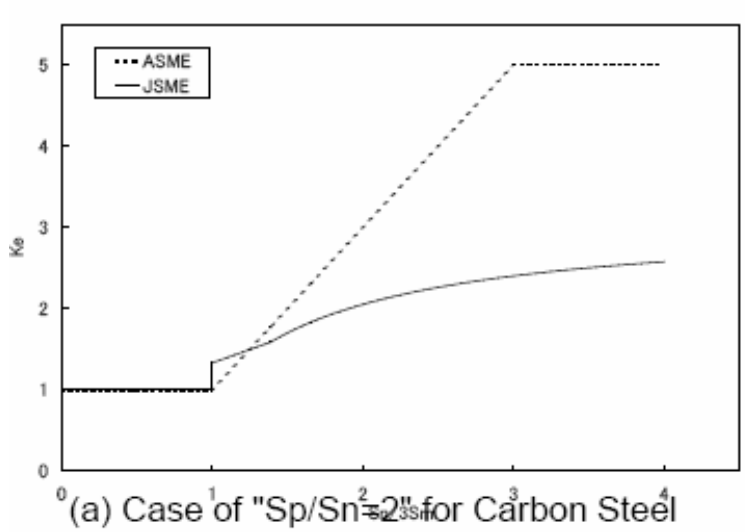
*c.* Nonmandatory Appendix 5-B: Evaluation of High-Cycle Thermal Fatigue

Regarding the requirements that are addressed in the mandatory appendices in ASME Section III, Subsection NB, there are several differences identified as below:

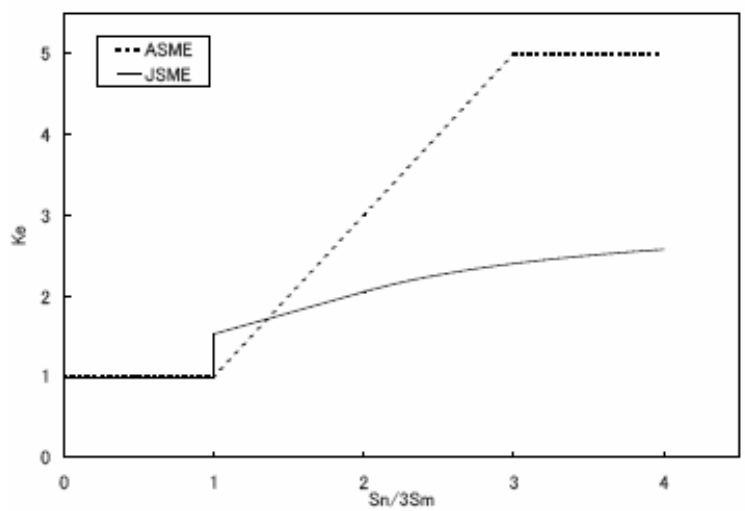
*a.* Mandatory Appendix II, Experimental Stress Analysis: JSME does not specify experimental stress analysis.

*b.* Mandatory Appendix III, Basis for Establishing Design Stress Intensity Values and Allowable Stress Values: Regarding new material test data, ASME permits use of available data for similar material if suitable test data do not exist, while JSME Material Code requires taking these data.

*c.* Mandatory Appendix IV, Approval of New Materials under the ASME Boiler and Pressure Vessel Code: JSME specifies requirements for base material only. JSME requires welding materials to have strength equal to or greater than that of base material.




(a) Case of "Sp/Sn=2" for Carbon Steel




(b) Case of "Sp/Sn=5" for Carbon Steel

**Figure 29—Comparison of $K_e$ Factor Used in the Simplified Elastic-Plastic Analysis Between JSME and ASME**

**Table 30—Comparison of Plastic Analysis Between JSME Code Case and ASME**

| | JSME Code Case | ASME NB-3228 |
|---|---|---|
| Primary Loads | – Lower-Bound Approach Method (EP FEA)<br>– Twice-Elastic-Slope Method (EP FEA)<br>– Elastic Compensation Method based on the lower bound theorem (Elastic FEA)<br>[Note: The yield strength is $S_m$ and the collapse load calculated is used.] | – Limit Analysis (EP FEA) [Note: The yield strength is $1.5S_m$ and two-thirds of the lower-bound collapse load is used.]<br>– Experimental Analysis<br>– Plastic Analysis [Note: The stress-strain relationship is not specified.] |
| Cyclic Loads | Shakedown Assessment<br>– Cyclic Yield Area Evaluation (Elastic FEA)<br>Ratchet Assessment (when Shakedown Assessment is not satisfied)<br>– Equivalent Plastic Strain Criterion<br>– Elastic Region Width Criterion (The elastic region shall remain in the wall thickness and the size shall not reduce.) | – The Design shall be considered to be acceptable if shakedown occurs. [Note: No clear evaluation method for shakedown is specified.] |
| Fatigue | Fatigue analysis using Ke-factors calculated by the Ke"-equation<br>Ke"=1+($\tilde{q}_p$ 1 )( $\tilde{1}$ 3 $S_m/S_p$)<br>where,<br>– Ke"-equation with fixed elastic follow-up factor $q_p$<br>qp=($\tilde{q}_1 q_0$ )($\tilde{1}$ 3 $S_m/S_p$)<br>$q_0$ = 1.5, $q_1$ = 4.0<br>– Ke"-equation with valuable $q_p$ evaluated by elastic-plastic analysis | – The numerically maximum principal total strain range multiplied by one-half the modulus of elasticity of the material is used for fatigue analysis. |

### 5.5.1 Piping, Valves, and Pumps

**Highlights**

- While in ASME, the piping stress limits against seismic loads (stress due to inertial reversing dynamic loads, Level D service limits) are given by $3S_m$ with a reduced B2 index, in Japan, JEAC 4601 requires fatigue analysis.
- JSME does not request welding specifications for pumps.

This section summarizes the major results and findings obtained through the comparison of design rules on Class 1 piping, pumps, and valves between JSME and ASME. Regarding the requirements

other than design, i.e., material, fabrication, examination, and testing, the similarities and differences between JSME and ASME are actually the same as in the case of Class 1 vessels; the comparison was rather focused on the design requirements.

The portions JSME and ASME Codes subjected to comparison are summarized in Table 31.

A summary table of the major differences is given in Appendix B. This section is divided into three parts: the first one concerning piping design, the second, pump design, and the third and final, valve design.

First, concerning piping design, the first paragraph addresses considerations for Local Conditions and Transients (NB-3612.4). These ASME requirements on piping systems design aspects are not addressed in JSME. They are covered by the requirements of the applicable ministerial ordinance or manufacturer's practice.

When it comes to allowance (Corrosion or Erosion, NB-3613.1), ASME requires that when corrosion or erosion is expected, the allowance of wall thickness shall be considered. On the contrary, JSME does not require consideration of corrosion or erosion in the design phase, while in the actual design practices, they are considered by the industry designers. In addition, for the operation and maintenance phase, requirements are specified by another standard for the management and control of piping wall thickness by periodical measurement for identified piping portions of potential erosion or corrosion (JSME S CA1-2005, "Rules on Pipe Wall Thinning Management").

For threading, grooving, miters, and extruded outlet piping (NB-3613.2, NB-3643.2, NB-3644), ASME allows the usage of threading, grooving, miters, and extruded outlet piping, while JSME stipulates that connections between pipes shall be limited to a welding joint or a flange joint (PPB-3430).

Furthermore, the requirement for miters and extruded outlet piping does not exist in JSME since these items are not used in the actual plants.

Concerning Design and Service Loadings (NB-3621), ASME identifies and classifies the loads to be concerned in design with detail and clear definitions, while JSME leaves them to the design specification (GNR-2220 and PPA-3300).

About the requirements for Class 1 Piping Analysis (NB-3630), ASME states that piping of NPS1 or less may be designed in accordance with the design requirements of NC (Class 2 piping), while JSME does not have such an alternative route. Class1 piping shall be designed in accordance with the design requirements of PPB (Class1 Piping).

For the elbow requirements (NB-3642.2), ASME states that the wall thickness of a short elbow crotch region (the portion of $\Phi$=210~330° defined in Figure 30) shall be 20% greater than the minimum wall thickness required for the straight pipe, but JSME does not have such a requirement.

Another difference relates to the requirement for reinforcement (NB-3643.3). Although two-thirds of the opening reinforcement is required to be within the defined region, a part of an equation to calculate the defined region is not stipulated in JSME (PPB-3424).

Although the definite distance between two openings shall be required for two unreinforced openings in order not to have reinforcements, a part of the requirement for openings not requiring reinforcement is not stipulated in ASME (PPB-3422).

In the case of two openings closer to each other, JSME defines the available ranges for reinforcement and the distance between two openings, while these definitions are not stipulated in ASME (NB-3643.3 versus PPB-3424).

Rules for the nozzle type of branch connection in JSME differ from ASME. Although the latter approves partial-penetration welding on branch connections, JSME does not approve it and applies full penetration only.

The next difference is the requirement for closure (NB-3646). ASME states the pressure requirements on closures. JSME requires separate pressure requirements for both paneling and plate, and these requirements are based on the ones for Class 2 components (PPB-3413, PPB-3415.2).

JSME requires the applicable condition of opening on head (panel) (PPB-3423), but ASME does not require it and has the definition for the required thickness of a head depend on the opening location on the head.

Concerning the requirement for permanent blanks (NB-3647.2), ASME approves permanent blanks, while JSME does not approve and they are not used for actual plants.

In addition, ASME approves temporary blanks (NB-3647.3), while JSME does not take it as the item needs to comply with the Codes.

Currently, expansion joints (NB-3649.1) cannot be applied under ASME and JSME. ASME has been working on developing the applicable rule.

There are some differences in the allowable stresses between JSME and ASME that include allowable primary stresses for Level A and B Service limits, allowable stresses for dynamic (seismic) loads. The allowable stresses are compared in Table 32.

ASME defines the allowable primary stress (Min ($1.8S_m$, $1.5S_y$), NB-3653, etc.) for Level B Service Limits. On the contrary, JSME does not define allowable primary stresses for Level A and B Service Limits.

ASME defines allowable stress for the loads including reversing dynamic loads (NB-3656, etc.) that is different from those for (B2' =2/3 B2), where a seismic load is considered to be a typical reversing dynamic load. While JSME does not define allowable stresses for seismic condition, JEAC 4601, which is the seismic design code in Japan, requires fatigue damage evaluation instead of primary stress limit.

Furthermore, JSME PPB-3536 (Simplified Elastic-Plastic Analysis) requires that the new $K_e$ Factor (NB-3653.6, etc.) shall be applied to obtain alternating stress intensities (refer to PVB-3315). The $K_e$ Factor is obtained by Japanese R&D results.

In addition, ASME defines the matters that shall be accounted in piping design. Examples are as follows.

*a.* Design Limits of Flanged Joints (NB-3658): ASME defines the allowable moments for flanged joints in Level A to D Service Limits. However, JSME defines that flanges shall be designed to use the equivalent pressure that is converted from moments on flanges.

*b.* Definitions of Joint Design (NB-3671): ASME defines the requirements for treaded joint, flared joints, compression joints and caulked joints, et al., as connections without welding. However, JSME requires that Class 1 piping shall be used with welded joints or flanged joints, so JSME does not define the requirement of a wide variety of joints.

*c.* Flexibility of Piping (NB-3672), Design Limits of Flanged Joints (NB-3658): ASME defines the general requirements of flexibilities (NB-3672) that piping shall be designed to have sufficient flexibility and cold springing that the maximum allowable stress due to cold springing is $2.0S_m$ (NB-3672.8, etc.). In Japan, flexibility is considered as part of general requirements and these requirements are not described in JSME.

Now turning to pump design, one of the first differences relates to the scope and applicability (NB-3411). Among the portions and parts defined in ASME, there are some that are not included in JSME, e.g., seal housing and seal glands, and so on. This difference goes back to MITI Notification 501, on which the JSME Code is based.

MITI Notification No. 501 defined a pressure-retaining boundary from the viewpoint that it is important that the pressure-retaining parts not be damaged and pumped fluid not leak outside. Leakage is restricted by the labyrinth, and the bearing, etc. of the pump, even if parts such as mechanical seals were damaged (NB-3411). MITI Notification No. 501 did not define these parts as subject to regulation.

Another difference relates to the requirement against corrosion (NB-3418). Because quantification is difficult, it is not regulated in JSME, though consideration to environmental effects such as corrosion is requested in ASME.

Concerning the requirements for welding (NB-3431), JSME does not request welding specification.

It is the same for reinforcement of openings (NB-3433): JSME does not specify reinforcement of openings. However, when openings are necessary except inlet or outlet, it is acceptable to analyze stress taking into account openings and stress does not exceed the allowable value defined in the regulation.

Piping and supports (NB-3435, NB-3438) are specified in other articles of JSME Code, and are not included in articles of the pump.

Finally, this last part covers valve design. A first notable difference relates to the evaluation of secondary stresses on valve casing by pipe reaction forces (NB-3545.2 (b)). JSME (VVB-3330) evaluates all tensile, bending and torsion forces of pipes as pipe reaction forces on a valve casing, but ASME evaluates only bending forces of pipes.

JSME recognizes only a flange structure as a joint structure of body and bonnet (NB-3546.1) but does not recognize a general pressure-sealing structure for high-pressure valves. Contrarily, ASME recognizes particular joint structures including the pressure-sealing structure.

As for the valve fatigue evaluation (NB-3550), JSME (VVB-3370) does not admit the exceptive stipulation (excluding fatigue evaluation due to temperature change) that is admitted by ASME. In the exceptive stipulation, JSME performs a fatigue evaluation in a narrower temperature difference range (lower than 14°C) for stainless steel, while ASME adopts a temperature difference range of lower than 17°C (30°F) for both carbon and stainless steel.

Furthermore, ASME evaluates quakeproof (NB-3524) values given in a design specification by a static loading test. However, JSME includes no relevant description but JEAG 4601(1984) / JEAC 4601(2008) includes the relevant description.

JEAG stipulates the soundness of a valve body even if a pipe connected to the valve breaks down, together with a quakeproof performance evaluation by “confirmed acceleration levels” that were obtained by a series of active function tests (vibration tests) and static loading tests.

Finally, ASME stipulates materials and structures of safety valves (NB-3590), while JSME does not. JSME (SRV-3010) stipulates that materials and structures of safety valves should conform to JIS B8210.

**Table 31—Comparison of ASME NB and JSME Class 1 Rules**

| | ASME Sec. III, Subsection NB | JSME |
|---|---|---|
| Piping | Article NB-3600, Piping Design | PPB-3000 Design of Class I Piping |
| Pump | Article NB-3400, Pump Design | PMB-3000 Design of Class I Pumps |
| Valve | Article NB-3500, Valve Design | VVB-3000 Design of Class I Valves |

**Table 32—Comparison Between ASME/JSME Allowable Primary Stress for Class 1 Piping**

| Code | | | Stress | Allowable Stress | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Design Condition | Level A Service Limits | Level B Service Limits | Level C Service Limits | Level D Service Limits |
| ASME | | | Primary Stress | 1.5Sm | | Min(1.8Sm,1.5Sy) | Min(2.25Sm,1.8Sy) | Min(3Sm,2Sy) |
| | | | Primary and Secondary Stress (Thermal) | — | 3Sm | | — | — |
| | | | Primary and Secondary | — | | 3Sm | 4.2Sm | 6Sm |
| | | | Primary, Secondary and Peak Stress | — | U≦1.0 | | — | — |
| Japanese Code | | JSME | Primary Stress | 1.5Sm | | | Min(2.25Sm,1.8Sy) | Min(3Sm,2Sy) |
| | | | Primary and Secondary Stress (Thermal) | — | 3Sm | | — | — |
| | | | Primary, Secondary and Peak Stress | — | U≦1.0 | | — | |
| | Seismic Loads | JEAG4601 | Primary Stress | — | | | 2.25Sm | 3Sm |
| | | | Primary and Secondary Stress*4 | — | | | 3Sm | 3Sm |
| | | | Primary, Secondary and Peak Stress | — | | | $U+U_{S1}$*3≦1.0 | $U+U_{S2}$*3≦1.0 |
| | | JEAC4601 (2008) | Primary Stress | — | | | Min(2.25Sm,1.8Sy) | — (Min(3Sm,2Sy))*2 |
| | | | Primary and Secondary Stress*4 | — | | | 3Sm | 3Sm |
| | | | Primary, Secondary and Peak Stress | — | | | $U+U_{Sd}$*3≦1.0 | $U+U_{Ss}$*3≦1.0 |

*1: Stress due to reversing dynamic loads
*2 :In case of involving the short period mechanical loads other than seismic loads
*3: Usage factor due to seismic loads
*4:Stress due to seismic inertia and anchor movement only

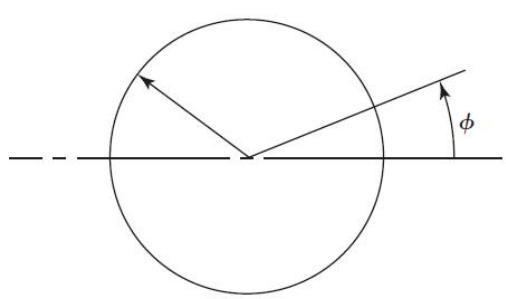



**Figure 30—Comparison of ASME NB and JSME Class 1 Rules**

## 5.6 Fabrication – Welding

**Highlights**

- Cutting, forming, and brazing are specified in ASME BPVC and not in JSME.

Generally, the requirements for fabrication for Class 1 vessels (NB-4000 in ASME) are almost the same. However, there are some differences between JSME and ASME as can be seen in this section.

First, for the matters related to brazing (reference ASME NB-4500), JSME does not specify requirements for brazing and special welding such as stud weld (reference ASME NB-4311). If necessary, procedures can be established according to JSME.

For Quality Assurance, ISO 9001 is applied for QA requirements in Japan.

Furthermore, ASME NB-4200 specifies requirements for cutting and forming, while JSME does not specify for any other than welding.

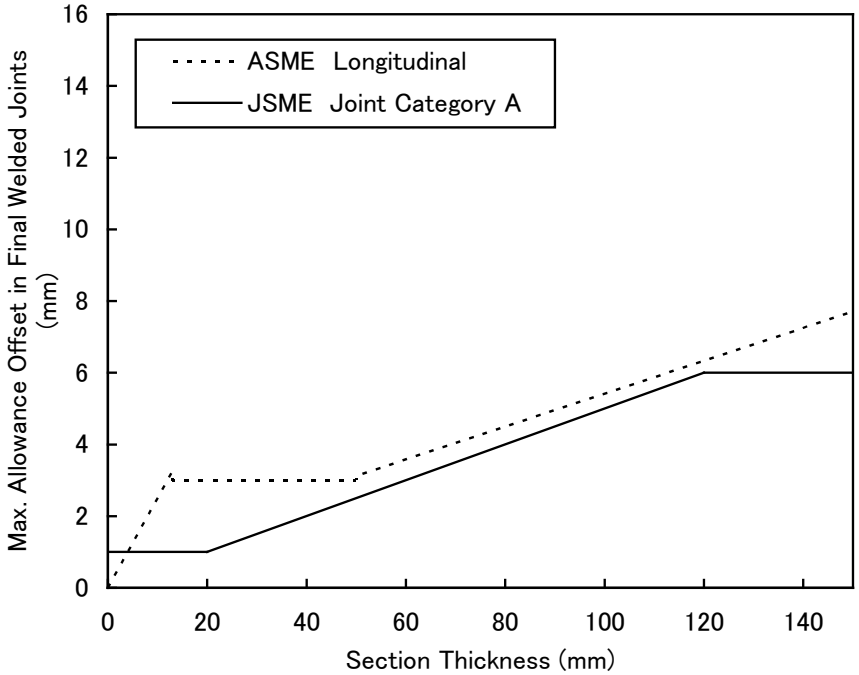
Moreover, JSME PVB-2412 does not permit exemptions for defects in base material found in the fabrication phase specified in NB-4131 of ASME Code.

In addition, JSME PVB-4110 has the same requirement of maximum difference in cross-sectional diameters of NB-4221, but does not have a requirement of maximum deviation for external pressure.

Concerning the alignment requirements for joints, JSME PVB-4231 stipulates slightly more severe requirements in the maximum allowable offset in final welded joints than ASME NB-4232. A comparison of the code requirements is shown in Figure 31.

Also, concerning the thickness of weld reinforcement, N-1080 of JSME S NB-1 has more severe requirements than NB-4426.1. A comparison of the code requirements is shown in Figure 32.

Finally, ASME permits and/or has provisions for fillet welds for piping branch connections (NB-4246), temper bead weld repair (NB-4622.9) and mechanical joints (NB-4700), while JSME does not.



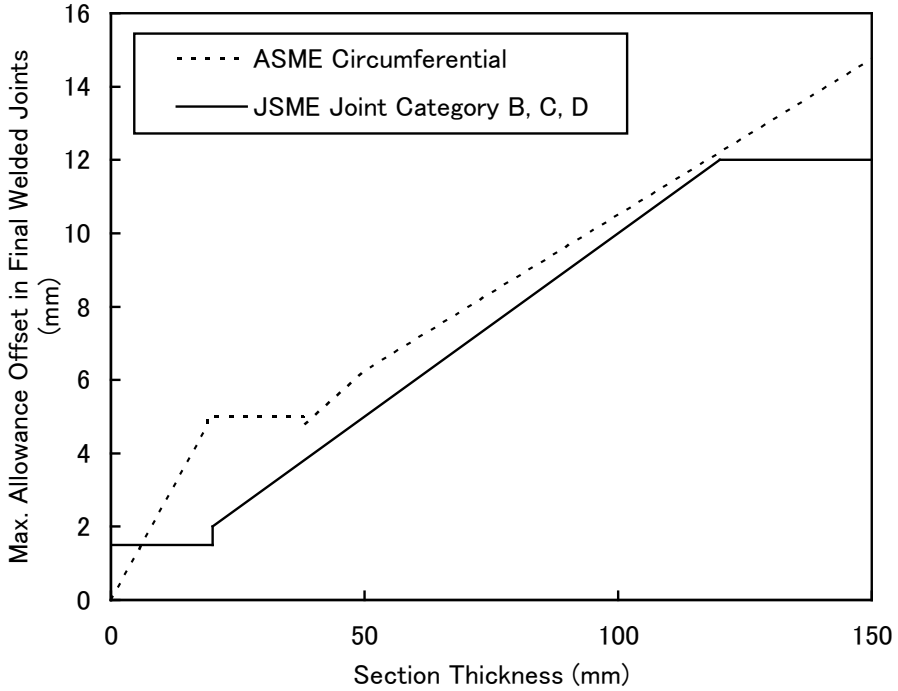




**Figure 31—Comparison of Maximum Allowance Offset in Final Welded Joints between JSME and ASME**

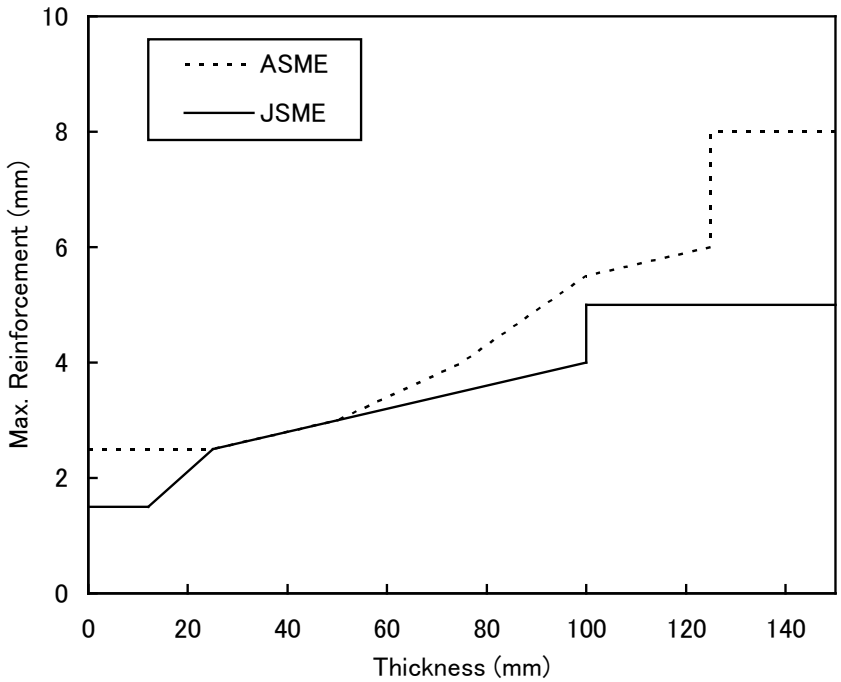



**Figure 32—Comparison of Maximum Thickness of Weld Reinforcement between JSME and ASME**

## 5.7 Examination

**Highlights**

- Examination requirements and acceptance criteria are based on MITI Ordinance in JSME.

Generally, the requirements for examinations for Class 1 vessels (NB-5000 in ASME) are almost the same. However, some differences exist in examination requirements and acceptance criteria. Those in JSME have their bases in the former MITI Ordinance for welding.

One other difference relates to the Quality Assurance: ISO-9001 is applied for QA requirements in Japan.

Furthermore, JSME requires pre-service inspection (PSI) to prepare a baseline record for future in-service inspection (ISI) and not to perform evaluation of an indicated flaw as per ASME NB-5332.

Concerning acceptance criteria of indications of imperfections on weld edge preparation surfaces, N-1030(3), Tables 9 and 10 of JSME S NB-1 are more restrictive than NB-5130. They require examination of thinner materials and are generally more restrictive regarding acceptance of linear indications. The following indications are unacceptable in each code.

**ASME**

(1) Linear indications: greater than 5 mm

(2) Rounded indications; greater than 5 mm

**JSME**

| Thickness | Length of linear indications |
|---|---|
| t < 16 mm | 2 mm |
| 16 < t < 50 mm | 4 mm |
| t > 50 mm | 6 mm |

greater than 4mm

For the acceptance criteria of NDE, JSME is slightly more restrictive than ASME in the following examinations.

- Radiographic examination (ASME NB-5320, Table 7 of JSME S NB-1)
- Magnetic particle examination (ASME NB-5342, Table 9 of JSME S NB-1)
- Liquid penetrant examination (ASME NB-5352, Table 10 of JSME S NB-1).

Regarding the requirements that are addressed in the mandatory appendices in ASME Section III, Subsection NB, there are several differences identified as below.

- Mandatory Appendix VI, Rounded Indication: JSME refers to JIS, so some differences exist in concepts for classification of indications, classification of contrast indicators, counting method of number of indications, indication size, and acceptance criteria.

The comparison of the maximum sizes of rounded indications is shown in Figure 33.

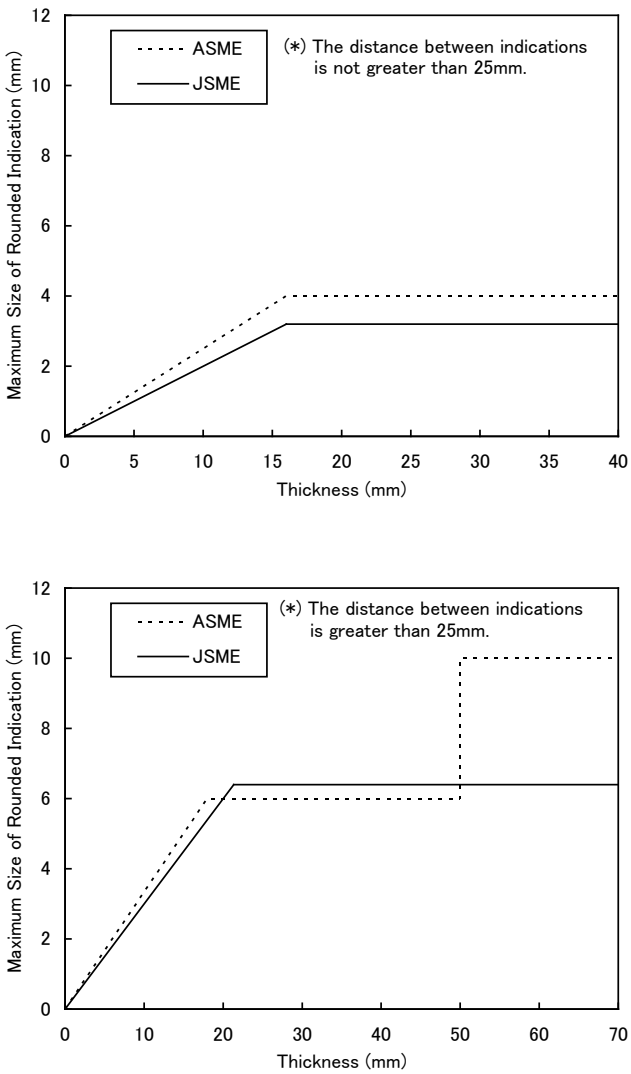



**Figure 33—Comparison of Maximum Size of Rounded Indication Between JSME and ASME**

## 5.8 Pressure Tests

**Highlights**

- JSME requires pressure testing at 1.1 x PO (operating pressure) if pressure test is conducted between first fuel loading and commercial operation.

Generally, the requirements for testing for Class 1 vessels (NB-6000 in ASME) are almost the same. However, there are some minor differences between JSME and ASME.

First, ASME NB-6114.2 has detailed provisions for substitution of pressure test prior to installation in the system, while JSME PHT-1112.2 does not specify in detail.

Second, JSME requires test pressure as 1.1 x PO (operating pressure) if the pressure test is conducted between first fuel loading and commercial operation (PHT-2111, 2112, 2121, and 2122).

In addition, ASME NB-6222 has different requirements for maximum permissible pressure according to classification of components, while JSME PHT-2130 stipulates the same requirement, 106% of test pressure or stress evaluation for independent classification of components.

JSME PHT-4010 stipulates a different test pressure holding time for valves than ASME NB-6223. (PHT-4010 requires 3 minutes of holding time for valves and 10 minutes for other components, while ASME NB-6223 requires 10 minutes for all components.) JSME PHT-3010 stipulates more detailed requirements for components designed for external pressure than ASME NB-6610. (JSME PHT-3010 allows pneumatic test of 1.1 times design pressure besides hydrostatic test of 1.25 times design pressure, while ASME NB-6610 allows hydrostatic test of 1.25 times design pressure only.)

ASME has provisions for machining after pressure test (NB-6115), venting (NB-6211), test medium (NB-6212 and NB-6312), pressure test gauges (NB-6400), and combination units (NB-6620), while JSME does not. ASME NB-6113 has provisions for witnessing of pressure testing, while JSME does not. Again, ISO 9001 is applied for QA requirements in Japan.

## 5.9 Overpressure Protection

**Highlights**

- JSME only defines design requirements for pressure relief devices, while ASME also defines a set of detailed systems requirements for overpressure protection.

Generally, the requirements for overpressure protection for Class 1 vessels (NB-7000 in ASME) are almost the same. However, there are some minor differences between JSME and ASME.

JSME only specifies design requirements (material, structure, calculation method of relieving capacity, etc.) for pressure relief devices. Many of them refer to JIS. The JSME Code itself does not have equivalent provisions to ASME NB-7000.

JSME has a Code Case for overpressure protection; however, it does not stipulate as many details as ASME.

ASME has provisions for direct spring-loaded valves, pilot-operated valves, and power-actuated valves as pressure relief valves (NB-7170), while JSME stipulates direct spring-loaded valves only (OPP-2000).

ASME has a provision for an overpressure protection report (NB-7200), while JSME does not.

Both codes specify similar requirements for number and set pressure of pressure relief devices (NB-7313 and OPP-3000); however, provisions of ASME NB-7313 are more detailed than those of JSME OPP-3000.

ASME NB-7510 stipulates relief valve operating requirements such as set pressure tolerance, while JSME does not. In Japan, JIS is applied for many such requirements.

ASME NB-7700 stipulates several methods for capacity certification, such as flow model test method, coefficient of discharge method, etc., while JSME SRV-3110 stipulates only coefficient of discharge method.

ASME NB-7800 stipulates QA/QC requirements such as stamping and marking, while JSME does not. ISO 9001 is applied for QA requirements in Japan.

## 5.10 Overview of Quality Aspects

**Highlights**

- No Authorized Inspection and Code Stamping system in JSME like ASME

In ASME, the QA-related requirements are given in Subsection NCA of Section III and NQA-1. Their counterparts of Japanese Codes are Chapter 1, General Requirements of JSME S-NC1-2008, Rules on Design and Construction for NPPs, Div. 1 LWRs; and JEAC 4111-2003, Code of Quality Assurance for Nuclear Power Plant Safety, which is applicable primarily to plant operation rather than manufacturing.

Generally speaking, the Japanese QA requirements have their basis in ISO 9001-2000 and are performance based, while the ASME requirements are compliance QA. Therefore, there exist significant differences between ASME and JSME (including JEA).

Below is a summary comparison between ASME and JSME on the QA-related requirements.

Starting with the comparison with ASME Subsection NCA, the first difference is related to NCA-1000, SCOPE OF SECTION III. It is not equivalent, but there is no meaningful technical difference between ASME and JSME. For the rest:

*a.* NCA-2000, CLASSIFICATION OF COMPONENTS AND SUPPORTS: Not equivalent, but almost no difference for their technical positions.

*b.* NCA-3000, RESPONSIBILITIES AND DUTIES: No correspondence in JSME, since Japan has no society's qualification and accreditation system like ASME. Thus, an article corresponding to NCA-3000 is not prepared in JSME Code.

*c.* NCA-4000, QUALITY ASSURANCE: In Japan, QA Code applicable to nuclear power plant is established and maintained by JEA and endorsed by Regulatory Authority independently from JSME Code. Thus, JSME Code has no article about Quality Assurance corresponding to NCA-4000. Also, the Japanese QA Code, established and maintained by JEA, is based on the “Performance-Base QA” concept of ISO 9001-2000, and has many differences from NCA-4000 and NQA-1-1994, which are based on “Compliance QA” concept.

*d.* NCA-5000, AUTHORIZED INSPECTION: Japan has no Authorized Inspection and Code Data Report system like ASME. Thus, the JSME Code has no article about Authorized Inspection corresponding to NCA-5000.

*e.* NCA-8000, CERTIFICATES, NAMEPLATES, CODE SYMBOL STAMPING, AND DATA REPORTS: Japan has no Authorized Inspection and Code Stamping system like ASME. Thus, the JSME Code has no article corresponding to NCA-8000.

*f.* NCA-9000, GLOSSARY: Not equivalent, but no meaningful technical difference between ASME and JSME.

Now, turning to the comparison with ASME NQA-1-1994, with regard to the Basic and Supplementary Requirements, there are significant differences. The JEA QA Code, based on the "Performance-Base QA" concept of ISO 9001-2000, is more generic and plain as compared with NQA-1-1994, which is based on the "Compliance QA" concept.

Major differences between NQA-1 and JEA QA Code include:

*(a)* For 18 Basic Requirements of NQA-1, JEA QA Code is "basically" or "conceptually" equivalent.

*(b)* For Supplementary Requirements of NQA-1, JEA QA Code has less detailed requirements.

*(c)* The differences between ASME and JEA Code are especially large in the following three Supplementary Requirements of NQA-1, where NQA-1 gives very detailed procedure requirements.

*(1)* SUPPLEMENT 3S-1, Supplementary Requirements for Design Control

*(2)* SUPPLEMENT 7S-1, Supplementary Requirements for Control of Purchased Items and Services

*(3)* SUPPLEMENT 17S-1, Supplementary Requirements for Quality Assurance Records

## 5.11 Conclusion

With regard to the rules on materials, design, fabrication, examination, testing and overpressure protection, it was confirmed that the very basic technical requirements are the same between ASME and JSME Codes. Especially, the basic design allowable limits for the failure modes that should be considered in design and for every operating condition are fundamentally identical.

There are, of course, a number of minor differences in the requirements of JSME and ASME Codes. A large part of these differences fall into a category, "ASME requirement that is not addressed or less detailed in JSME," which reflects the industry's level of quality activities and technologies in Japan.

Figures 34, 35 and 36 are charts summarizing the similarities and differences based on the comparison results between ASME and JSME Codes given in the Appendix B. These bar diagrams give a good general picture of the nature and number of similarities and differences between the two codes.

From the similarity and differences of JSME and ASME Codes, it could be concluded that, although there are number of minor differences, JSME Code provides essentially the same level of requirements for Class 1 components as compared to those to ASME Code.

Nevertheless, as described in the previous section, there are differences between ASME and JSME requirements. The sources of these differences are identified and classified as follows.

*a.* Utility or manufacturer's own QA program based on ISO 9001 is applied to the QA activities in Japan.

*b.* JSME Code (Rules on Design and Construction) was first developed mainly based on MITI Notification No. 501, which contains the detailed technical rules for structural design of nuclear components established by the regulatory authority. In developing MITI Notification No. 501, JSME sifted through ASME Section III and adopted provisions therein that were judged necessary from the regulator's point of view. With this background, there are number of provisions that exist in ASME Section III but not in JSME Code.

*c.* JSME Code specifies applicable JIS (Japanese Industrial Standards) for base metals, but does not specify those for welding materials. In the JSME Code, material specifications are not designated for welding materials. A manufacturer qualifies applicable welding material based on the welding procedure qualification test conducted in accordance with the performance

requirement of Part 2 of JSME S NB1-2007, “Rules on Welding for Nuclear Power Plants.” While MITI Notification No. 501 that is the basis for JSME Code for Design referred to the ASME Code Section III, MITI Ordinance No. 81 that is the basis for JSME Code for Welding did not refer to ASME Code Section III. The structure of MITI Ordinance No. 81 is different from that of ASME Section III. It was developed based on the Japanese industry's experience and includes requirements for thermal power components.

*d.* In Japanese construction activities, inspections by the regulatory authority in the manufacturing stage are limited to welding inspections and shop pressure testing, since, from the standpoint of Japanese regulatory authority, confirmation of Code compliance requirements shall be carried out for completed condition during Japanese style “Stamping” by the regulatory authority and preoperational testing.

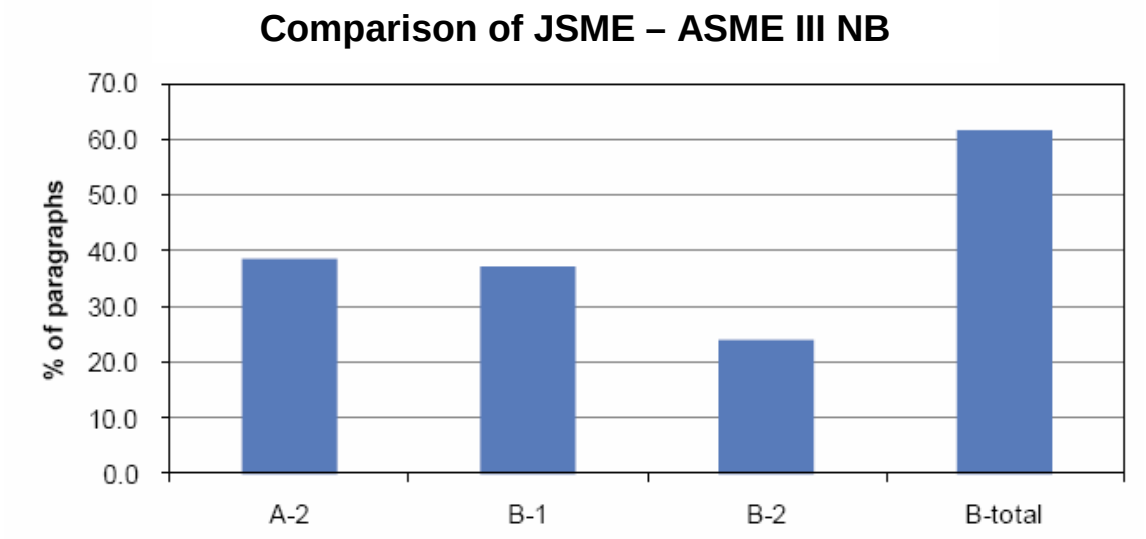
*e.* JSME Code SNA-1-2008, “Rules on Fitness-for-Service for Nuclear Power Plants,” which is a JSME counterpart of Section XI, requires performing pre-service examination, but does not have acceptance criteria. This is based on a position that the objective of pre-service examination is to prepare a baseline record for ISI and not to perform evaluation of flaws revealed.

*f.* The JSME Code does not have some definitions that are specified in the ASME Code. Definitions are specified according to needs.

*g.* The JSME Code may not have provisions for those activities that are ordinarily expected to be performed if not specified.

*h.* The JSME Code Committee has made technical judgment to establish the requirements based on available research and development results.

*i.* No corresponding (equivalent) provision is made in the JSME Code. Codes and Standards issued by an SDO other than JSME are applied.



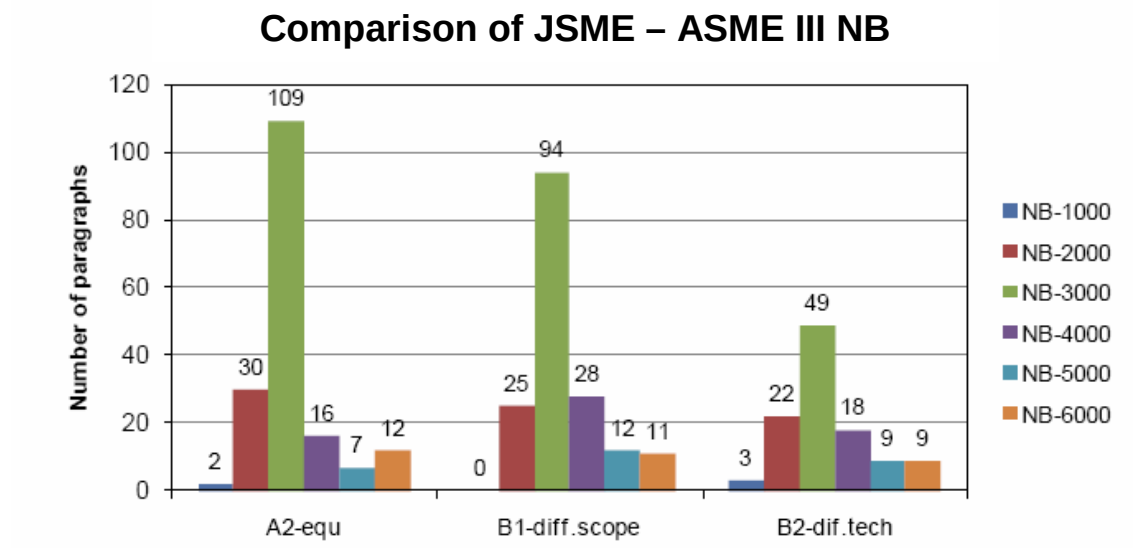




**Figure 34—Detailed Section-by-Section Comparison Between ASME BPVC Section III NB Paragraphs and JSME S-NC1-2008**

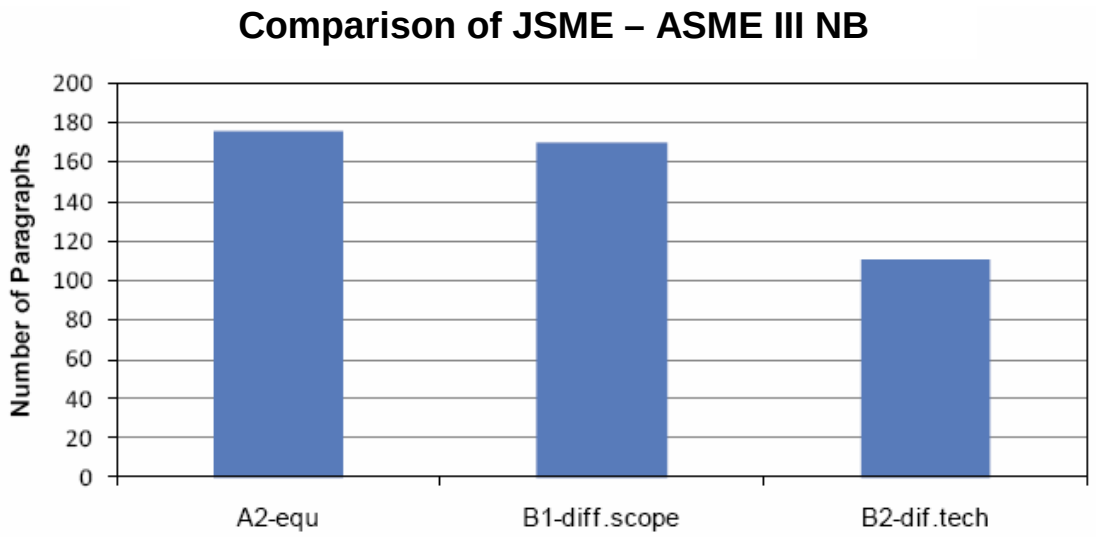



**Figure 35—General Comparison Between ASME BPVC Section III NB Paragraphs and JSME S-NC1-2008**

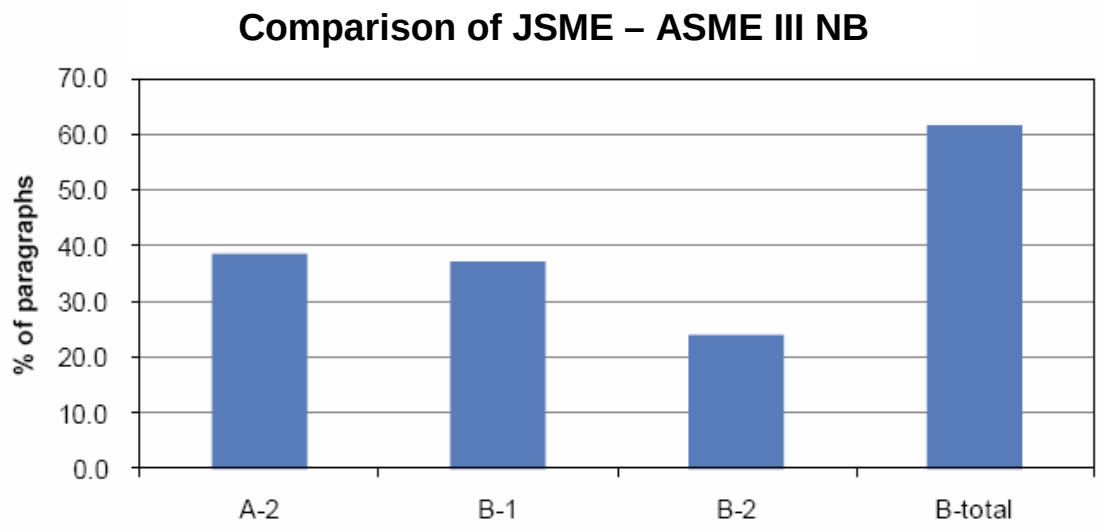



**Figure 36—General Comparison Between ASME BPVC Section III NB Paragraphs and JSME S-NC1-2008 in Percentages**

# 6 KEPIC VERSUS ASME BPVC SECTION III COMPARISON

## 6.1 Abstract

Nuclear power plants have been continuously constructed in Korea during the three decades since Kori Nuclear Power Plant, the first nuclear power plant built in Korea, started commercial operation in 1978.

Currently, 17 units of PWR types and 4 units of pressurized heavy water reactor (PHWR) types are in operation in Korea, and the Shin-Kori, Shin-Wolsung and Shin-Ulchin Nuclear Power Plants are currently being constructed – evidence that nuclear power has become an important energy source in Korea.

ASME BPVC has been applied to all existing nuclear power plants, with the exception of Ulchin Plants Units 1 and 2, where RCC was applied and Wolsung Units 1 through 4, where CSA was applied. Accordingly, KEPIC has adopted the technical requirements of ASME BPVC without modification, following the spirit of safety of ASME BPVC, and has customized the requirements of system and operation for the local environment.

Thus developed, KEPIC has been applied to all new nuclear power plants under construction, starting with Units 5 and 6 of Ulchin Nuclear Power Plant, and it is also being applied to the construction of the UAE nuclear power plant.

As the global demand for nuclear power increases rapidly during this current nuclear renaissance, a demand for a comparative analysis of major nuclear power plant design codes has been identified, with the focus being the major regulatory institutions of nuclear power countries. A comparison has been conducted on ASME (USA), RCC (France), JSME (Japan), KEPIC (Korea), CSA (Canada), and ENES (Russia), and the differences in codes between each SDO and ASME 2007 edition have been compared and analyzed.

This section contains the results of a comparison of ASME and KEPIC in relation to the safety of nuclear power, Class 1 pressure vessels, piping, pumps, valves, etc. based on a study made over the last several years. As a result, it was found that there was no difference in technical requirements, with the exception of system requirements, and it has been concluded that there are no technical issues in applying equipment manufactured in accordance with KEPIC to nuclear power plants where ASME is applied.

KEA would like that the result provided in this report can be utilized as important data that will enable a better understanding of the differences in the nuclear power plant design codes of the various regulatory institutions of each country, equipment manufacturers, construction companies and certification institutions, and that technical exchanges between SDO of each country can become more active, and that collaboration to promote the safety of nuclear power plants will be increased based on this result.

## 6.2 Introduction

In accordance with the agreement among SDOs participating in TG MDEP, differences of ASME BPVC were noted and closely analyzed with regard to Class 1 components. In the analysis of differences, administrative requirements as well as technical requirements were included. As for the technical requirements, KEPIC-MNB and ASME BPVC Section III Div. 1 NB were compared. For administrative requirements, KEPIC-MNA and ASME BPVC Section III Div. 1 NCA were compared. With the base of requirements in the ASME BPVC 2007 Edition, the corresponding KEPIC 2005 Edition – 2008 2nd Addendum – was compared in summary. The requirements of KEPIC-MN deal with piping, pumps and valves, as well as Class 1 pressure vessels, the same as ASME NB, and all the requirements in KEPIC-MNB were compared with the corresponding ASME

BPVC. The administrative requirements deal with the differences in the parts where KEPIC follows Korean laws and regulations much like ASME follows U.S. laws and regulations.

The comparison results were divided into four groups in accordance with the agreement among SDOs and the bases are as specified in the general introduction of this report (Section 6.1).

## 6.3 Preliminary Paragraphs and Scope Presentation

This section includes a comparison of the requirements on ASME NB 1000 and KEPIC-MNB 1000, a general requirement among the Class 1 equipment requirements of ASME and KEPIC.

ASME NB 1000 specifies various requirements, including aspects of construction, temperature limits, and jurisdictional boundaries related to Class 1 equipment design and manufacturing. KEPIC has basically the same configuration and contents as ASME NB, but a few differences are mentioned below.

KEPIC has a sole certification and stamping system that is different than ASME but is very similar (see Table 39).

KEPIC demands that KEPIC-MI (equivalent with ASME BPVC Section XI) be met for in-service inspection in MNB 1110.

Also, KEPIC mentions that the rules of KEPIC-MN may be used for HVAC (refrigerator and air cleaner), which are applicable to the category of KEPIC-MH (requirements for HVAC equivalent with ASME AG-1) when specified in the Design Specification.

KEPIC adopts KEPIC-MDP, MNC and MNG instead of ASME Section II Part D, Section III NC and NG; however, these are equivalent to each of the corresponding requirements.

**Table 33—Composition of KEPIC-MNB 1000 and ASME NB 1000**

| KEPIC-MNB | ASME NB | Title | Remarks |
|---|---|---|---|
| MNB 1110 | NB-1110 | ASPECTS OF CONSTRUCTION COVERED BY THESE RULES | KEPIC includes KEPIC-MI for ISI and KEPIC-MH for HVAC. |
| MNB 1120 | NB-1120 | TEMPERATURE LIMITS | KEPIC adopts KEPIC-MDP instead of ASME Sec. II Part D. |
| MNB 1130 | NB-1130 | BOUNDARIES OF JURISDICTION | Same as ASME |
| (MNB 1131) | (NB-1131) | Boundary of Components | Same as ASME |
| (MNB 1132) | (NB-1132) | Boundary between Components and Attachments | KEPIC adopts KEPIC-MNC and MNG instead of ASME Sec. III NC and NG. |
| MNB 1140 | NB-1140 | ELECTRICAL AND MECHANICAL PENETRATION ASSEMBLIES | Same as ASME |

## 6.4 Materials

**Highlights**

- KEPIC has adopted the calibration procedure of KRISS for a Charpy-V Impact Test Machine and the procedure has a narrower range of tolerance values and is more conservative than the requirements of ASTM E23.
- For NDE personnel, KEPIC additionally requires a national license based on Korean domestic law in addition to the requirements of ASME Section V.

ASME requires the calibration of the Charpy-V Impact Test Machine to follow ASTM E23-02a and use the standard specimen of NIST. However, KEPIC requires following KASTO 93-21102-094 (which is equivalent with ASTM E23-93) to reflect the reality in Korea, and uses the standard specimen of KRISS (Korea Research Institute of Standards and Science) in accordance with domestic laws. For reference, KASTO is the Korea Association of Standards & Testing Organization based on Korean laws and KRISS buys standard specimens from NIST. The calibration procedures of KRISS were developed under the ISO quality assurance system based on ASTM E23. However, it has a narrower range of tolerance values and is more conservative than the requirements of ASTM E23.

As for the nondestructive examination (NDE) requirements, it adopted KEPIC-MEN, technically the same as ASME Section V. However, as for NDE personnel, KEPIC additionally requires a national license based on Korean domestic law in addition to the requirements of ASME Section V.

KEPIC's code symbol system is different from that of ASME and detailed matters are described in the comparison items of the administrative requirements in Clause 5.6 (the contents should be put in examination).

## 6.5 Design

**Highlights**

- Design methodologies of KEPIC-MNB are the same as those for ASME Section III NB.

There is no difference between KEPIC and ASME regarding design.

## 6.6 Piping, Valves, and Pumps

**Highlights**

- The requirements for piping, valves, and pumps of KEPIC-MNB are the same as those of ASME Section III NB.

The composition and requirements of KEPIC-MNB are essentially the same as those of ASME NB, as it adopted the same composition. There are no differences except those mentioned in the previous clause. Table 34 sums up the code layout comparison.

**Table 34—Composition of KEPIC-MNB and ASME NB**

| KEPIC-MNB | Contents | ASME NB |
|---|---|---|
| MNB 3400 | Pump Design | NB-3400 |
| MNB 3500 | Valve Design | NB-3500 |
| MNB 3600 | Piping Design | NB-3600 |

## 6.7 Fabrication – Welding

**Highlights**

- Fabrication requirements of KEPIC-MNB are the same as ASME Section III NB.
- KEPIC and ASME require t min. for the counterbore length of fittings for pre-service inspection (PSI), but KEPIC allows 0.5-inch counterbore length for fittings in Code Case.

There is no significant difference between KEPIC and ASME regarding fabrication. For reference, ASME requires t min. for the counterbore length of fittings for PSI, which is an additional requirement to acquire more NDE signals during the test conducted during the operation added after ASME BPVC 1995. This does not affect matters related to safety. Before then, the counterbore length of fittings was not separately specified even in ASME BPVC.

In any event, the related requirements of KEPIC are the same as ASME. However, in 2009 (comparing only up to 2007 Edition), the counterbore length of fittings of 0.5 inch was enabled with the Code Case, which shall be applied through an agreement with the regulatory organization. Korea has been building existing power plants by applying 0.5 inch, and has proven that it has not affected safety based on continued construction and operation of the power plants.

## 6.8 Examination

**Highlights**

- NDE personnel qualification is different as they follow different requirements.

Regarding the PSI, KEPIC-MNA does not adopt the fracture mechanics data required by ASME NCA3252 (a) (6).

Regarding the certification of NDE personnel, ASME requires following ASNT SNT-TC-1A within the requirements of NB. However, as ASNT SNT-TC-1A is adopted in KEPIC-MEN, the NDE requirements, KEPIC-MNB, must follow KEPIC-MEN.

## 6.9 Pressure Tests

There is no difference between KEPIC and ASME with regard to the tests.

## 6.10 Overpressure Protection

**Highlights**

- Personnel qualification follows KEPIC-QAR.

The terminology “NV Certification Holder,” which is used in ASME requirements, is expressed as “Pressure Relief Valve Manufacturer” in KEPIC, operating a different code symbol system from ASME.

ASME requires following Section III Appendix XXIII for Personnel Qualification with regard to the Certification of the Overpressure Protection Report. However, KEPIC requires following KEPIC’s equivalent KEPIC-QAR. KEPIC-QAR has the same basic contents as Section III Appendix XXIII. However, in terms of matters regarding national certification, the Korean national education system and qualification system are applied as shown in Table 35.

**Table 35—Comparison Between KEPIC-QAR and ASME Section III Div. 1 Appendix XXIII**

| Description | KEPIC | ASME |
|---|---|---|
| Applicable Standard | KEPIC-QAR | ASME Sec. III Div.1 App. XXIII |
| Technical Field | Identical to ASME | Mechanical, Structural |
| Required<br>National Certificate | – Professional Engineer (2-yr job experiences), or<br>– Engineer (7-yr job experiences) | Registered Professional Engineer |
| Knowledge | Identical to ASME | Code &Working Knowledge |
| Accreditation Body | KEA | Certificate Holder |

## 6.11 Overview of Quality Aspects

**Highlights**

- KEPIC adopts KEPIC-MNA and KEPIC-QAP, while ASME has Subsection NCA and NQA.

As shown in Table 36, KEPIC develops and adopts KEPIC-MNA and QAP based on ASME BPVC Section III NCA and NQA-1, and integrates the requirements of ASME Section III Div. 3 WA as MNA. Regarding the Authorized Inspection, KEPIC-QAI, which was developed based on ASME QAI-1, and the "NB Rules and Regulations" of U.S. NBBI, were applied.

**First, comparing KEPIC-MNA and ASME Subsection NCA, it can be said that KEPIC-MNA basically includes the contents of ASME Section III NCA and Div. 3 WA with the same basic composition as that of ASME. However, as shown in**

Table 38, it newly established KEPIC-MNA 6000 and has been operating various report forms, different from ASME NCA. In addition, the requirements related with Div. 2 among NCA requirements are separated as KEPIC-SNA, the general requirements of the structure part.

The code symbol system of KEPIC is based on the ASME system. However, as shown in Table 39, it is operated differently from ASME. The symbols are formally marked, rather than the use of code symbol stamping.

The differences of terminology between KEPIC-MNA and ASME NCA are shown in Table 40.

Second, comparing the KEPIC-QAP and ASME NQA-1, the KEPIC-QAP was based on the ASME NQA-1 1994 edition and 1995 Addendum, comprising QAP-1 and QAP-2 by maintaining the same structure (NQA-1, NQA-2) before the integration of ASME NQA-1 and NQA-2 (1994). All the requirements are the same as NQA-1, except matters that are applied with Korean domestic laws in terms of requirements.

**Table 36—Comparison for QA and Administrative Requirements**

| Code | | Mechanical | Concrete Containment | TC/SC Containment |
|---|---|---|---|---|
| ASME Sec. III | General Requirement | NCA | NCA | WA |
| | Data Report | Div. 1 App. | Div. 1 App. | WA |
| KEPIC MN, SN | General Requirement | MNA | SNA | MNA |
| | Data Report | MNZ | SNA | MNZ |

**Table 37—Comparison for QA and Administrative Requirements**

| Description | ASME | KEPIC |
|---|---|---|
| Applicable Standard | ASME QAI-1 | KEPIC-QAI |
| Organizations | – Enforcement Authority<br>– Insurance Company | Independent Organization to Owner, Certificate Holder, and Material Organization |
| Accreditation Body | ASME | KEA |
| Government Acceptance | State Government Enforcement | Accepted by Regulatory Body if required |

**Table 38—Composition of KEPIC-MNB and ASME NB**

| Article | KEPIC-MNA/SNA | ASME Section III Subsection NCA |
|---|---|---|
| 1000 | General | |
| 2000 | Classification of Components | |
| 3000 | Responsibilities and Duties | |
| 4000 | Quality Assurance | |
| 5000 | Authorized Inspection | |
| 6000 | Documentation (KEPIC only) | |
| 8000 | Certificate, Nameplates and Code Symbol | |
| 9000 | Glossary | |

**Table 39—Comparison of Code Symbol System Between KEPIC and ASME**

| Description | ASME SectionIII Div.1 | KEPIC-MN |
|---|---|---|
| Components | N<br>1 | kepic<br>1N |
| Parts & Appurtenance | N PT<br>3 | kepic<br>3NP |
| Installation | NA<br>2 | kepic<br>2NC |

**Table 40—Terminology Comparison Between KEPIC-MNA and ASME NCA**

| Code Subsection | ASME Section III Subsection NCA | KEPIC-MNA |
|---|---|---|
| Applicable Organization | Owner<br>N-Certificate Holder<br>NPT-Certificate Holder<br>NA-Certificate Holder<br>Material Organization<br>Pressure Relief Device<br>Testing Laboratory | Owner<br>Manufacturer<br>Manufacturer (only for Fabrication)<br>Installer<br>Material Organization<br>Pressure Relief Device<br>Testing Laboratory |
| Accreditation Body | ASME | KEA |

**Table 41—Comparison Between KEPIC-QAP and ASME NQA-1**

| KEPIC-QAP | ASME NQA-1 | Title | Remark |
|---|---|---|---|
| QAP-1 | Part I | Requirements of Nuclear Quality Assurance Program for Nuclear Facility | Basic Requirements and Applicable Supplementary Requirements are mandatory to be adopted in KEPIC-XNA 4200 |
| QAP-2 | Part II & subpart 3.2 of Part III | Quality Assurance Requirements for Nuclear Facility Application | Not adopted in KEPIC-XNA such as MNA, SNA etc., but applied in Contract Requirements |

## 6.12 Conclusion

So far, KEPIC-MNB, the requirements for Class 1 pressure vessels, pumps, pipes, etc., has followed the spirit of ASME safety in terms of technical matters, and there are no technical differences.

In addition, in terms of QA and the administrative requirements related to nuclear safety, KEPIC-MNB adopted and has operated the requirements of ASME in most of the parts. However, it reflected the differences resulting from different laws and regulations and education systems in Korea from those of the U.S. KEPIC introduced ASME's code symbol system and operates independent code symbol systems through simplification. However, there are no requirements to have been relaxed from ASME levels regarding safety.

Thus far, the differences between KEPIC and ASME BPVC with regard to Class 1 component-related requirements have been analyzed. In addition, the differences in QA and administrative requirements have been noted. As explained above, KEPIC-MN has the same technical matters, as it adopted the same contents of the technical requirements of ASME BPVC NB by adopting them unchanged.

In terms of the systematic parts, both have the same basic contents. However, KEPIC tried to be more subjective relating to the regulations with regard to regulations on nuclear power safety, system operation, qualification entitlement, etc., by naturally applying Korean domestic laws, albeit through the same basic frameworks.

In conclusion, KEPIC and ASME have no noticeable differences as regards nuclear safety. Class 1 components designed and manufactured in accordance with KEPIC-MNB can be applied in the power plant construction projects that are applied with ASME BPVC Section III.

KEA aims to establish various cooperative relationships with ASME, such as endorsing both parties of certificate holders under KEPIC or ASME.

# 7 CSA VERSUS ASME BPVC SECTION III COMPARISON

## 7.1 Abstract

The Canadian and American nuclear industries are organized around different reactor concepts and have developed construction rules specific to each type. The CSA Standards reference the ASME BPVC and its requirements where applicable. The CSA Standards specify requirements for the materials, design, fabrication, installation, quality assurance, and inspection of those pressure-retaining components and supports that are not covered by the ASME BPVC. This section is an attempt to provide a comprehensive comparison between the Canadian CSA Standard N285.0-08 and the ASME BPVC Section III.

## 7.2 Introduction

In Canada, all nuclear reactors for power production are of the CANDU design at this time. The CANDU reactor is a pressurized heavy water reactor (PHWR) that makes use of multiple horizontal Zircaloy pressure tubes, through which the pressurized heavy water coolant flows over fuel bundles, removing the heat of the fission reaction. In contrast, the fuel in pressurized water reactor (PWR) and boiling water reactor (BWR) reactor designs is located in a single large pressure vessel through which the coolant flows over the fuel. The CSA N285.0 Standard was developed to accommodate those unique features of the CANDU concept not addressed in ASME BPVC Section III, which was developed based on the PWR and BWR concepts.

The requirements of the CSA N285.0 Standard are directed to the licensee. It contains requirements that are wider in scope than ASME Section III. In many ways, it acts as an intermediate document between the Regulatory requirements and the component. It places the responsibility for adherence to the requirements on the Licensee, even though the actual performance of much of the work is done by others. ASME Section III, on the other hand, is directed to the construction of components only and places the responsibility for adherence to the requirements on the Certificate Holders defined in Section III. However through N285.0, direct reference to the requirements of ASME Section III Div.1, it achieves indirectly many results identical to Section III.

The CSA N285.0 Standard specifies the technical requirements for the design, procurement, fabrication, installation, modification, repair, replacement, testing, examination and inspection of, and other work related to, pressure-retaining and containment systems, components and supports over the service life of a CANDU nuclear power plant.

This Standard applies to all pressure-retaining systems, including their components and supports, in a CANDU nuclear power plant.

This Standard applies to containment components, but does not apply to concrete containment structures.

This Standard does not apply to portable assemblies of pressurized items that are temporarily connected to a system or component to enable testing, venting, draining, calibration, or other maintenance activities, provided that they do not reduce the ability of a special safety system or safety-related system to perform its design safety function; are under surveillance when connected and are removed upon completion of their function; and are constructed to Standards deemed by the licensee to be suitable for the application.

## 7.3 Preliminary Paragraphs and Scope Presentation

The requirements of the CSA Standard N285.0 are wider in scope than in ASME BPVC Section III. CSA Standard N285.0 places the responsibility for adherence to the requirements on the Licensee even though the actual performance of the work is done by others. The ASME BPVC Section III is intended for the construction of components only and places the responsibility for adherence to the requirements on the Certificate Holder identified in the Code.

CSA Standard N285.0 is an intermediate document between the Regulatory requirements and the construction of the component. CSA Standard N285.0 specifies the technical requirements for the design, procurement, fabrication, installation, modification, repair, replacement, testing, examination and inspection of, and other work related to, pressure-retaining and containment systems, components, and supports over the life-cycle of a CANDU Nuclear Power Plant. This Standard includes metal containment components that are part of the containment system but does not apply to the concrete containment structures. This is covered by the CSA N287 Series.

This Standard does not apply to portable assemblies of pressurized items that are temporarily connected to a system or component to enable testing, venting, draining, calibration, or other maintenance activities, provided that they:

*a.* do not reduce the ability of a special safety system or safety-related system to perform its design safety function;

*b.* are under surveillance when connected and are removed upon completion of their function; and

*c.* are constructed to Standards deemed by the licensee to be suitable for the application.

As noted above, some aspects of the CANDU reactor design are different than the light water reactor (LWR) concepts (PWR/BWR) for which the ASME BPVC Section III was developed. The most significant difference is associated with the reactor vessel rather than with the associated equipment such as other vessels, pumps, valves, and piping systems. The CANDU concept has resulted in special materials and components not covered by the ASME BPVC Section III requirements.

CSA Standard N285.0-08, Annex I covers the construction requirements for components unique to the CANDU design. The requirements for the special Zirconium material properties used for the components are covered by the specifications in CSA Standard N285.6. This Standard also includes a specification for the material, CSA G40, commonly used for supports in the CANDU design. This specification has not been adopted by ASME BPVC Section III; however, this material specification has properties that are similar to SA-56.

Another area not covered directly by the ASME BPVC Section III is the metallic components associated with containment systems. CSA Standard N285.0 has developed Annex J to cover these items.

**Classification of Components**

In Canada, the rules for classification of systems are provided in the CSA Standard N285.0-08; Clause 5.0 and Annex A. Once the system has been classified, the components adopt the classification of the system. The component is then constructed to the requirements of the ASME BPVC Section III except those items that are unique to the CANDU concept. The construction requirements for these items are covered in Annex I of the CSA Standard N285.0-08. The CANDU components receive a unique classification to identify them as having specific construction requirements outside the scope of ASME BPVC Section III. For example, a CANDU component in a Class 1 system will be classified as Class 1C.

The requirements for the CANDU Containment System are different from the ASME BPVC Section III requirements. The concrete portions of the Containment Systems for CANDU reactors are covered by the CSA Standards in the CSA N287 Series. ASME BPVC Section III addresses concrete containment in Division 2. The metallic portions of the Containment System are covered by Annex J of the CSA Standard N285.0-08. The classification of these metallic components is referred to as a Class 4 item.

Annexes I and J often refer back to ASME BPVC Section III with guidance on the application of the requirements in the referenced portion of the ASME BPVC Section III to these CANDU items.

**Conformity Assessment**

CSA has adopted a conformity assessment approach very similar to the requirements of the ASME BPVC Section III. Construction of components must be controlled under a Quality Assurance Program that satisfies the requirements of ASME BPVC Section III and that the requirements for Authorized Inspection are met including the use of nameplates and the issuance of data reports. The required level of conformance to the ASME BPVC Section III requirements is very high.

There is, however, no requirement for the components used in Canada to be stamped. The qualification of the quality programs is done by organizations acceptable to the Regulatory Authority. This is usually the Provincial authority with responsibility for the non-nuclear boilers and pressure vessels that usually perform the authorized inspection duties for non-nuclear equipment. A Certificate is issued by these organizations to indicate the successful implementation of the quality assurance program required by CSA Standard N285.0-08 for the construction of nuclear components. In Canada, there is no requirement for a Certificate of Authorization for the Owner as required in ASME BPVC Section III.

**Requirements for Instrumentation and Instrument Lines**

The design of sensing elements of instruments is outside the scope of the Standard, except that when an instrument is included in the design of a system, the system designer shall ensure that the pressure boundary of the sensing element is rated for the design conditions of the system. Instruments are treated as fittings and the registration of their design is required by CSA Standard N285.0-08.

Instruments included in the design of a system and that have an inlet larger than NPS 3/4 and a pressure boundary that is subject to the system flow have to meet the requirements associated with the classification of the system.

The pressure boundary portion of instrument systems or components that have an inlet of NPS 3/4 and smaller may be treated as non-nuclear fittings.

Instrument lines for process systems or safety systems have to meet the requirements for the classification of the system to which they are attached, except instrument lines NPS 3/4 and smaller may be constructed in accordance with the requirements for non-nuclear instrumentation unless they are associated with the control of systems that cool the fuel.

**Design Registration**

The CSA Standard N285.0-08 requires the pressure boundary design for each item be registered. Welding Procedures are also required to be registered in Canada. This is effectively an approval process and registration numbers are issued for each item registered. This is a process that has carried over from the non-nuclear pressure boundary requirements and is intricately wound into the administrative system associated with the Authorized Inspection. ASME recognizes this process by providing a field on the Date Reports for the insertion of the Canadian Registration Number (CRN), although there are no requirements for Registration of designs in ASME BPVC Section III or any other Sections of the ASME BPVC.

**Requirements for Overpressure Protection**

CSA Standard N285.0 has adopted all the overpressure requirements in ASME BPVC Section III except it specifies the contents of the Overpressure Protection Report. It has also added requirements when the shutdown systems are part of an integrated overpressure protection system designed to protect the heat transport system with an online reactor. The CANDU system is outfitted with two shutdown systems and various pressure-relief devices, which are required to prevent failure of the heat transport system due to overpressure. The credit allowed for the action of overpressure-relief detection devices determines the classification of loadings to be considered in the qualification of the heat transport overpressure protection system. The service limits to be used for events leading to overpressure are provided in the Standard and are referenced in the ASME BPVC Section III definitions of Levels A, B, C, and D Service Limits in NCA-2140.

Overpressure protection devices are not required for small isolatable volumes, for such lower-probability events as loss-of-coolant accidents (LOCAs), or for main feedwater line or main steam line breaks, provided that a set of conditions is met, which includes:

*a.* The volume involved is less than 42.5 L (1.5 $ft^3$);

*b.* The containment boundary integrity is maintained;

*c.* There shall be no impairment of fuel cooling.

**Repair, Replacement, Refurbishment, Modification, and Testing**

The CSA Standard N285.0-08 also covers a broader scope than ASME BPVC Section III. The ASME BPVC Section III covers new construction only, whereas CSA Standard N285.0-08 includes requirements for repairs, replacements, refurbishment and modifications as well. There are also requirements for system pressure test and operational pressure test. While these rules are somewhat similar to ASME BPVC Section XI requirements, they are not based on the same principles, nor do they reference ASME BPVC Section XI the same way as the requirements in CSA Standard N285.0-08 refer to ASME BPVC Section III for new construction.

## 7.4 Materials

The ASME technical requirements for materials are directly referenced by the CSA N285.0 Standard as shown in Table 42. The exceptions identified in Clause 8.1.1 are associated with the materials that are unique to the CANDU concept and are not referenced in Section III.

**Table 42—Equivalence Between the N285.0 and ASME NB-2000**

| Topic | ASME Section III | N285.0-08 |
|---|---|---|
| Materials | NB-2000 | **8.1.1 Class 1 systems**<br>Material for pressure retention in Class 1 systems and components shall comply with the requirements of the ASME BPVC, Section III, Division 1, NB-2000, or the CSA N285.6 Series. |

Note:
CSA N285.6 material is used when rules are not provided by ASME, for example: Although, ASME SB-658 specification applies to Zirconium alloy pipe, the N285.6 standard references ASTM B-353, Zirconium Alloy Tubing, and imposes additional requirements.

CSA N285.6 considers additional material aspects; for example, component deterioration.

## 7.5 Design

The ASME technical requirements for design are directly referenced by the CSA N285.0 Standard as shown in Table 43. There are no exceptions identified in Clause 7.1.1. However, CSA has developed a series of standards, the N289 Series, that identifies the Canadian requirements for considering the evaluation and impact of seismic loadings on the pressure boundary items. Canada also requires that the design of items go through an approval process known as Design Registration.

**Table 43—Equivalence Between the N285.0 and ASME NB-3000**

| Topic | ASME Section III | N285.0-08 |
|---|---|---|
| Design | NB-3000 | **7.1.1 Class 1**<br>Class 1 systems and components shall be designed to comply with the requirements of the ASME BPVC, Section III, Division 1, NB-3000. |

Note:
In addition to the above, CSA N285.0-08, Clause 7.1.8 – Seismic requirements states: When the system classification list or the design specification states that the effect of seismic loadings is to be considered, the licensee shall meet the system requirements of the CSA N289 series of Standards.

### 7.5.1 Piping, Valves, and Pumps

The ASME technical requirements for design are directly referenced by the CSA Standard N285.0 as shown in Table 44. There are no exceptions identified in Clause 7.1.1.

**Table 44—Equivalence Between the N285.0 and ASME NB-3400/-3500/-3600**

| Topic | ASME Section III | CSA N285.0-08 |
|---|---|---|
| Pump Design | NB-3400 | **7.1.1 Class 1**<br>Class 1 systems and components shall be designed to comply with the requirements of the ASME BPVC, Section III, Division 1, NB-3000*. |
| Valve Design | NB-3500 | |
| Piping Design | NB-3600 | |

## 7.6 Fabrication – Welding

The ASME technical requirements for fabrication and installation are directly referenced by the CSA N285.0 Standard as shown in Table 45. There are no exceptions identified in Clause 9.2.1. However, the CSA standard requires that the welding procedure receive a prior approval process that is over and above the ASME requirements.

**Table 45—Equivalence Between the N285.0 and ASME NB-4000**

| Topic | ASME Section III | N285.0-08 |
|---|---|---|
| Fabrication & Installation | NB-4000 | **9.2.1 Class 1 systems**<br>The licensee shall have Class 1 systems, including their components and nonstandard fittings, fabricated and installed to comply with the requirements of the ASME BPVC, Section III, Division 1, NB-4000. |

## 7.7 Examination

The ASME technical requirements for examination are directly referenced by the CSA N285.0 Standard as shown in Table 46. There are no exceptions identified in Clause 11.1.1. The CSA standard requires that qualifications of NDE personnel in Canada conform to the CGSB Standard rather than the SNT-TC-1A Standard required by ASME Section III. Qualification to the SNT-TC-1A Standard is not excluded but requires approval of the ANI and the licensee before it is acceptable. This Clause also illustrates the broader scope of N285.0 compared to Section III because it addresses repairs and replacements, whereas Section III only considers new construction.

**Table 46—Equivalence Between the N285.0 and ASME NB-5000**

| Topic | ASME Section III | N285.0-08 |
|---|---|---|
| Examination | NB-5000 | **11.1.1**<br>The licensee shall have documentation to demonstrate that Class 1 systems and their components have been examined in accordance with the requirements of the ASME BPVC, Section III, Division 1, NB-5000. The effective date shall be established in accordance with Clause 4.3. Examination procedures and techniques for repairs and replacements may be in accordance with a later edition of the ASME BPVC, Section III, Division 1, NB-5000. |

## 7.8 Pressure Tests

The ASME technical requirements for pressure test are directly referenced by the CSA N285.0 Standard as shown in Table 47. There are no exceptions identified in Clauses 11.4.1 – 11.4.4.

**Table 47—Equivalence Between the N285.0 and ASME NB-6000**

| Topic | ASME Section III | N285.0-08 |
|---|---|---|
| Testing | NB-6000 | **11.4.1**<br>The licensee shall have documentation to demonstrate that all new systems and components have been subjected to a pressure test in accordance with Clause 11.4.<br>**11.4.2**<br>A pneumatic pressure test may be used only when a hydrostatic pressure test is not practicable because of service conditions, and provided that precautions have been taken for the protection of personnel.<br>**11.4.3**<br>The licensee shall retain the data report to demonstrate that a pressure test has been performed to the satisfaction of an inspector, who has countersigned the data report (see Table 1).<br>**11.4.4**<br>The licensee shall have documentation to demonstrate that Class 1 systems and their components have been tested in accordance with the requirements of the ASME BPVC, Section III, Division 1, NB-6000. |

## 7.9 Overpressure Protection

The ASME technical requirements for overpressure protection are directly referenced by the CSA Standard N285.0 as shown in Table 48. There are no exceptions identified in Clause 7.7.1.1. Once again, this Clause illustrates the difference between the U.S. and Canadian concept since there is a Class 4 and Class 6 in the Canadian context. The Standard CSA N285.0 has a list of suggested contents for the overpressure report, which would take precedence over the list of contents in NB-7200.

**Table 48—Equivalence Between the N285.0 and ASME NB-7000**

| Topic | ASME Section III | N285.0-08 |
|---|---|---|
| Overpressure | NB-7000 | **7.7.1.1**<br>Overpressure protection of Class 1, 2 and 3 systems and Class 4 components shall comply with the requirements of Clause 7.7 and the following articles from the ASME BPVC, Section III, Division 1:<br>(a) for Class 1 systems, NB-7000;<br>(b) for Class 2 systems, NC-7000;<br>(c) for Class 3 systems, ND-7000; and<br>(d) for Class 4 components, NE-7000. |

## 7.10 Overview of Quality Aspects

CSA N285.0 cites the Section III Quality Assurance program for construction of new components as shown in Table 49. The requirement to meet NCA-3800 for materials does permit the use of other quality assurance programs provided certain added requirements in NCA-3800 are met.

**Table 49—Equivalence between the N285.0 and ASME NCA-4000**

| Topic | ASME Section III | N285.0-08 |
|---|---|---|
| Quality Assurance | NCA-4000 | **10.3 Activities undertaken by a contractor**<br>Activities performed by a contractor or a licensee acting as a contractor associated with procurement, design, fabrication, installation, modification, replacement, or repair shall meet the following requirements:<br>(a) For Class 1, 1C, 2, 2C, 3, 3C or 4 systems, components, and supports, activities shall be carried out under a quality assurance program that satisfies the requirements of the ASME BPVC, Section III, Division 1, NCA-4000.<br>**10.4 Activities undertaken by a material organization**<br>Activities performed by a material organization or a licensee acting as a material organization associated with the manufacture or supply of materials for use in Class 1, 1C, 2, 2C, 3, 3C or 4 systems or components (including welding consumables) shall meet one of the following requirements:<br>(a) activities shall be carried out under a quality program that satisfies the requirements of the ASME BPVC, Section III, Division 1, NCA-3800*; |

* Although other quality standards apply to licensed operating CANDU stations and commercial products and service providers, Class 1 pressure boundary activities must comply with ASME requirements shown above.

## 7.11 Conclusion

Although the comparison of the CSA N285.0 Standard with ASME Section III has identified differences, they are relatively few given the significant volume of requirements. From the Canadian perspective, the implementation of the CSA Standard N285.0 is effectively the implementation of Section III.

The differences result either from different regulatory requirements or technical differences that are a result of the different concepts that are not addressed by Section III. This report identifies the technical differences, which are detailed in Appendix D.

# 8 PNAE G-7 VERSUS ASME BPVC SECTION III COMPARISON

## 8.1 Abstract

Russia is among the six leading countries in the world in terms of nuclear power generating capacity; these include the USA, France, Japan, Russia, Korea, and Ukraine. There are 11 BWR units of RBMK (Reaktor Bolshoy Moshchnosti Kanalniy or "high power channel-type reactor") type and 18 PWR units of WWER (water water energy reactor) type operating in Russian territory. In total, there are 49 WWER units worldwide in operation today, which represents more than 11% of the total number of operating NPPs in the world. All these reactors are designed and operated in accordance with the PNAE G-7 series of documents or the previous versions of normative documents included in the PNAE G-7.

Due to certain political and economic trends during the 20th century, regulatory support in the field of nuclear energy developed in the USSR almost independently from the rest of the world. Of course, the authors of PNAE G-7 had access to corresponding editions of the ASME and RCC-M codes (in fact, there is an official Russian translation of the RCC-M Code, 1988 Edition). Their main focus, however, was on features of domestic industry as well as on the accepted standardization system and existing practice for design and operation of NPP components within the USSR. Thus, compared to the other codes and standards discussed in this report, the PNAE G-7 series probably has the most significant differences, both in structure and technical content, relative to the ASME Code.

The significant difference in the structure of the PNAE G-7 versus ASME Section III, as described in Section 3.5 of this report, makes it very difficult to conduct a line-by-line comparison of ASME Subsection NB and documents of the PNAE G-7 series. Nevertheless, one-sided comparisons were made, i.e., ASME Code requirements were compared with the requirements of PNAE G-7.

As a result of the comparison, one can conclude that the bases of two compared documents are similar relative to technical concepts and normative approaches. Their implementation differs in the technical features that have resulted through historic development.

In the development of modern SPiR codes, the authors have attempted to harmonize the SPiR with the ASME Code, at least in structure. Regarding harmonization of specific requirements for materials, production, and examination, harmonization remains an ongoing process driven by domestic industry.

## 8.2 Introduction

This chapter provides a comparison of the requirements of ASME Code and PNAE G-7 series of documents concerning Class 1 components as defined by ASME Section III and similar components according to PNAE G-7-008-89. The approach described in Section 2 of this report was applied to complete the detailed comparison of these two codes.

It should be noted that the evaluation system used depends significantly on the individual opinion of the expert. As an example, in assessing the results of hydrostatic tests, the ASME Code prescribes the following:

*NB-6224 Examination for leakage after application of pressure:*

*Following the application of the hydrostatic test pressure for the required time, all joints, connections, and regions of high stress, such as regions around openings and thickness transition sections, shall be examined for leakage. Except in the case of pumps and valves which shall be examined while at test pressure, this examination shall be made at a pressure equal to the greater of the Design Pressure or three-fourths of the test pressure and it shall be witnessed by the Inspector. Leakage of temporary gaskets and seals, installed for the purpose of conducting the hydrostatic test and which will be replaced later, may be permitted unless the leakage exceeds the capacity to maintain system test pressure for the required amount of time. Other leaks, such as those from permanent seals, seats, and gasketed joints in components, may be permitted when specifically allowed by the Design Specification. Leakage from temporary seals or leakage permitted by the Design Specification shall be directed away from the surface of the component to avoid masking leaks from other joints.*

PNAE G-7-008-89 (5.7) requires the following:

*Equipment and piping shall be considered to pass the hydrostatic (pneumatic) test if the process of testing and examination results in no leaks and ruptures of the metal; in the process of pressure holding according to Section 3.4.1 the pressure drop was within the limits specified in Section 5.4.3, and following tests, no apparent residual strain is indicated. During hydrostatic (pneumatic) test of equipment and assembly units (parts) of pipeline leakage through the technologic seal, designed for testing, is not factor for rejection.*

It is evident that the intent of the requirements is extremely close and a classification "A2" can be defined as a result of the comparison. However, as a result of interpretation of the requirements by the individuals performing the comparison and particular mention of residual strain in the PNAE G-7-008-89 document, the author of the detailed comparison assigned a classification of "B2."

Further, it should be noted that a significant number of "B1" classifications does not necessarily imply that similar relevant requirements are not implemented when applying the Russian documents; rather, it only indicates that are no such requirements specifically included in the PNAE G-7 series of documents. However, similar requirements could be applied though implementation of other applicable guidance documents and standards. As noted in Section 3.5 of this report, specific differences in the standardization approach applied within the nuclear sphere of the Russian Federation results in the presence of a significant number of guidance documents and standards that are typically applied as supplemental requirements to the PNAE G-7 documents. Thus, although specifically absent in PNAE G-7 requirements, similar requirements can be found in the guidance documents and standards that apply to a particular product or in the applicable standards for semi-products.

## 8.3 Preliminary Paragraphs and Scope Presentation

The ASME Code recognizes three Safety Classes (1, 2, and 3), whereas PNAE G-7-008-89 recognizes three safety groups (A, B, and C). However, there is not necessarily a like correspondence between PNAE G-7-008-89 Safety Groups A, B, and C and ASME Class 1, 2 and 3. In fact, as the scope of the PNAE G-7 series of documents is much narrower than that of the ASME Code and applies only to the pressure boundary elements of the nuclear island, all three Safety Groups of PNAE G-7 are more closely aligned to ASME Class 1.

PNAE G-7 design rules are generally independent of the safety group. In particular, the strength analysis rules for all safety groups are the same within PNAE G-7 and are generally consistent with Class 1 as defined per ASME Section III. However, the construction and operation rules (including testing and examination) do depend on the safety group according to PNAE G-7-008-89.

PNAE G-7 does not apply to fuel cells and other internals, equipment and piping supports, steel structures, turbine bodies, transport containers, or metal-facing of concrete components.

PNAE G-7-002-86 does not contain a clear definition of the boundaries between the components of the various groups, compared to the chapters of Nx-1130 of the ASME Code.

PNAE G-7-002-86 does not define any stamping system or certificate holders.

## 8.4 Materials

Requirements for structural materials accepted for use in NPP components are defined in PNAE G-7-002-86 (3). Mechanical material properties used in strength analysis are given in PNAE G-7-002-86 (Appendix A). Methods for determination of mechanical properties are defined in PNAE G-7-002-86 (Appendix 2).

Similar information is included in Section II and Chapter NB-2000 of the ASME Code.

PNAE G-7-002-86 (Appendix 9) and ASME Section II contain the list of materials accepted for use.

The list defined in ASME is based on ASTM specifications. The PNAE G-7-002-86 list is based on USSR standardization documents, which include state and industry standards as well as manufacturers' specifications. For any particular semi-product, PNAE G-7-002-86 allows the use several different standards.

Since the ASME Code and PNAE G-7 documents are based on different standardization systems, it is not possible to conduct a one-to-one comparison for most materials defined in the ASME Code versus those of the PNAE G-7 and vice versa. This limitation is also related to specificity of manufacturing in the USA and the Russian Federation (previously USSR).

For some of the most popular materials, close equivalents can be found. For example, a comparison can be made between austenitic steels 321H and 08X18H10T. Comparison of requirements for their chemical composition are provided in Table 50.

**Table 50—Requirements for Chemical Composition of Austenitic Steels 321H and 08X18H10T**

| Material Grade | Element Mass Fraction, % | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | C | Si | Mn | Cr | Ni | Ti | S | P |
| 321H | 0,04 to 0,10 | Up to 1,0 | 2,0 | 17,0 to 20,0 | 9,0 to 13,0 | C×4 to 0,6 | ≤ 0,03 | ≤ 0,045 |
| 08X18H10T | ≤ 0,08 | ≤ 0,8 | ≤ 2,0 | 17,0 to 19,0 | 9,0 to 11,0 | C×5 to 0,7 | Up to 0,02 | ≤ 0,035 |

Mechanical properties of materials, that are similar relative to their chemical composition, may differ slightly (see Figure 37 and Figure 38). At the same time, one should note that the mechanical properties depend on the type of semi-product in PNAE G-7-002-86, while in the ASME Code, they do not.

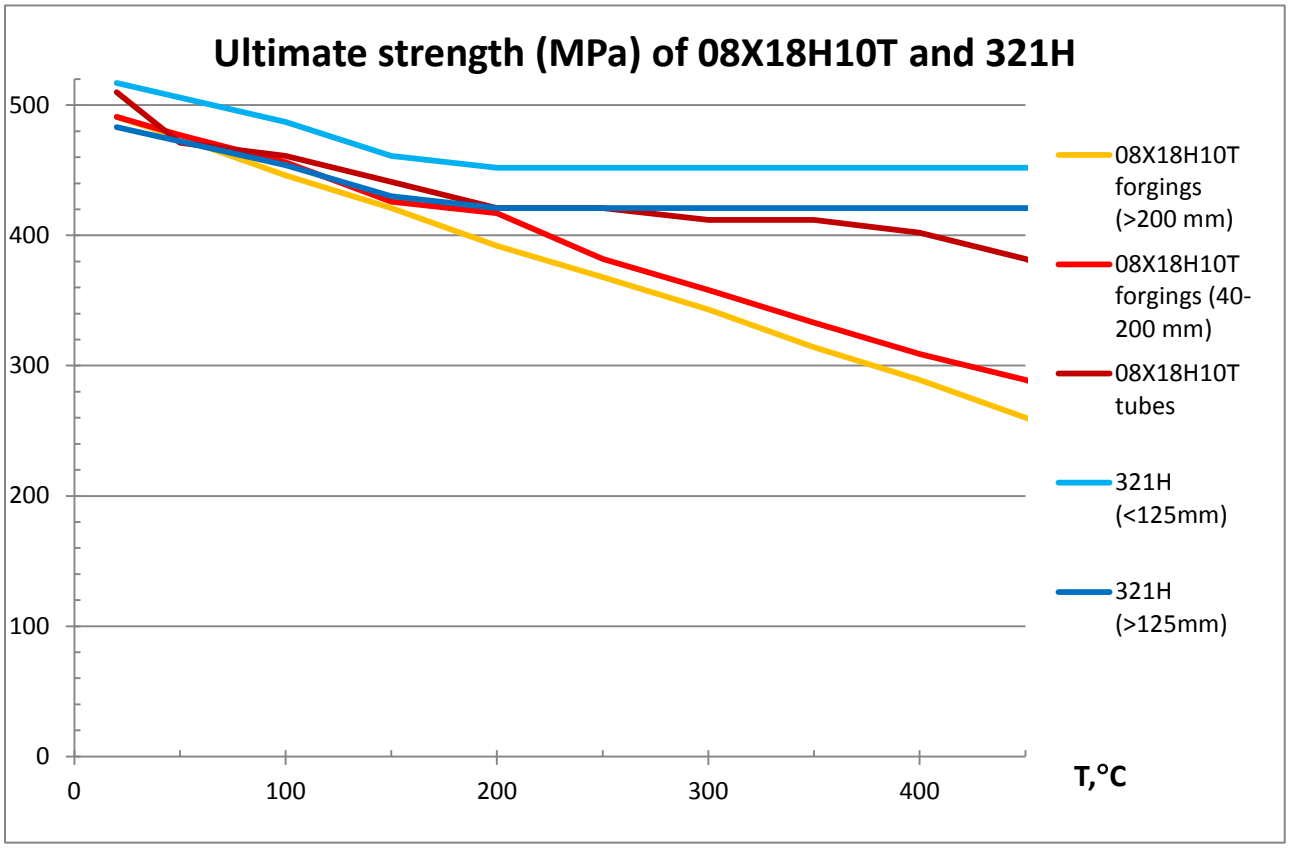



**Figure 37—Tensile Strength of Similar Austenitic Stainless Steels**

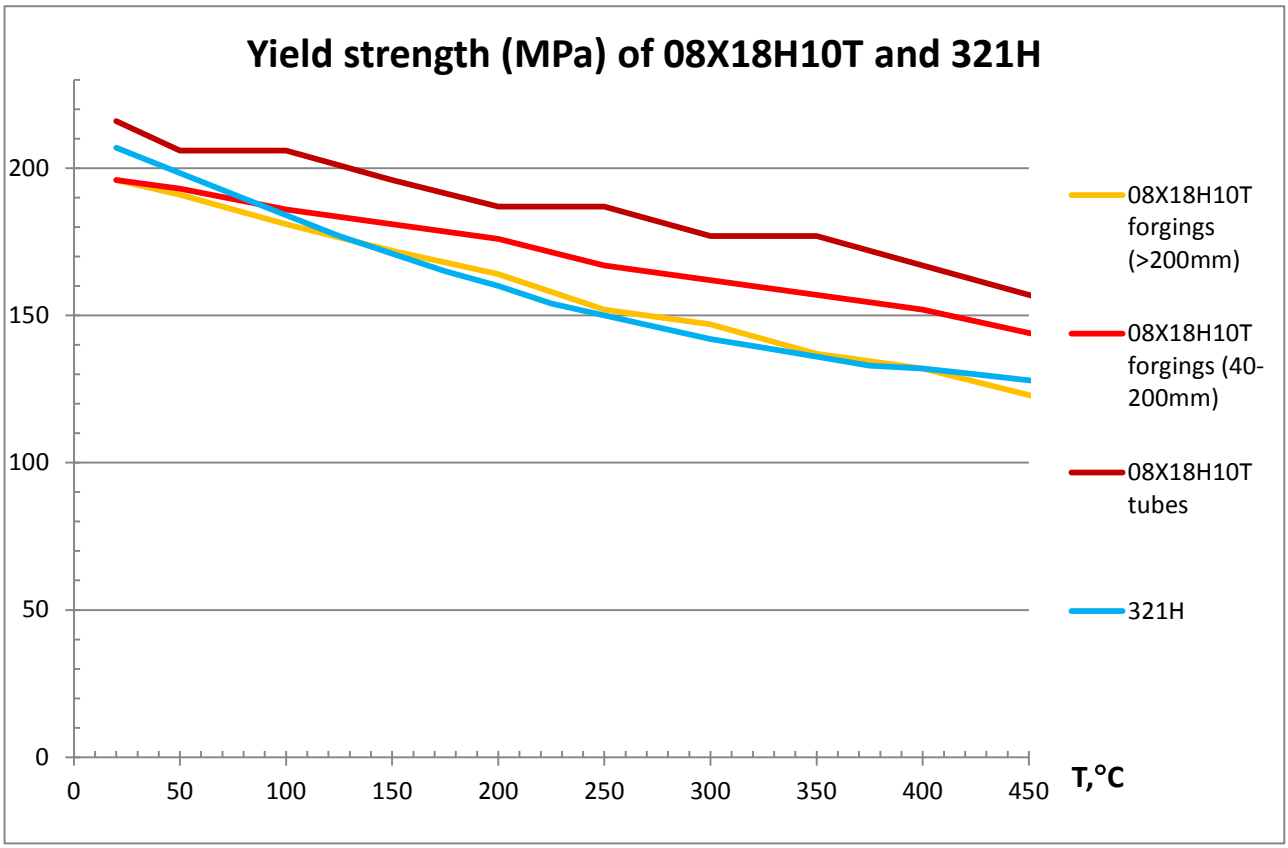



**Figure 38—Yield Strength of Similar Austenitic Stainless Steels**

The majority of the controlled characteristics defined in specifications pertaining to ASME materials and standards for Russian Federation semi-products are the same. These include determination of chemical composition, mechanical properties testing, visual examination, ultrasonic examination, radiographic examination, microstructure examination, etc. At the same time, there are significant technical differences relative to the specific requirements associated with these general characteristics and these vary depending on exact standard or specification. For example, standards pertaining to Russian Federation semi-products usually require tests at high temperatures (350°C) and the rules for conducting tests differ in details such as specimen geometry.

PNAE G-7-002-86 does not include general requirements for nondestructive tests of semi-products as does NB-2500 of the ASME Code. Such requirements are defined in specific Russian Federation standards and, in some cases, in PNAE G-7-014-89 – PNAE G-7-019-89 as well. Application of Russian Federation standards, however, is not mandatory.

If it is necessary to apply a new material, requirements defined in PNAE G-7-008-89 (3.4) are provided to support acceptance of the specific new material. A similar approach is applicable relative to the ASME Code and procedures for providing data pertaining to new materials are generally consistent between the two codes. In particular, element composition, allowable admixture limits, semi-products manufacturing procedures, service temperature range, heat treatment, and allowable external action (neutron irradiation) are considered.

Among other material requirements, ASME NB-2000 identifies the requirements for fracture toughness. NB-2300 contains detailed requirements for different types of semi-products. Similar but less detailed requirements are defined in PNAE G-7-002-86 (Annex 5.2).

Both ASME and PNAE G-7-002-86 require estimation of a lower service temperature and reference nil-ductility temperature $RT_{NDT}$ ($T_{k0}$), but use different approaches to estimate them. In determining nil-ductility temperature, the main difference is that ASME uses different criteria depending on material thickness and component application (e.g., material for vessels, piping, etc.). PNAE G-7-002-86 uses criteria depending only on the yield strength of the material. Another difference is that ASME uses lateral expansion (in mm) and absorbed impact energy (in J) to obtain $RT_{NDT}$ versus PNAE G-7-002-86, where impact toughness value, defined as absorbed energy divided by the specimen area (J/cm$^2$), is used.

## 8.5 Design

### 8.5.1 Classification of Equipment and Piping

According to PNAE G-7-008-89, equipment and piping are divided into safety groups A, B, and C, depending on the degree of system influence they have on NPP security.

Group A includes equipment and piping for which failure is the initial event leading to exceeding established design accident limits for fuel element damage under security systems design operation. Group A also includes the pressure vessel (and flow channels in the case of RBMK or CANDU-type reactors).

Group B includes equipment and piping that provide reactor core cooling and/or require the activation of safety systems and for which failure leads to non-recoverable leakage of coolant (leakage in excess of design capacity of safety valves).

Group C includes equipment and piping, not included in group A and B, for which failure leads to leakage of coolant, which provides the reactor core cooling, for which failure leads to failure of a safety system or an individual safety system channel, or for which failure leads to high- or intermediate-level radioactive release to the environment.

Appendix 2 of PNAE G-7-008-89 provides examples of component classification relative to groups A, B, and C for different types of NPPs. A specific equipment and piping classification list, indicating relevance to groups A, B, and C, is developed by the general designer for each individual NPP unit.

Since the scope of PNAE-G7 is limited to the pressure boundary elements of the nuclear island, it does not define graded rules to be applied depending on component classification as does the ASME Code where the most stringent rules are applied to Class 1 components. According to PNAE G-7-002-86, strength analysis is carried out by the same rules and criteria for equipment and piping regardless of the classification relative to groups A, B, and C.

As the overall specific rules for classification of equipment differ between ASME Section III and PNAE G-7, a clear equivalence between ASME Class 1, 2, and 3 and PNAE G-7-008-89 Group A, B, and C cannot be defined. Likewise, however, as the rules for classification differ, so does the application of design and analysis rules. For example, while the ASME Class 1 rules would apply to primary circuit components such as the primary side of steam generators, these components would be classified within PNAE G-7-008-89 Group B but the same design and analysis rules as those used for PNAE G-7-008-89 Group A would be applied.

### 8.5.2 Classification of Service Levels

PNAE G-7-002-86 (2) recognizes the following types of operation conditions:

- Design pressure at design temperature
- Normal operating conditions (NOC) – service conditions at operation provided by NPP's operations' schedule (steady-state conditions, startup, safety control system operation, changing power, shutdown)
- Violation of normal operating conditions (VNOC) – any deviation from NOC (of pressure, temperature, loads, etc.), that requires reactor shutdown to eliminate this deviation but not putting systems of emergency cooling of active zone into operation

- Emergency situation (ES) – any deviation from NOC and VNOC whose consequences can lead to such malfunction of active zone cooling that requires putting systems of emergency cooling of active zone into operation
- Pressure tests

Seismic loads can be applied along with any of the preceding operational conditions (NOC, VNOC, ES).

PNAE-G7 design documentation should include safety estimations of beyond-design-basis accidents. However, at present in the Russian Federation, there is no conventional legal practice of strength analysis for beyond-design-basis accidents.

Classification of design loads according to PNAE G-7 is carried out by the design organization.

As follows from the description of classifications of conditions according to PNAE G-7 and the ASME Code, the classification approaches are somewhat different. In the ASME Code, the loadings are divided according to allowable mechanical damage from application of these loadings, and in the PNAE G-7, according to the functional criteria. A very general correspondence of the classification of operating conditions is provided in Table 51 below.

**Table 51—Correspondence of Operation Conditions Classification**

| PNAE G-7 | ASME Code |
|---|---|
| NOC | Level A limits<br>Level B limits |
| VNOC | Level B limits<br>Level C limits |
| ES | Level C limits<br>Level D limits |
| Beyond design basis accident | Level D limits |

Additionally, cases of simultaneous service and seismic loads are considered in PNAE G-7. Two types of earthquake are defined:

- Maximum design earthquake (MDE) is an earthquake with average recurrence of 10,000 years.
- Project earthquake is an earthquake with average recurrence of 100 years.

Considering these definitions for earthquakes used in PNAE G-7, it is apparent that they differ from the safe shutdown earthquake (SSE) and operating basis earthquake (OBE) assigned to NPP when applying the ASME Code.

### 8.5.3 Nominal Allowable Stress (Design Stress Intensity)

The ASME Code and PNAE G-7-002-86 use the same mechanical characteristics to determine allowable stress (design stress intensity). There are differences, however, in values of safety factors. The values of nominal allowable stresses differ between the ASME Code and PNAE G-7-002-86 depending on the safety class to which a component belongs and design method applied (“design by formula” or “design by analysis”).

According to PNAE G-7-002-86 (3.4), nominal allowable stress for equipment and piping loaded by internal pressure is defined by:

$$[\sigma] = \min\left(\frac{R_m{}^T}{2{,}6}; \frac{R_{p0,2}{}^T}{1{,}5}\right),$$

where $R_m{}^T$ is the minimal value of ultimate strength at temperature;

$R_{p0,2}{}^T$ is the minimal value of yield strength at temperature.

(Note: In case of external pressure, the safety factor for yield strength increases from 1.5 to 2.0.)

Design stress intensity according to ASME Code is calculated as follows:

$$S_m = \min\left\{\frac{1}{3}S_T; \frac{1{,}1}{3}S_T R_T; \frac{2}{3}S_y; \frac{2}{3}S_y R_y\right\},$$

where $S_T$ is the specified minimum ultimate strength at room temperature;

$R_T$ is the ratio of the average temperature dependent trend curve value of tensile strength to the room temperature tensile strength;

$S_y$ is the specified minimum yield strength at room temperature;

$R_y$ is the ratio of the average temperature dependent trend curve value of yield strength to the room temperature yield strength.

Safety margins for ultimate strength are close: in PNAE G-7-002-86 the factor is 2.6, while in ASME, it is 3.0. Safety margin for yield strength for ferritic materials in both normative-technical documents is equal to 1.5.

In the formula from PNAE G-7-002-86 as opposed to the ASME Code, values of mechanical characteristics at room temperature are not used. In the ASME Code, a possibility of increasing $S_m$ for austenitic and some other steels is specially identified, while austenitic steels are considered among others in PNAE G-7-002-86.

Nominal allowable stress for bolts is determined as:

$$[\sigma] = \frac{R_{p0,2}{}^T}{2}$$ according to PNAE G-7-002-86,

$$S_m = \min\left\{\frac{1}{3}S_y; \frac{1}{3}S_y R_y\right\}$$ according to ASME Code.

As follows from these formulae, safety margins over yield strength for fasteners differ by 1.5 times. However, this does not lead to significant difference in results of strength confirmation analysis.

PNAE G-7-002-86 applies different mechanical characteristics for semi-products of the same material. Therefore, according to PNAE G-7-002-86, nominal allowable stress for forgings will be different than nominal allowable stress for pipes. This is illustrated in Figure 39 in an example of material grade 08X18H10T and its analog according to the ASME Code – 321 austenitic steel.

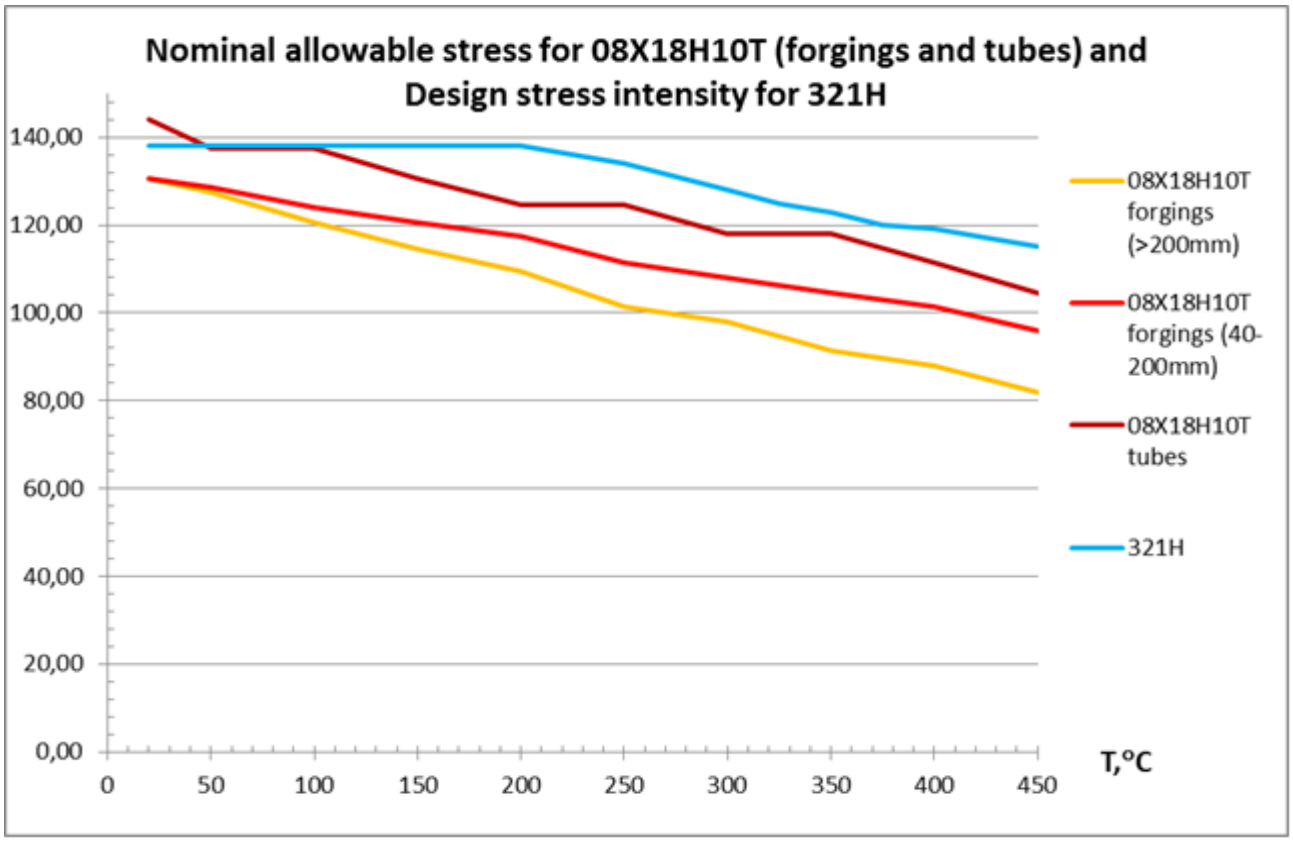



**Figure 39—Nominal Allowable Stress for 08X18H10T and Design Stress Intensity for 321H**

### 8.5.4 Determination of Principal Dimensions (Analysis by Formula)

Strength analysis for components, according to PNAE G-7-002-86 (1.2.2), is carried out in two steps. The first step is preliminary determination of principal dimensions and the second is detailed structural analysis. Determination of principal dimensions means determination of the minimum wall thickness using simple formulae.

In the ASME Code, rules for similar analysis to determine minimum thicknesses are given in NB-3130 (General Design Rules), NB-3300 (Vessels), NB-3400 (Pumps), NB-3500 (Valve), and NB-3600 (Piping).

Corrosion effects of the operational environment on wall thickness are considered during analysis, both in PNAE G-7-002-86 (4.1.4) and ASME NB-3121. PNAE G-7-002-86 includes more specific data on values to be applied for corrosion allowance whereas this information is typically included in the Design Specification when applying ASME rules. PNAE G-7-002-86 includes a table which defines numerical values of corrosion allowances to be applied for different steels depending on environmental conditions.

Both PNAE G-7-002-86 and the ASME Code contain formulae for estimation of principal dimensions of components of the most common shapes (cylindrical, spherical, elliptical and conical shells, pipes, etc.). Comparison of formulae is given in Table 52.

**Table 52—Formulae for Estimation of Wall Thickness**

| Component Shape | $s_R$ according to PNAE G-7-002-86 | $t$ according to ASME Code |
|---|---|---|
| Cylindrical shell | $\frac{p\,D}{2\varphi[\sigma]-p}$ (4.2.1) | $\frac{p\,R}{S_m-p/2}$ (NB-3324.1) |
| Conical shell | $\frac{p\,D}{2\varphi[\sigma]-p}\times\frac{1}{\cos\alpha}$ (4.2.1) | No formula available |
| Elliptical or torispherical bottom | $\frac{p\,D}{4\varphi[\sigma]-p}\times\frac{D}{2\,H}$ (4.2.1) | No formula available |
| Half sphere bottom or spherical shell | $\frac{p\,D}{4\varphi[\sigma]-p}$ (4.2.1) | $\frac{p\,R}{2S_m-p}$ (NB-3324.2) |
| Pipe, tee | $\frac{p\,D_a}{2\varphi[\sigma]+p}$ (4.2.2) | $\frac{p\,D_0}{2(S_m+0{,}4p)}$ (NB-3641.1) |
| Circular flat covers and bottoms | $K_4\,D_R\sqrt{\frac{p}{\varphi[\sigma]}}$ (4.2.3) | No formula available |

Evaluation of these formulae shows that they are almost identical except for the use of the strength reduction factor φ in PNAE G-7-002-86.

PNAE G-7-002-86 recognizes two types of strength reduction factors φ and $\varphi_d$ where φ applies for considering strength reduction resulting from a single hole, or a number of holes, and $\varphi_w$ applies for strength reduction associated with a welded connection where the value of coefficient $\varphi_w$ depends on the amount of examination applied to the specific welded joint.

NB-3330 of the ASME Code contains similar requirements for accounting for holes in components but applies a different approach to account for these rather than application of a strength reduction factor.

According to PNAE G-7002-86 (4.3.1.4), the maximum allowable diameter $d_0$ of unreinforced single holes is determined as follows:

$$d_0=\left(\frac{2}{\varphi_0}-1{,}75\right)\sqrt{D_m(s-c)}$$

where $\varphi_0$ is a strength reduction factor depending on size and shape of shell or bottom.

ASME (NB-3332.1(a), NB-3643.3(a)) also does not require reinforcement of a single hole, if its diameter $d_0$ does not exceed value of

$$d_0\le 0{,}2\sqrt{Rt}\,.$$

Considering an ultimate case $\varphi_0 = 1$, $d_0$, determined according to PNAE G-7-002-86, will be 76% larger than when using the ASME Code. When $\varphi_0 < 1$, this difference appears to be even larger. In practice, however, this apparent difference between ASME and PNAE-G7 is likely insignificant since

applicable stresses associated with the hole will be compared with corresponding allowable stresses during analysis and, if these conditions are met, there will be no need to satisfy the more strict requirements of hole reinforcement according to ASME paragraph NB-3331(c).

According to PNAE G-7-002-86, in case of $d > d_0$, a hole must be reinforced and the strength reduction factor shall be determined considering hole reinforcement as follows:

$$\varphi = \left[ 1 + \frac{A}{2 \cdot (s-c) \cdot \sqrt{D_m \cdot (s-c)}} \right],$$

Where, $A$ is a sum of all cross-section areas of reinforcement, determined by specific formulae.

According to the ASME Code, the cross-sectional area of reinforcement should not be less than the cross-section area of metal removed from the wall to make the hole (considering adjustments for sloping tees). In PNAE G-7-002-86, this area is allowed to be reduced by the area of metal that should have been removed to make the maximum allowable unreinforced hole.

Both PNAE-G7 and ASME include recommendations for geometric parameters of hole reinforcements (PNAE G-7-002-86 (4.3.1.10 – 4.3.1.16) and ASME NB-3334 although the specific recommendations included in each standard may be somewhat different.

### 8.5.5 Stress Classification

Stress classification in both PNAE G-7-002-86 and the ASME Code is carried out to make sure that stresses combined in specific groups (according to chosen strength theory) do not exceed corresponding allowable values.

As strength theory, both documents use the theory of maximum shear stresses.

The documents use same nomenclature for stress categories but designations are different. Examples of stress category comparison are given in Table 53.

**Table 53—Comparison of Stress Categories**

| | Symbols according to PNAE G-7-002-86 | Symbols according to ASME Code |
|---|---|---|
| General membrane stress | $\sigma_m$ | $P_m$ |
| Local membrane stress | $\sigma_{mL}$ | $P_L$ |
| General bending stress | $\sigma_b$ | $P_b$ |
| Local bending stress | $\sigma_{bL}$ | $Q$ |
| General thermal stresses | $\sigma_T$ | $Q$ |
| Stresses from restrained free end displacements of pipes | $\sigma_K$ | $P_e$ |

Recommendations for stress classification are included in PNAE G-7-002-86 (Table 5.1 and 5.2) and Tables NB-3217-1,2 of the ASME Code and these recommendations are very similar.

PNAE G-7-002-86 uses a special acronym to designate stress category groups, whereas the ASME Code uses a sum sign. Examples of comparison of stress category groups are given in Table 54.

**Table 54—Comparison of Stress Category Groups**

| | Symbols according to PNAE G-7-002-86 | Symbols according to ASME Code |
|---|---|---|
| All components excluding bolts | $(\sigma)_1$ | $P_m$ |
| | $(\sigma)_2$ | $P_{m(L)} + P_b$ |
| | $(\sigma)_{RV}$ | $P_{m(L)} + P_b + P_e + Q$ |
| | $(\sigma_{aF})$ | $P_{m(L)} + P_b + P_e + Q + F$ |
| Bolts | $(\sigma)_1$ | $P_m + Q_m$ (Note 1) |
| | $(\sigma)_{3w}$ | $P_m + Q_m$ |
| | $(\sigma)_{4w}$ | $P_m + P_b + Q$ |
| | $(\sigma_{aF})_w$ | $P_m + P_b + Q + F$ |

Note:
1. Here, $Q_m$ stands for mean stresses only from initial tightening.

### 8.5.6 Mechanical Loads Evaluation

According to the ASME Code, mechanical load evaluation can be carried out by computational or experimental methods. Computational analysis, in turn, can be performed by using elastic and elastic-plastic analysis.

In accordance with PNAE G-7-002-86, an elastic analysis is the only acceptable method of mechanical load assessment. According to PNAE G-7-002-86 (Tables 5.6 and 5.14), stresses estimated in the analysis of components and pipelines should not exceed the values shown in Table 55. Similar data for bolt stress limitation are shown in Table 56.

**Table 55—Mechanical Stress Limitations in Components and Pipelines in Accordance with PNAE G-7-002-86**

| Service Level | $(\sigma)_1$ | $(\sigma)_2$ |
|---|---|---|
| NOC | [σ] | 1,3 [σ] |
| VNOC | 1,2 [σ] | 1,6 [σ] |
| ES | 1,4 [σ] | 1,8 [σ] |
| NOC+MDE (Note 1) | 1,4 [σ] | 1,8 [σ] |
| NOC+DE (Note 1) | 1,2 [σ] | 1,6 [σ] |
| NOC+DE (Note 2) | 1,5 [σ] | 1,9 [σ] |

Notes:
1. I category seismic stability components and pipelines limits.
2. II category seismic stability components and pipelines limits.

**Table 56—Stress Limitations in Bolts in Accordance with PNAE G-7-002-86**

| Service Level | $(\sigma)_1$ | $(\sigma)_{3w}$ | $(\sigma)_{4w}$ |
|---|---|---|---|
| NOC | [σ] | 1,3 [σ] | 1,7 [σ] |
| VNOC | 1,2 [σ] | 1,6 [σ] | 2,0 [σ] |
| ES | 1,4 [σ] | 1,8 [σ] | 2,4 [σ] |
| NOC+MDE (Note 1) | 1,2 [σ] | – | 2,2 [σ] |
| NOC+DE (Note 1) | 1,4 [σ] | – | 2,0 [σ] |
| NOC+DE (Note 2) | 1,5 [σ] | – | 2,3 [σ] |

Notes:

1. I category seismic stability components and pipelines limits.
2. II category seismic stability components and pipelines limits.

The ASME Code limits stresses obtained from elastic analysis to the values given in Table 57 and Table 58.

**Table 57—Mechanical Stress Limitation in Components and Pipelines in Accordance with ASME Code NB-3000**

| Service Level | $P_m$ | $P_L + P_b$ |
|---|---|---|
| A | $S_m$ | 1,5 $S_m$ |
| B | 1,1 $S_m$ | 1,1×1,5 $S_m$ |
| C | min (1,2 $S_m$; $S_y$) | min (1,8 $S_m$; 1,5 $S_y$) |
| D | min (2,4 $S_m$; 0,7 $S_u$) | 1,5× min (2,4 $S_m$; 0,7 $S_u$) |

**Table 58—Stress Limitation in Bolts in Accordance with ASME Code NB-3000**

| Service Level | $P_m$ | $P_m + Q_m$ | $P_m + P_b + Q$ |
|---|---|---|---|
| A, B, C | $S_m$ | 2,0 $S_m$ | 3,0 $S_m$ |
| D | – | min ($S_y$; 0,7 $S_u$) | $S_u$ (Note 1) |

Note:

1. For high-strength bolts only (with tensile strength more than 700 MPa)

Results of the detailed comparison provided in Appendix E show that component and piping stress limits of PNAE G-7-002-86 NOC and ASME Code Level A loads are similar. PNAE G-7-002-86 uses a slightly more conservative increasing coefficient to estimate the bending stresses: 1.3 instead of 1.5 as used in the ASME Code.

Slightly different methodologies are used in to determine bolt stress limits. The ASME Code prescribes the same allowable stresses as in the A, B, and C level restrictions. PNAE G-7-002-86 allows a stress increase for the VNOC service condition.

Both PNAE-G7 and ASME limit the bearing stress. The PNAE G-7-002-86 limit ($1.5S_y$) is higher than that of ASME NB-3227 ($S_y$).

In addition to bearing stresses, ASME paragraph NB-3227 introduces other special stress restrictions. PNAE G-7-002-86 does not include these restrictions except in the case of shear stress, for which PNAE G-7-002-86 and ASME both define similar limits.

### 8.5.7 Buckling Analysis

Both PNAE G-7-002-86 (5.5) and ASME NB-3133 contain analytical expressions for determining the buckling load for components of simple geometrical shape (bottoms of hemispherical, elliptical, spherical forms and cylindrical, spherical, and conical shells). However, methodologies for determining the loads are significantly different.

Dimensions of shells and pipes used in the buckling analysis according to PNAE G-7-002-86 and the ASME Code are simiar. More detailed classification of different types of ribs and their influence on the allowable loads for the shells is given in PNAE G-7-002-86.

Geometric constraints and limits on the allowable deviation from the roundness are defined in PNAE-G7 to be applied to buckling analysis of cylindrical shells under external pressure using formulae from PNAE G-7-002-86. Geometric constraints are not defined in a similar explicit form in the ASME Code.

Two types of instability for various types of boundary conditions are considered in the analysis under longitudinal compression in PNAE G-7-002-86. These are not explicitly reflected in the ASME Code.

Combined action of axial compression and external pressure is considered in PNAE G-7-002-86 but similar requirements are not discussed in the ASME Code.

PNAE G-7-002-86 and the ASME Code both apply the same material properties (elastic modulus at specified temperature and yield strength at specified temperature) in the analysis of buckling.

Comparative analyses of cylindrical structures of austenitic steels applying monograms from the ASME Code and formulae from PNAE G-7-002-86 indicated satisfactory agreement for critical stress levels less than 0.43 of the yield strength at design temperature. Similar comparison were not performed for other levels of loads, structural forms, or materials.

### 8.5.8 Ratcheting Analysis

Both PNAE-G7 and ASME restrict the range of stresses, excluding those resulting from stress concentrations, obtained from the results of elastic analysis for normal operation conditions.

According to PNAE G-7-002-86, the stress range from all loadings is limited by:

$$\min\left[\left(2{,}5-\frac{R_{p0,2}^{T}}{R_{m}^{T}}\right)R_{p0,2}^{T},\ 2R_{p0,2}^{T}\right],$$

Where: $R_{p0,2}^{T}$ is the yield strength of material,

$R_{m}^{T}$ is the ultimate tensile strength of material.

In addition, the maximum stress used in calculating the stress range must not exceed the tensile strength value.

According to PNAE G-7-002-86, the stress range limitations are not mandatory for cases where distortion of the structure during operation cannot affect normal operation of the structure (there is no failure of leak-tight connections, no jamming of movable parts, no excessive distortion of passage sections defining coolant flow, and no unacceptable strains of associated components).

According to ASME NB-3222, the stress range is limited by $3S_m$, which, for a number of cases, is equal to $2R^T_{p0,2}$. NB 3228.5 defines the conditions under which the limits on the range of the stresses can exceed $3S_m$. Similar conditions in PNAE G-7-002-86 are absent.

Additionally, NB-3222.6 requires consideration of deformation limits. PNAE G-7-002-86 does not contain such a requirement.

PNAE G-7-002-86 includes a method for ratcheting evaluation of shell structures with linear or parabolic stress distribution across the wall thickness.

### 8.5.9 Fatigue Analysis

Both PNAE-G7 and ASME define requirements for fatigue.

The ASME Code defines allowances for considering Service Loadings for which Level C or D Service Limits are designated when accounting for stress variation. PNAE G-7-002-86 requires evaluating the full history of stress changes in all operational conditions.

According to PNAE G-7-002-86 (5.3), a typical sequence of loading during all service conditions (including pressure tests) is established. The values of six stress components for the applicable coordinate system and defined sequence of loadings are determined by elastic analysis. The values of principal stresses $\sigma_i$, $\sigma_j$ and $\sigma_k$ are determined from the six stress components. The index i is assigned to the largest principal stress for the loading process, and the other two principal stresses for the same time moment are assigned the indices j and k ($\sigma_i>\sigma_j>\sigma_k$). Thus, the principal stress directions (principal planes) are fixed.

PNAE G-7-002-86 does not contain recommendations regarding the procedure for fixing the real principal stresses to fixed planes. In practice, the principal stress vector is rotated to the nearest position, which is normal to the fixed principal area. The absolute value of the vector does not change.

The dependencies of principal stresses variation ($\sigma_i$, $\sigma_j$ and $\sigma_k$) are determined on the fixed principal planes for all time sequence of loading conditions. Stress intensities $(\sigma)_{ij}$, $(\sigma)_{jk}$ and $(\sigma)_{ik}$ are determined by Treska theory for time-history moments when increase (decrease) of the absolute value of any of the components of principal stresses is replaced by its decrease (increase). Thus, three time sequences of stress variations $(\sigma)_{ij}$, $(\sigma)_{jk}$ and $(\sigma)_{ik}$ are received.

Further, these three sequences are transformed into a sequence of "local conditionally elastic stresses" $(\sigma_F)_{ij}$, $(\sigma_F)_{jk}$ and $(\sigma_F)_{ik}$ by taking into account the stress concentration and possible plastic deformations.

The ASME Code uses a special stress ($S_{alt}$) for fatigue analysis. In a general case of rotation of the principal planes at a given point during loading, the procedure is as follows. Values of the six stress components are taken at a current time at a given point during loading. The time when extreme conditions in a cycle of stresses occur (algebraic maximum or minimum of stresses) is chosen. The ASME Code does not contain recommendations for choosing this moment and only notes that several moments might have to be considered to choose one that provides the maximum value of stress intensity. Then, for each time of stress cycle, its corresponding stress components are subtracted from the same name stress components for a selected time. These differences describe the increment of the stress tensor in comparison with the state at a chosen point of the time history and they are marked by a stroke. Principal stresses $\sigma_1$`, σ2`, and σ3` are determined according to the differences for each moment of the time history. Then, the time history of differences $S_{12}` = \sigma_1` - \sigma_2`$, $S_{23}` = \sigma_2` - \sigma_3`$, and $S_{31}` = \sigma_3` - \sigma_1`$are determined and the maximum absolute range of any stress differences is obtained. $S_{alt}$ is taken equal to half of the aforesaid range. The value of $S_{alt}$ is corrected by $K_e$ factor within a simplified elastic-plastic analysis.

This summary description of the methodology of defining of stress variation shows some of the differences between the ASME Code and PNAE G-7-002-86. The differences in accounting for rotation of the principal planes (a conditional fixing of the principal stresses to fixed planes in PNAE G-7-002-86 and subtraction of a fixed stress from the current stress in the ASME Code) lead to different values of the calculated stress amplitudes. In particular, according to PNAE G-7-002-86, stress cycle is absent when the cyclic rotation of planes at constant absolute values of the principal stresses is present, and the ASME Code fixes the cycle that corresponds to the increment of the stress tensor due to rotation. The difference in this case becomes less if the angle of rotation is smaller. In practice, the rotation angle of the principal planes is small and, in rare cases, it reaches 30°. Neither of the two approaches is considered to have any significant advantage over the other.

If the elastic stresses exceed the cyclic yield stress, both PNAE G-7 and ASME prescribe the introduction of a correction to account for plastic deformation of the material. The $K_e$ factor is used for this correction in the ASME Code. In PNAE G-7-002-86 (5.3.8), the $K_e$ factor is not applicable directly. The formula for $K_e$ can be obtained from formula the following fomula:

$$K_e = \left(2 \cdot R_{pe}^T\right)^{\frac{\nu-1}{\nu+1}} \cdot \left\{ \frac{1+\nu}{2} \left[\Delta(\sigma_L)\right]^2 + \frac{1-\nu}{2} \left(2 \cdot R_{pe}^T\right)^2 \right\}^{\frac{1}{1+\nu}},$$

where $2 \cdot R_{pe}^T$ is proportionality limit and ν is exponent of the cyclic diagram. The formula of the cyclic diagram is presented below:

$$\sigma = 2\, R_{pe}^T \cdot \left( \frac{E^T \cdot \varepsilon}{R_{pe}^T} \right)^{\nu}.$$

According to the ASME Code, the $K_e$ factor is calculated as follows:

$$K_e = \begin{cases} 1{,}0 & if \quad S_n \le 3S_m \\ 1{,}0 + \left[ \dfrac{1-n}{n(m-1)} \right] \left[ \dfrac{S_n}{3S_m} - 1 \right] & if \quad 3S_m < S_n < 3mS_m \\ \dfrac{1}{n} & if \quad S_n \ge 3mS_m \end{cases}$$

Where: $S_n$ is the magnitude of the primary and secondary stresses and $m$ and $n$ are material parameters.

Comparison of the calculated $K_e$ factor values for carbon steel is shown in Figure 40. As shown, the difference may be significant.

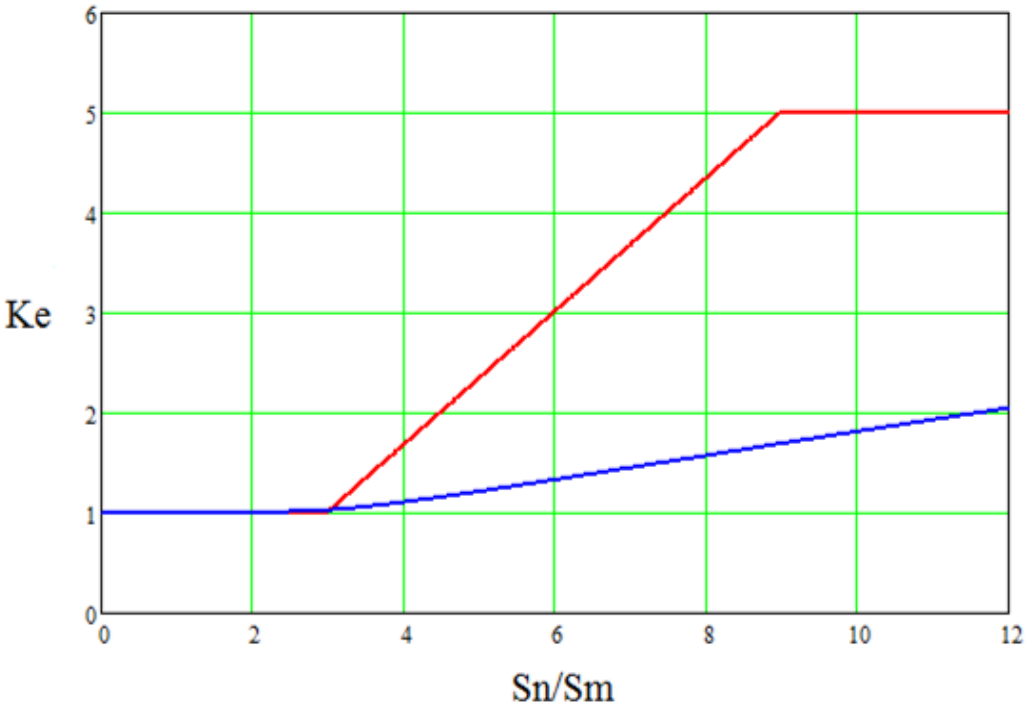



**Figure 40—Comparison of the Calculated $K_e$ Factor for Carbon Steel**

ASME Code design fatigue curves are based on experimental strain cycling at room temperature. A specific modulus of elasticity corresponds to each curve. ASME design fatigue curves use safety or reduction factors of 2 for amplitude and 20 for number of cycles versus best fit curves.

PNAE G-7-002-86 design fatigue curves are developed based on Manson-Langer type equations. Fatigue curves for various types of materials (carbon, low-alloy and austenitic stainless steel alloys, zirconium, and aluminum) calculated based on actual values of mechanical properties were compared with experimental curves of the materials of Russian and foreign grades. Satisfactory coincidence between analysis and experiment was obtained. Safety factors used for the fatigue curves in the equipment and piping analysis are 2 for amplitude and 10 for number of cycles. According to PNAE G-7-002-86, safety factors for bolt analysis are 1.5 and 5.

According to the ASME Code, failure of a sample is a limiting condition for fatigue analysis. According to PNAE G-7-002-86, limiting condition of a sample is a crack with length about 0.5–2 mm. This fact can explain the difference in safety factor while the design curves are close (as shown in Figure 41).

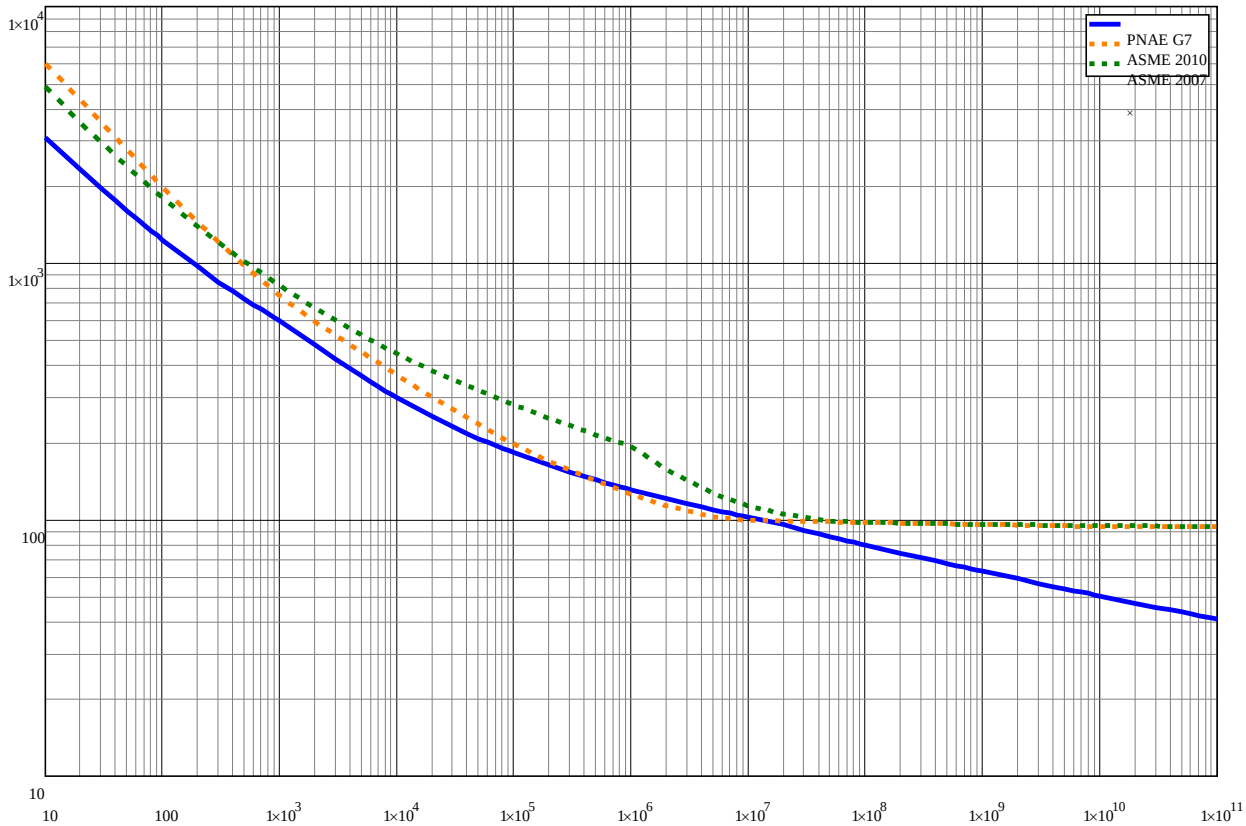



**Figure 41—Designed Fatigue Curves for Austenitic Steels at Room Temperature**

The difference in safety factors when analyzing bolts does not lead to a considerable difference in analysis results because the ASME Code requires use of a concentration factor during bolt evaluation, which is limited to 4.0. PNAE G-7-002-86 (5.3.12) requires use of an analytical formula that depends on parameters of threaded joints to calculate the theoretical stress concentration factor. The maximum value of the theoretical stress concentration factor for standard metric threads with controlled root radius is 5.14.

Design curves in the ASME Code were plotted considering the maximum effect of cycle asymmetry. Theoretical formulae in PNAE G-7-002-86 allow determination of design curves considering any value of asymmetry, which allows elimination of unnecessary conservatism.

Cyclic strength of weld metal (weld heat affected zone) can be lower than that of base metal. According to PNAE G-7-002-86, for standard welded joints, a fatigue strength reduction factor $\varphi_s$ should be found from experiment. PNAE G-7-002-86 (5.6.12) defines the fatigue reduction factor for a number of typical welded joints. ASME does nor apply a fatigue strength reduction factor for welded joints.

PNAE G-7-002-86 also considers an increase of fatigue damage in the case of superposition of high-frequency cycles on low-frequency cycles. For example, superposition of vibration and load cycles related to heating and cooling of a circuit. The factor to reduce the allowable number of low-frequency cycles depends on a ratio of stress amplitude and cycle frequencies that can reach up to several tens of times. These factors are determined by experiment.

Accounting for stress due to pressure test in the fatigue analysis varies. According to the ASME, fatigue analysis is carried out without considering the first 10 cycles of pressure tests, or any combination of 10 such tests. According to PNAE G-7-002-86, all test cycles are taken into account.

### 8.5.10 Fast Fracture Analysis

Curve $K_{IR} = f\,(T - RT_{NDT})$ is used in the ASME Code for brittle fast fracture analysis. The curve is based on the lower boundary of the $K_I$ critical values data, obtained by the static, dynamic, and crack brake tests. $RT_{NDT}$ temperature is determined in drop weight tests and Charpy test by impact fracture toughness and transverse expansion values.

Curves $K_{IC} = f\,(T - T_k)$ are used in PNAE G-7-002-86. The curves are based on the lower-boundary $K_{IC}$ critical values data, obtained during static loading of samples from vessel steels and their welds. There is also a generalized curve for other steel grades. The critical nil-ductility temperature $T_{k0}$ is determined by impact bending test results. The $T_k$ temperature is determined from $T_{k0}$ by introducing the temperature shifts $\Delta T_k$ as a result of radiation, thermal, and fatigue aging.

In most cases, $T_k$ temperature is slightly above $RT_{NDT}$ temperature.

For simplicity of curve comparison, assume that $RT_{NDT} = T_k$. The curve comparison for PNAE G-7-002-86 (Figures 5.14 – 5.17) and the ASME Code (Figure G-2210.1) shows that the generalized curve used in PNAE G-7-002-86 (Figure 5.17) is close to the ASME Code curve. The remaining curves for the materials used in reactor pressure vessel manufacture in Russia lie to the left of the ASME Code curve. This may be a result of the difference in properties for the materials used in the Russian Federation and the USA for reactor pressure vessel manufacturing.

A normal to maximum stress direction surface crack was adopted as a postulated defect in ASME G-2120. The crack depth is assumed to be 1/4 of wall thickness with a length equal to 1.5 of wall thickness for 101.6 to 304.8 mm thicknesses. The same crack for 304.8 mm thickness is taken for thicknesses of more than 304.8 mm. A 25.4 mm depth crack is taken for thicknesses of less than 101.6 mm. Smaller defect sizes may be used if reasonable assurance can be provided that large cracks cannot be found in the construction.

Semi-elliptical surface cracks of 0.25 wall thickness depth and 0.75 wall thickness length are specified in PNAE G-7-002-86 (5.8.5.2) without any thickness restrictions.

In the ASME Code, calculated crack length is larger than in PNAE G-7-002-86, but crack depth is the same.

Safety factors equal to 2.0 for stress intensity factor identified by primary stresses, and 1.0 for stress intensity factor identified by secondary stresses, are specified in ASME Code G-2215. A safety factor of 2.0 is introduced in PNAE G-7-002-86 (5.8.3.1) regardless of the nature of the stress. In addition, a temperature margin of 30°C is introduced.

Safety factors equal to 1.5 for stress intensity factor identified by primary stresses, and 1.0 for stress intensity factor identified by secondary stresses, are specified in ASME Code G-2400 for hydraulic test conditions; also, a temperature margin of 60°F (33°C) for $RT_{NDT}$ is introduced. A safety factor of 1.5 is introduced in PNAE G-7-002-86 (5.8.3.1) regardless of the nature of the stress. In addition, a temperature margin of 30°C is introduced.

## 8.6 Fabrication and Welding

This subsection presents the results of comparisons of the basic provisions pertaining to welding and manufacturing.

ASME and PNAE standards are similar in fundamental principles pertaining to qualification of welding processes; both describe an organizational approach for certification and qualification of welding processes; define of essential parameters fundamental for development of welding process specifications; provide heat treatment requirements (pre-heating, control of temperature during welding and heat treatment after welding); and specify test and examination requirements for qualification of welding processes and examination of weld joint quality.

Comparative analysis of concepts and definitions from ASME and PNAE G-7 are presented in Table 59.

**Table 59—Fundamental Concepts of ASME Code Section IX and PNAE G-7**

| ASME Code | PNAE G-7 | Comments to PNAE G-7 |
|---|---|---|
| Specification of the welding process | Industrial engineering documentation | Developed by manufacturer. Provides guidance to manufacturing personnel. |
| Qualification of the welding process | Industrial certification of the welding technology | Executed on the basis of the certification program of welding technology and industrial engineering documentation. Both documents are developed by the manufacturer who also carries out the certification. |
| Welding procedure qualification report | Report of industrial certification of the welding procedure | Report must include:<br>• all regulated parameters of welding technology;<br>• all results of tests obtained by destructive and nondestructive examination methods. |

ASME Section IX specifies the list of welding parameters (see Table 60) that must be addressed in the welding procedure specification. The type and the number of parameters specified in this list are identical to those to be provided in the industrial engineering documentation in accordance with PNAE G-7.

**Table 60—List of Welding Technology Parameters Specified in ASME Code and PNAE G-7**

| Welding Technology Parameters | ASME Code | PNAE G-7 |
|---|---|---|
| Structural shape of a joint | Requirements are defined by manufacturer | PNAE G-7-009-89 |
| Base metal | ASME Code Section II<br>ASTM Specifications<br>ASME Code Section IX | PNAE G -7-008-89<br>PNAE G -7-009-89 |
| Welding consumables | ASME Code Section II<br>ASW Specification<br>ASME Code Section IX | PNAE G -7-009-89 |
| Initial heating conditions | Requirements are defined by manufacturer | PNAE G -7-009-89 |
| Sequential heat treatment | Requirements are defined by manufacturer | PNAE G7-009-89 |
| Electrical characteristics | Requirements are defined by manufacturer | PNAE G7-009-89 (recommended) |
| Technique of welded joints | Requirements are defined by manufacturer | PNAE G-7-009-89 |
| The numerical values, ranges, and descriptions of changes in significant variables that change conditions of welding and affect mechanical properties | ASME Code Section IX | Not provided |
| The numerical values, ranges, and descriptions of changes in significant variables that affect manufacturing joint quality | ASME Code Section IX | Not provided |

Comparison of the types of test methods and specimens required by the PNAE G-7-010-89 and ASME codes for various types of welded joints during qualification of the welding process is presented in Table 61. This table indicates that requirements defined by both Codes relative to basic examination methods are virtually the same. One significant difference noted from this table is that the ASME Code includes drop weight testing but PNAEG-7-010-89 does not.

**Table 61—Types of Tests and Examinations Used for Qualification of Welding Procedures**

| Type of Testing or a Control | Type of a Sample | Availability in Standards | |
|---|---|---|---|
| | | ASME Code | PNAE G-7-010-89 |
| 1. Tensile test | Flat | + | + |
| | Segmental (for tubes of large diameter) | + | + |
| | Cylindrical | + | + |
| | Flat section of a tube | + | + |
| 2. Bend test | Transversal side bend | + | – |
| | Transversal, surface of a weld is outside | + | + |
| | Transversal, root of a weld is outside | + | + |
| | Longitudinal, surface of a weld is outside | + | + |
| | Longitudinal, root of a weld is outside | + | + |
| 3. Bending impact test | With V-notch for Charpy tests | + | + |
| 4. Drop weight tests of notched samples | By specification ASTM E 208 | + | – |
| 5. Tests of fillet welds | Samples for examination and macroexamination | + | + |
| | Samples for collapse tests | + | – |
| 6. Radiographic examination | Test welded joint | + | + |
| 7. Tests on welded studs | Samples for bend test or for flattening from above | + | – |
| | Samples for torsion and tensile tests | + | – |
| 8. Examination by liquid penetrant | Test welded joint | + | + |

Notes:

+ - provided by standards

– - not provided by standards

Another significant difference between the ASME and PNAE-G7 relative to welding is the requirement for destructive testing of production welds which is obligatory according to Russian regulatory documents. While ASME Design Specifications may define supplemental requirements requiring destructive examination of particular types of weld joints, ASME Section III does not define requirements for destructive examination of welds beyond the testing required to support welding procedure qualification. Likewise, whereas the ASME approach for procurement and certification of welding consumables is based on assessment and qualification of approved suppliers and certification of materials by the Supplier, PNAE G-7-010-89 requires each lot of materials to be independently tested by the equipment manufacturer prior to use.

## 8.7 Examination

This section contains the comparison of the PNAE G-7-010-89 and the ASME Code requirements and acceptance standards for examination of welded joints.

The ASME Code more clearly stipulates the required examination methods and extent of examination depending on the types of welded joints (butt, corner with full penetration or with constructive gap, longitudinal or circular, etc.) for elements of all classes of equipment and piping. Nevertheless, the PNAE G-7-010-89 and the ASME Code approaches to classification and treatment of defects is virtually identical; the most dangerous defects – cracks, lack of fusion, and incomplete fusion – are not permitted by either and implementation in practice is similar.

Acceptance standards for production welds in the PNAE G-7 Code are, in general, consistent with those of the ASME Code for respective types of examinations but, on a specific case-by-case basis, acceptance criteria for specific examinations may be more or less conservative.

Both PNAE G-7 and the ASME Code apply the same nondestructive examination methods:

- Visual
- Liquid Penetrant Examination
- Magnetic Particle Testing
- Radiography
- Ultrasonic Testing

Table 62 presents the mandatory methods and extent of examination from both Codes for different weld joint categories.

**Table 62—Methods and Amounts of Welds Examination According to PNAE G-7-010-89 (Category I) and ASME Code (Class 1 Subsection NB)**

| Type of Weld Joint | Code | Thickness or Diameter, mm | Method and extent of NDE, % | | |
|---|---|---|---|---|---|
| | | | RT | UT | LPT or MT |
| Butt joints of vessels and pipelines | PNAE G-7-010-89 | s < 5.5 | 100 | – | 100 |
| | | d > 5.5 | 100 | 100 | 100 |
| | ASME Code | Any | 100 | – | 100 |
| Corner joints of vessels, joints with full penetration | PNAE G-7-010-89 | d < 5.5 | 100 | – | 100 |
| | | d > 5.5 | 100 | 100 | 100 |
| | ASME Code | Any | 100 | 100 | 100 |
| Corner joints of nozzles, pipe outlets, welds with full penetration | PNAE G-7-010-89 | < 30 | 50 | – | 100 |
| | | > 30 | 100 | 100 | 100 |
| | ASME Code | < 100 | – | – | 100 |
| | | >100 | 100 | 100 | 100 |
| Corner joints, joints with partial penetration (with structural gap) | PNAE G-7-010-89 | Any | – | – | 100 |
| | ASME Code | Any | – | – | 100 |

The data from Table 62 indicates that the extent of NDE for production weld joints (radiography, ultrasonic inspection, liquid penetrant, and magnetic particle inspection) of Category I according to PNAE G-7-010-89 is generally equivalent to that required by ASME Code Class I components.

### 8.7.1 Examination of Surface of Welded Edges

The ASME Code requires surfaces of weld bevel edges with a thickness greater than 50 mm to be examined by the liquid penetrant or magnetic particle method. PNAE G-7-008-89 includes similar requirements and prescribes to examine surfaces of edges after machining. PNAE G-7-010-89 acceptance criteria for surface examination of edges of bevels for Category I welds are more stringent than those of ASME; acceptance standards for PNAE G-7-010-89 for Category II welded joints are equivalent to those of ASME.

### 8.7.2 Radiographic Examination

Classification of defects is similar in both PNAE G-7 and the ASME Code.

Figure 42(a) provides a graph of acceptance criteria for single large defects vs. thickness of welded elements for ASME Class 1 components and Category I welded joints per PNAE G-7-010-89.

The graph shows that for most large defects, the criteria of PNAE G-7-010-89 for Category I welded joints are more stringent than those of the ASME Code. For other categories of welded joints, the situation is the same.

Figure 42(b) provides a graph of acceptance criteria for round and single indications vs. thickness of welded elements according to the requirements for ASME Class 1 components and Category I welded joints per PNAE G-7-010-89. The graph shows that acceptance criteria of PNAE G-7 are more stringent than those of the ASME Code through most of the range of thicknesses.

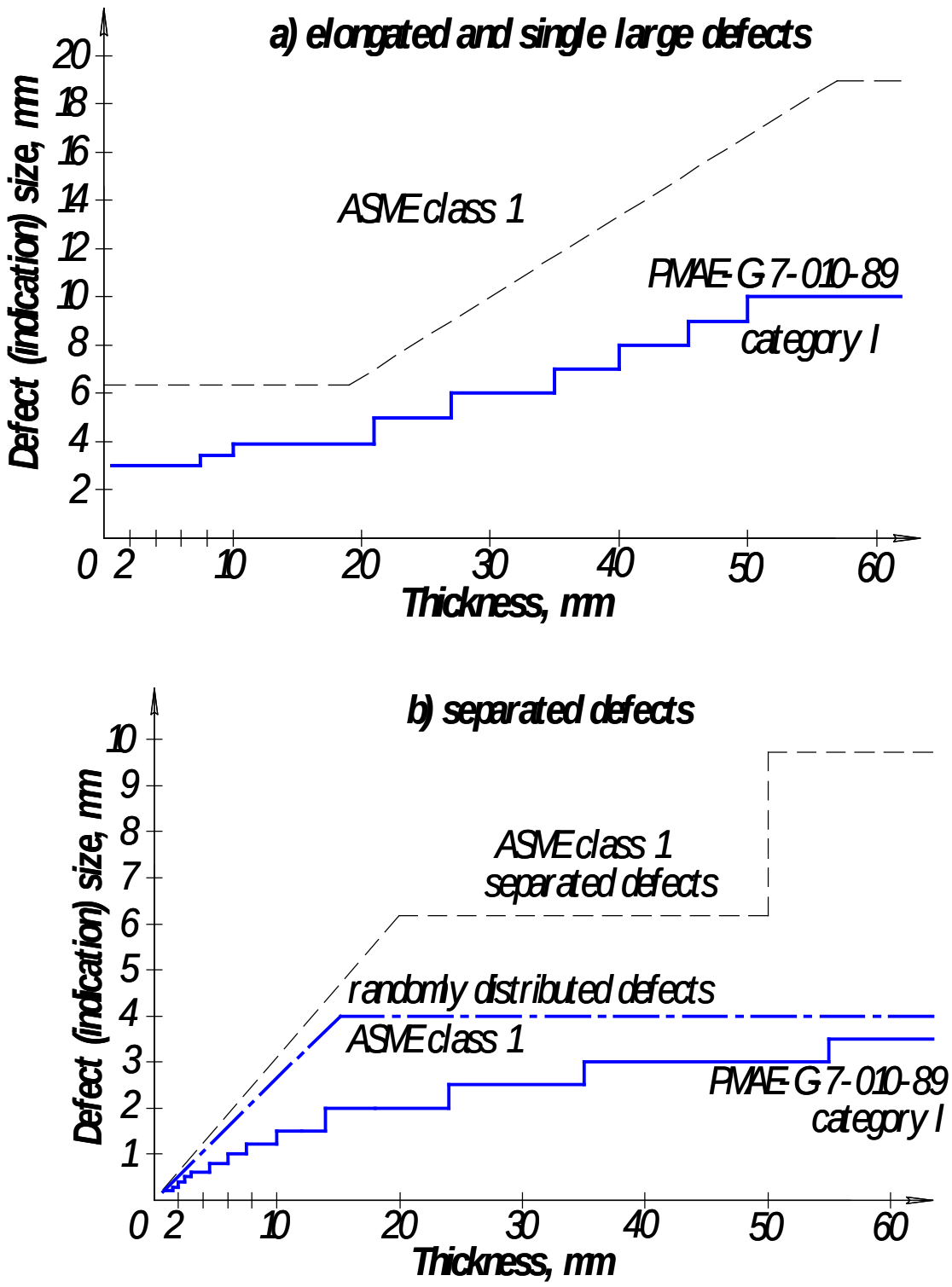



**Figure 42—Sizes of Unacceptable Defects vs. Thickness of Welded Elements for Radiographic Examination According to PNAE G-7-7-010-89 and ASME Code**

### 8.7.3 Liquid Penetrant and Magnetic Particle Method

ASME and PNAE G-7 both require liquid penetrant or magnetic particle method to applied in conjunction with radiographic examination for welded joints of Class I components (or Category I and II welds in the case of PNAE G-7). Figure 43 provides a plot of acceptance criteria vs. thickness of welded elements.

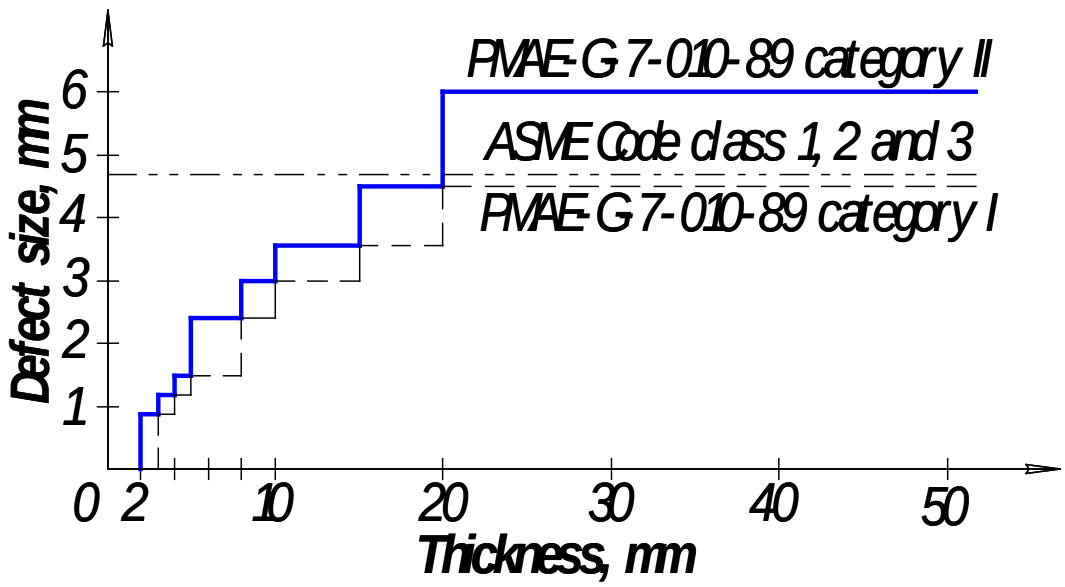



**Figure 43—Sizes Unacceptable Defects vs. Thickness of Elements during Liquid Penetrant or Magnetic Particle Examination According to PNAE G-7-010-89 and ASME Code**

The comparative analysis shows that both Codes treat elongated indications in the same way (they are not allowed). Acceptance criteria for rounded indications per PNAE G-7-010-89 are more stringent than those of the ASME Code for thicknesses up to 20 mm thickness. For greater element thicknesses, PNAE G 7-010-89 requirements for Category I are virtually identical to those of the ASME. PNAE G-7 criteria for Category II welded joints with thickness over 20 mm are less stringent than those of the ASME Code. However, PNAE G 7-010-89 limits the maximum number of indications per 100 mm of seam length and the ASME Code does not.

Acceptance standards for magnetic particle and liquid penetrant methods in PNAE G-7-010-89 and the ASME Code are similar, so no further analysis is provided.

### 8.7.4 Ultrasonic Examination

During comparison of acceptance standards in Russian regulatory documents and the ASME Code, one common requirement is apparent — elongated defects detected during ultrasonic examination are not permitted. For other types of defects, comparative analysis was not performed because of significant differences in defect assessment methods.

### 8.7.5 Convexity of Weld Seams

Figure 44 is a plot of the limit values of weld seam convexity vs. thickness of welded elements according to PNAE G 7-010-89 (maximum values for different weld types with account of positive tolerance) and the ASME Code.

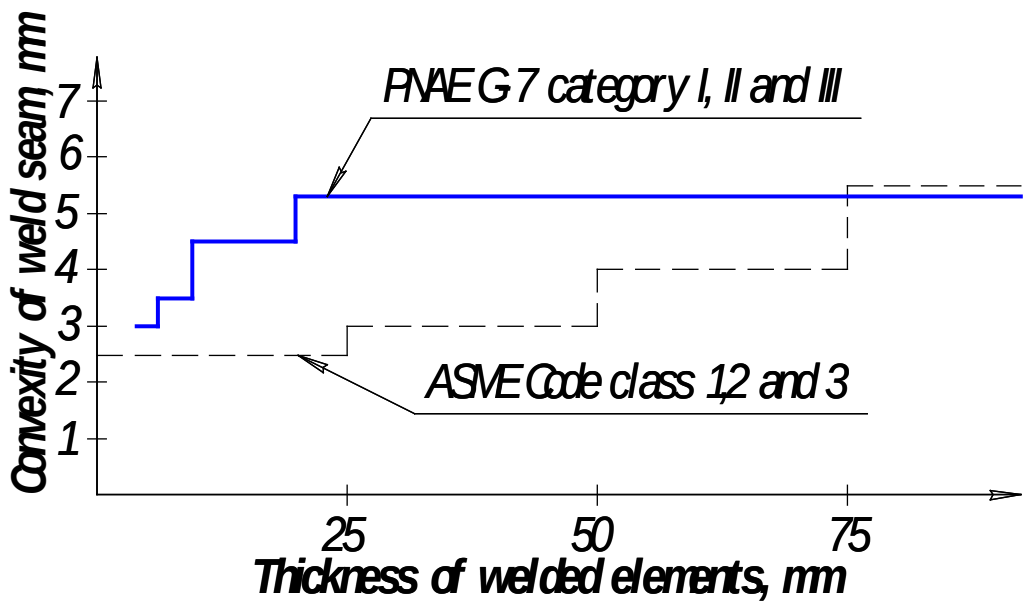



**Figure 44—Limit Values of Weld Seam Convexity vs. Thickness of Welded Elements According to PNAE G 7-010-89 and ASME Code**

The data indicate that the ASME criteria for allowable weld convexity of welds is more stringent than that of PNAE G-7 for thicknesses up to 75 mm; for greater thicknesses, the requirements are the same.

### 8.7.6 Offset of Weld Edges in Butt Weld Joints

Acceptance standards for offsets of edges in butt weld joints in the ASME Code and PNAE G 7-010-89 are shown in the Figure 45 as the dependence of maximum allowable offsets in longitudinal (a) and circular seams (b) vs. thickness of welded elements.

These graphs show that the PNAE G-7 criteria for maximum offset are generally more stringent than those of the ASME Code; for longitudinal seams in the thickness range from 40 to 70 mm, requirements of the ASME Code are more stringent than those of PNAE G-7-7-010-89.

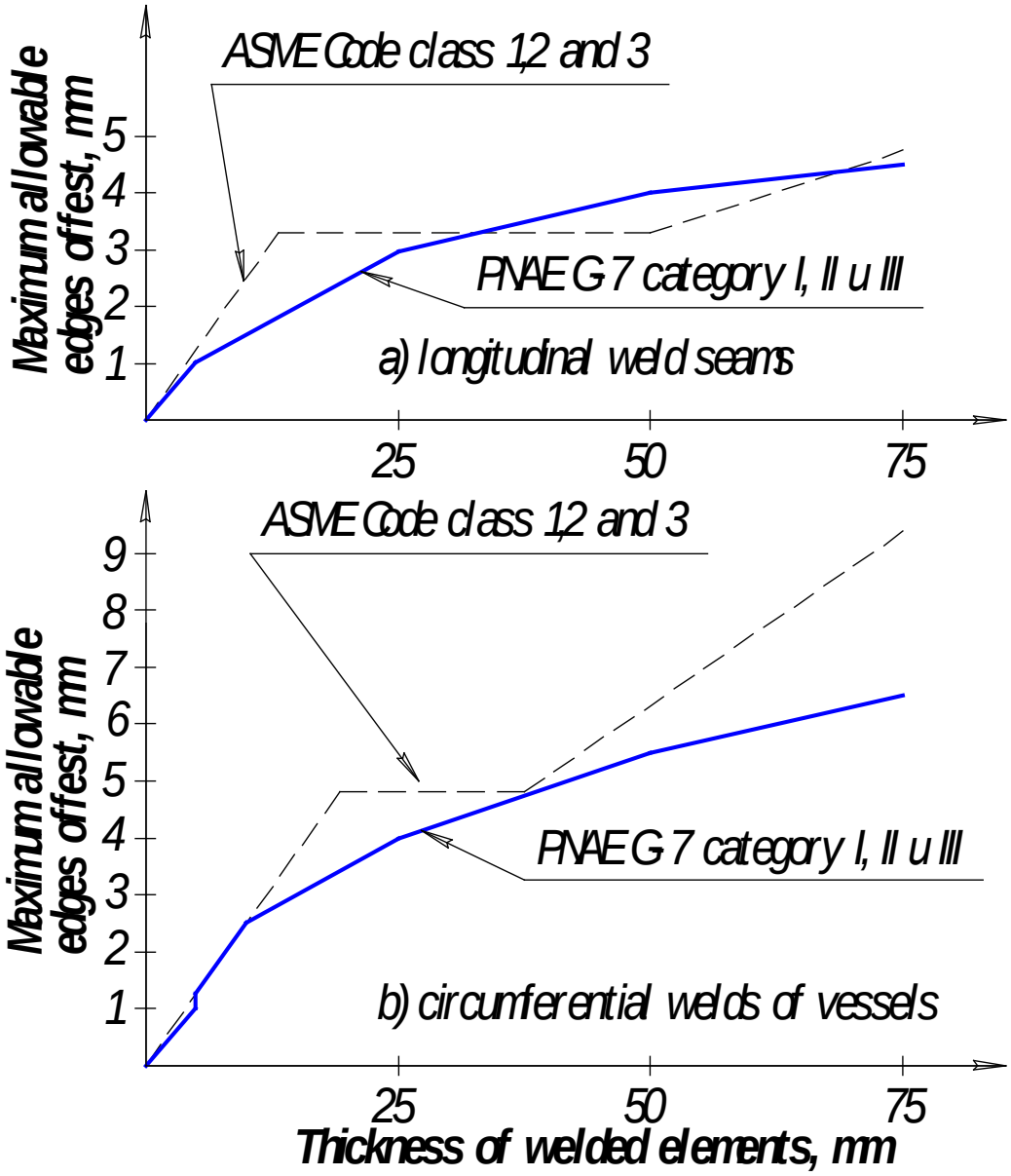



**Figure 45—Dependence of Maximum Allowable Edge Offsets in Longitudinal (a) and Circular Seams (b) vs. Thickness of Welded Elements**

## 8.8 Pressure Tests

PNAE G-7-008-89 (5) and PNAE G-7-002-86 (5.4) establish approaches for determining the pressure test conditions to be applied after manufacturing, installation, and operation of equipment and NPP piping.

As is the case for ASME, a hydrostatic pressure test using water as a test media is preferred per PNAE G-7-008-89. Likewise, replacing the hydrostatic tests with pneumatic tests is allowed (PNAE G-7-008-89 5.1.3 and NB-6112) but, conditions for replacing hydrostatic tests with pneumatic tests are somewhat different.

The minimum testing pressure values required by PNAE G-7-008-89 and ASME NB-6000 are different.

According to PNAE G-7-008-89 (5.2.1–5.2.2), the pressure ($P_h$) of component hydraulic tests shall be:

$$P_h \geq 1{,}25P\frac{[\sigma]^{T_h}}{[\sigma]^{T}},$$

Where: P is design pressure of a component

T is design temperature of a component

$T_h$ is temperature of a component under test

$[\sigma]^{T_h}$ is nominal allowable stress at temperature $T_h$

$[\sigma]^{T}$ is nominal allowable stress at temperature T

Values $[\sigma]^{T_h}$ and $[\sigma]^{T}$ are determined according to PNAE G-7-008-86.

If P < 0.49 MPa, $P_h$ > 1.5P, but not greater 0.2 MPa.

Pressure of component pneumatic tests, according to PNAE G-7-008-89 (5.5.1), shall be:

$$P_p \geq 1{,}15P\frac{[\sigma]^{T_p}}{[\sigma]^{T}},$$

where $[\sigma]^{T_p}$ is nominal allowable stress at temperature of the pneumatic tests.

The test pressure to be applied for component hydrostatic tests must be at least 1.25 P according to ASME NB-6221(c), where P is the design pressure.

Therefore, PNAE G-7-008-89 hydraulic test requirements are similar to those of ASME NB-6000.

Maximum allowable test pressure of components, as in PNAE G-7-008-89 and ASME NB-6000, is bounded by the conditions of strength and stability. Limitations of stress $P_m$ are identical ($P_m < 0.9S_y$, where $S_y$ is yield strength at test temperature). Limitations on stresses $P_m + P_b$ from the ASME Code are less stringent.

Maximum stresses in bolts during testing are not specified in ASME NB-6000. According to PNAE G-7-002-86 (5.4.6), the average stresses in the bolts are limited to $0.7S_y$.

Both ASME and PNAE G-7 define requirements relative to a lower limit test temperature to prevent brittle fracture. The PNAE G-002-86 (5.8.6) and PNAE G-7-008-89 (5.3) method of calculating this temperature $(T_h)_{min}$ differs slightly from that given in ASME Code Appendix G.

The requirements of PNAE G-7-008-89 and the ASME Code for the preparation of components for pressure tests during manufacturing and mounting are similar to those defined in ASME.

According to PNAE G-7-008-89 (5.4.1), pressure measurement during the tests should be conducted using two independent calibrated pressure gauge or measuring channels. The total error of a pressure measurement during tests shall not exceed ±5% of the nominal value of the test pressure. Sensors and devices with a total error not exceeding ±3% of the maximum measured temperature must be applied for temperature measurement.

According to ASME NB-6412, common error of calibration and readout by using digital devices should not exceed 1% of test pressure value. Thus, according to the ASME Code, permissible error in measuring test pressure is less than in PNAE G-7-008-89.

According to PNAE G-7-008-89 (5.4.1) and ASME NB-6223, holding times at hydrostatic test pressure are equal (10 minutes), while holding times at pneumatic test pressure are different – 30 minutes for PNAE G-7-008-89 (5.5.6) and 10 minutes for ASME NB-6323.

Rules for interpretation of pressure test results in PNAE G-7-008-89 (5.7) and ASME NB-6224 and 6324 are similar with ASME requirements for controlling a leak being more detailed than in PNAE G-7-008-89.

## 8.9 Overpressure Protection

This section highlights the differences between the PNAE G-7 and ASME codes that relate to overpressure protection.

The prescriptions concerning overpressure protection are given in NB-7000 of ASME Code and PNAE-G-7-008-89 (6.2). These chapters differ significantly. The ASME Code has more detailed requirements for pressure relief devices. There are requirements for construction, installation, a list of devices permitted and prohibited for use, Overpressure Protection Report requirements, requirements for set pressures and relief capacity of pressure relief devices, requirements for certification including experimental and theoretical assessment of relief capacity in different environments, and marking and stamping rules.

Although overpressure protection requirements in PNAE G-7-008-89 have no structure and are less detailed, they generally cover the same aspects that are defined in NB-7000 of ASME Code, with some exceptions. For example, in PNAE G-7-008-89, there is no such term "Certificate Holder" and no certification requirements and methods for assessment of pressure relief devices capacity, while the ASME Code pays much attention to these things. Also, in PNAE G-7-008-89, there are no Overpressure Protection Report requirements with the exception of a requirement that the number, type, installation location, and other requirements for pressure relief devices must be specified in design documentation. Nevertheless, despite all their differences, both documents have similar requirements concerning the capacity of safety devices; as an example, according to the ASME Code, the total relieving capacity shall be sufficient to prevent a rise in pressure of more than 10% above the design pressure, while according to PNAE G-7-008-89, test pressure shall not exceed the level from which excess pressure is measured by more than 15%.

In addition, PNAE G-7-008-89 (6.2) includes some specific requirements that are not reflected in the ASME Code. These requirements particularly relate to equipment and piping with liquid metal coolant.

In conclusion, it is worth noting that the sections under consideration vary significantly in content and structure; however, despite the differences, there are similarities in terms of required capacity of pressure relief devices.

## 8.10 Overview of Quality Aspects

This section contains information about quality assurance on nuclear power uses in the Russian Federation.

### 8.10.1 Normative Legal Basis

The Federal Law, "On Nuclear Power Uses," was instituted in Russia in November1995. It contains lists of Federal rules and norms in six clauses, which make demands for safe usage of nuclear power. Compliance with these rules and norms is necessary while carrying out any nuclear power use activities, particularly in quality assurance. The norms and rules are binding on all persons involved in nuclear power usage and operation of the law applies to the entire Russian territory.

Rules and norms are approved by "Rostechnadzor" (Russian regulatory body). The list of norms and rules was approved by the Russian Federation Government.

According to Clause 35 of the Federal Law, "On Nuclear Power Uses," the operating organization provides management and coordination of development and implementation of quality assurance programs for all parts of the life cycle (design, manufacturing, erection, operation, and decommissioning) of NPPs.

According to the document "General regulations on ensuring of nuclear power plants safety":

- Paragraph 1.2.6: "Arrangement and safety of systems (components), which are important for NPP safety, documentation and different kinds of operations which are safeguarding of NPP, must be a subject of quality assurance activity."
- Paragraph 1.2.7: "NPP's operator supplies design and execution of quality assurance programs in all stages of NPP's lifecycle and with this purpose it develops general quality assurance program and controls activity of organizations which make various works and give services for NPP (exploration, design, research, construction, assembly organizations, systems and components sources, manufacturer plants of NPP's equipment and etc.)."

### 8.10.2 Quality Assurance Programs

Norms and rules in "Requirements for quality assurance program for NPP" (NP-011) determine a purpose of the quality assurance program of NPPs, requirements for the structure, content and realization of the quality assurance program of NPP, and are intended for designed, constructed, operated, and decommissioned NPPs including operation with radioactive waste inside the NPP territory.

Equipment and reliability of importance for NPP safety systems (components), documentation and different kinds of activities that affect an NPP's safety are subjects of the quality assurance activity. The NPP operator develops general quality assurance program for NPPs and particular quality assurance programs. The general program was called "POKAS (O)" and particular programs are called "POKAS (VE)," "POKAS (E)," and "POKAS (VvE)." Organizations that provide services for NPP operators develop their own particular quality assurance program.

Particular programs were developed for:

- Choosing an area for NPP deployment – "POKAS (VP)"
- Design of NPP – "POKAS (P)"
- Design of reactor facility – "POKAS (R)"
- Design of equipment, components and systems that are important for NPP safety – "POKAS (I)"
- Construction of NPP power units – "POKAS (S)"

- Implementation of NPPs – “POKAS (VE)”
- NPP operation including improvements and upgrades – “POKAS (E)”
- Decommissioning of NPPs – “POKAS (VvE)”

NPP operator:

- Makes a choice of companies that provide additional services
- Establishes requirements for such companies
- Inspects the quality assurance programs of such companies
- Controls and carries out internal audits of the implementation of common and particular quality assurance programs for the NPP, within its responsibility
- Collects and analyzes information about quality of work performed and services provided
- Makes revision of quality assurance programs POKAS (O), POKAS (VE), POKAS (E), and POKAS (VvE)

The NPP designer develops, approves, and implements quality assurance program POKAS (VP) and POKAS (P).

The reactor facility designer develops, approves, and implements POKAS (RU).

The designer of equipment, items, and systems important for safety of the NPP develops, approves, and implements POKAS (S).

The erection company develops, approves, and implements POKAS (S).

The NPP operator develops, approves, and implements POKAS (O), POKAS (VE), POKAS (E), and POKAS (VvE).

Divisions of the quality assurance program are as follows:

1. Quality assurance policy
2. The legal form of relationships between the NPP operator and companies providing services
3. Recruitment and training of staff (personnel)
4. Normative documents
5. Document management
6. Expertise of design
7. Control of purchased equipment, components, materials, and services
8. Inspection of purchased equipment, components, materials, and services
9. Production activity of the NPP operator and organizations hired and providing services to it
10. Inspections
11. Supervision of tests
12. Metrological assurance
13. Quality assurance software routine and design methods
14. Reliability control
15. Inconsistency control
16. Correction steps
17. Storing of quality records
18. Audits

### 8.10.3 Norms and Rules, "Requirements for report content about WWER type reactors (NP-006-98) safety justification (OOB NPP)"

Requirements of the regulatory body for content and form of the report about WWER-type reactor safety feasibility are presented in this document. The report contains a documentation package, which represents the justified application for an NPP's erection and service license.

Requirements for quality assurance of all operations and services affecting an NPP's safety that ab applicant must provide in the NPP Safety justification report documentation package are presented in Clause 17 of this document. The information must provide assurance of correct design, building, and service, and satisfy specified quality assurance requirements for the NPP.

Conformance Evaluation

Conformance evaluation of safety nuclear power usage is imposed according to Federal Law, "About technical regulation," and realized according to requirements of "Rules of conformity assessment of components, materials and products delivered to nuclear power facilities" (NP-071-006). This document establishes conformity assessment rules for components, materials, and products delivered to nuclear power facilities. These rules are mandatory during manufacturing and delivery of equipment for these facilities. Equipment, components, materials, and products delivered to NPPs should pass conformity assessment with requirements of Federal codes for NPP systems, equipment, components, materials, products and other documents, which are included in established order in requirements specification, technical regulations, and technical requirements. There are forms of conformity assessment for equipment, components, materials, and semi-finished products delivered to NPPs: state control (supervision), tests, acceptance, and confirmation of correspondence. In assessing the compliance of equipment designed and produced for NPP systems (special equipment), quality plans, which are attached to equipment certificates, should be considered. Notes about conducted operations and applications should be included in the quality plans.

### 8.10.4 Conformance Evaluation in the Form of Tests

Tests of manufacturing equipment, components, materials, and semi-finished products should be done according to quality plans, technological processes, programs, and methods of testing. Each manufacturing step (technical operation of manufacturing, if necessary) may begin only after completion of examination and tests of the previous step with development and approval of the proper report document by the manufacturer and the operator.

Equipment, components, materials, and products should not be delivered and used on NPPs until completion of operations noted in quality plans, programs, and test reports, which confirm their conformance to established requirements. In cases when, for special equipment acceptance tests, a sampling of equipment is stipulated by federal rules and norms in nuclear power safety usage and codes, acceptance of the sample is carried out according to requirements of this document in the presence of representatives of acceptance board members.

### 8.10.5 Conformance Evaluation in the Form of State Control (Supervision)

Conformance evaluation of equipment, components, materials, and products in the form of state supervision is realized within the scope of supervision and control of compliance with federal norms and rules and control of manufacturing licenses, given by the regulatory body.

### 8.10.6 Conformance Evaluation in the Form of Acceptance

Conformance evaluation in acceptance form is mandatory for special equipment. Consequently, acceptance should confirm:

- Implementation of procedures and processes stipulated by technical documentation

- Full implementation of examination and tests during manufacturing
- Availability of documents with examination and test results
- Removal of any identifed nonconformances

A joint resolution of “Rosatom” (governing body) and “Rostechnadzor” (regulatory body) confirms “The procedure and the amount of conformity assessment of equipment, products, components, materials and supplies delivered to NPPs” and organizations that are authorized to evaluate confirmation, particularly VO, “Safety.”

### 8.10.7 Conformance Evaluation in the Form of Confirmation of Compliance

Conformance evaluation in confirmation of compliance of equipment, components, materials, and products for NPPs in confirmation of compliance form is carried out in the “System of certification of equipment, products and technology for NPP, radiation sources and storages” (further – System) in the form of mandatory certification.

At present in Russia, 16 systems of mandatory certification have been created and are operated. These systems were organized in accordance with Russia law, “About certification of production and services.”

These systems of mandatory certification were developed by “Rostechnadzor,” “Rosatom,” and organizations that were granted accreditation permissions. Functionality of certification systems is regulated by appropriate documents.

“System of certification of equipment, manufactures and technologies for NPP, radiation sources and storages” was developed according to Clause 37 of Russian Federal Law, “On Nuclear Power Uses.”

Conformance of equipment characteristics (parameters), components, materials, and products for NPPs to nuclear technical requirements is established in federal norms and rules and other documents, which are included in the established order in draft proposal, specification, and technical requirements. Conformance is controlled during mandatory certification.

Conformance evaluations of equipment, components, materials, and products for NPPs in mandatory certification form in the Russian system is realized to assure high nuclear and radiation safety levels of nuclear facilities by confirming they meet the following requirements:

- Mandatory requirements established by the regulatory body ("Rostechnadzor") (federal norms and rules, etc.)
- Mandatory requirements established by operation organization “Rosatom”
- Mandatory requirements of technical regulations enforced by the law and decree of the Russian Government, which are propagated on equipment and piping applicable in nuclear energy.

In addition, the necessity of compliance with requirements of Russian national nuclear standards and codes, in established order, shall be determined. Requirements of other documents, introduced in established order in objective specifications and technical requirements, shall be satisfied. The system was created according to active international norms and rules to ensure recognition of the certificates outside Russia.

Mandatory certification in the system is realized by accredited bodies established in System order:

- Certification bodies – 5
- Certification expert centers – 16
- Prospector laboratories (centers) – 36 (including 5 foreign)

Conformance evaluation in certification form ensures:

1. Comprehensive approach of conformance evaluation of all equipment`s lifecycle, from design (examination of draft proposal, specifications on delivery of other documentation) to operation of equipment in nuclear facilities, with results considering equipment operation, including analyses of inconsistencies or failures that are found at the time of operation.
2. Documented conformance of all necessary indicators (parameters) of equipment, components, materials, and semi-finished products important for safety with nuclear power code requirements (federal norms and rules, state and state and international standards, etc.) and delivery specification.

## 8.11 Conclusion

The comparison of Russian vs. U.S. codes shows a large number of technical differences with the major objectives nevertheless being the same.

The approach implemented relative to codes and standards in the Russian nuclear sphere includes the application of a significant number of guidance documents and related standards that supplement the PNAE G-7 series. Therefore, requirements that may not be specified in PNAE G-7 are usually found in related applicable guidance documents and standards and would be applied for specific material product forms and particular parts or components. While GOST and OST standards are typically referenced in the PNAE G-7 series, relevant guidance documents are not. However, these would generally be defined in a specific requirements document and approved by the owner and/or regulatory body.

# 9 REFERENCES

[1] RCC-M Code, "*Règles de Conception et de Construction des Matériels Mécaniques des Ilots Nucléaires REP*" ("Design and Construction Rules for Mechanical Components of PWR Nuclear Islands"), édition 2007.

[2] ASME Boiler and Pressure Vessel Code, Section III, Division I, Rules for Construction of Nuclear Facilities Components, 2007 Edition.

[3] L. Durand-Roux, T. Berger, J. M. Grandemange, M. Lemoine, A practical example of code comparison evaluation of conformance to the ASME III code of large nuclear replacement parts manufactured according to RCC-M.

[4] Y. Asada, et al., Recent Development of Codes and Standards of Boiler and Pressure Vessels in Japan. Chapter 50, K. R. Rao, Editor, COMPANION GUIDE TO THE ASME BOILER AND PRESSURE VESSEL CODE, ASME, 2006.

# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ABET | Accreditation Board of Engineering and Technology |
| AFCEN | *Association Française pour les règles de Conception, de construction et de surveillance en exploitation des matériels des Chaudières Electro Nucléaires* (French Association for Design, Construction and In-service Inspection Rules for Nuclear Island Components) |
| AFNOR | *Association Française de Normalisation* (French Association of Standardization) |
| AIA | Authorized Inspection Agency |
| AISC | American Institute of Steel Construction |
| ANI | Authorized Nuclear Inspector |
| ANSI | American National Standard Institute |
| ASME | American Society of Mechanical Engineers |
| ASME ST-LLC | ASME Standards Technology, LLC |
| ASN | *Autorité de Sûreté Nucléaire française* (French Safety Authority) |
| ASNT | American Society for Nondestructive Testing |
| ASTM | American Society for Testing and Materials |
| AWS | American Welding Society |
| BPVC | Boiler and Pressure Vessel Code |
| BWR | Boiling water reactor |
| CEA | *Commissariat à l'Energie Atomique* (Atomic Energy Authority) |
| CGSB | Canadian General Standards Board |
| CKTI | Russian Central Boiler and Turbine Institution |
| CMTR | Certified Material Testing Report |
| CNSC | Canadian Nuclear Safety Commission |
| COFREND | *Confédération FRançaise pour les Essais Non-Destructifs* (French confederation for nondestructive testing) |
| CRISM | Central Research Institute of Structural Materials |
| CSA | Canadian Standards Association |
| CSWG | MDEP Codes and Standards Working Group (formerly WGCMO) |
| DCN | *Direction des Constructions Navales* (Naval Construction Authority) |
| DEP | *Département des Equipements sous Pression* (Pressure Equipment Department of French Safety Authority - ASN) |
| EDF | Electricité de France |
| EN | European Norms |
| ENES | Engineering Center of Nuclear Equipment Strength |
| ES | emergency situation |
| ESPN | *Equipment Sous Pression Nucléaire* (French regulation for Pressurized Equipment for Nuclear applications) |
| ETC | EPR Technical Code |
| FANR | UAE Regulatory Organization |

## ABBREVIATIONS AND ACRONYMS (cont.)

| | |
|---|---|
| GOST, OST, TU, CKTI, ICP MAE | Russian Federation or USSR standards |
| HVAC | heating, ventilation and air conditioning |
| ID | identification |
| IEC | International Electrotechnical Commission |
| ISI | in-service inspection |
| ISO | International Organization for Standardization |
| JEAC | Japanese Electric Association Code |
| JEAG | Japanese Electric Association Guide |
| JIS | Japanese Industrial Standards |
| JNES | Japan Nuclear Energy Organization |
| JSME | Japanese Society of Mechanical Engineers |
| KASTO | Korea Association of Standards & Testing Organization |
| KEA | Korea Electric Association |
| KEPIC | Korea Electric Power Industry Code |
| KRISS | Korea Research Institute of Standards and Science |
| LWR | light water reactor |
| MITI | Ministry of International Trade and Industry |
| MDE | maximum design earthquake |
| MDEP | Multinational Design Evaluation Programme |
| MEST | Korean Ministry of Education, Science and Technology |
| MKE | Korean Ministry of Knowledge Economy |
| N/A | not applicable |
| NBBI | National Board of Boiler and Pressure Vessel Inspectors |
| NBBPVI | National Board of Boiler and Pressure Vessel Inspectors (NBBI predecessor) |
| NDE | nondestructive examination |
| NDIS | Japanese Society of Non-Destructive Inspection Standards |
| NIKIET | Research and Development Institute of Power Engineering |
| NISA | Nuclear and Industry Safety Agency |
| NIST | National Institute of Standards and Technology |
| NOC | normal operating conditions |
| NPP | nuclear power plant |
| NRC | American Nuclear Regulatory Commission |
| NSSC | Nuclear Strategic Steering Committee |
| OBE | operating basis earthquake |
| PED | European Pressure Equipment Directive |

## ABBREVIATIONS AND ACRONYMS (cont.)

| | |
|---|---|
| PHWR | pressurized heavy water reactor |
| PNAE | Rules and Norms on Nuclear Energy |
| PPS | Product Procurement Specification, or Part Procurement Specification |
| PQR | Procedure of Qualification Record |
| PTC | Performance Test Codes |
| PSI | pre-service inspection |
| PWR | pressurized water reactor |
| QA | quality assurance |
| QAI | Qualifications for Authorized Inspection |
| RBMK | Reaktor Bolshoy Moshchnosti Kanalniy |
| RCC | *Règles de Conception et de Construction* (Design and Construction Rules) |
| RCC-M | *Règles de Conception et de Construction des Matériels Mécaniques des Ilots Nucléaires REP* (Design and Construction Rules for Mechanical Components of PWR Nuclear Islands) |
| REP | *Réacteur à Eau Pressurisée* (Pressurized Water Reactor) |
| RPE | Registered Professional Engineer |
| RSE | *Règles de Surveillance en Exploitation* (Rules for Safety during Operation) |
| RSE-M | *Règles de Surveillance en Exploitation des Matériels mécaniques des îlots nucléaires REP* (In-Service Inspection Rules for Mechanical Components of PWR Nuclear Islands) |
| SDOs | Standards Development Organizations |
| SI | *Système International* (International System) |
| SSE | safe shutdown earthquake |
| STR | *Spécification Technique de Référence* (Technical Reference Specification) |
| TBT | Technical Barriers to Trade |
| TC | Technical Committee |
| TEMA | Tubular Exchanger Manufacturers Association |
| UAE | United Arab Emirates |
| USSR | Union of Soviet Socialist Republics |
| VNOC | violation of normal operating conditions |
| WGCMO | MDEP Working Group on Component Manufacturing Oversight |
| WP | Welding Procedure |
| WNA | World Nuclear Association |
| WPS | Weld Procedure Specification |
| WTO | World Trade Organization |
| WWER | water water energy reactor |

# APPENDIX A: RCC-M VERSUS ASME SECTION III DETAILED COMPARISON TABLE

## Appendix A: RCC-M vs. ASME Comparison Table

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| ***modified cells with previous version*** | ***modified cells with previous version*** | ***modified cells with previous version*** | ***modified cells with previous version*** | ***modified cells*** | |
| **Article NB-1000 Introduction** | | **B 1000** | | | |
| NB-1100 Scope | | A 1100 - B 1100 | | | |
| NB-1110 Aspects of Construction Covered by These Rules | rules for the material design, fabrication, examination, testing, overpressure relief, marking, stamping and preparation of reports by the Certificate Holder | | no stamping, no certificate holder in RCCM | | B2 |
| | rules for strength and pressure integrity, failure of them would violate the pressure retaining boundary | A 1100 Objectives | equivalent | | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| | rules cover initial construction, but do not cover deterioration which may occur in service as result of corrosion, radiation, instability of material | | partially covered by RCCM: fatigue, rupture, corrosion, radiation and thermal ageing | through analysis or through material technical specification | B1 |
| NB-1120 Temperature Limits | temperature limits of Section II, part D, Subpart 1, Tables 2A, 2B and 4 | Appendix ZIII 211 Material Specification | equivalent | | A2 |
| NB-1130 Boundaries of Jurisdiction Applicable to This Subsection | boundary between component and attachments | | not so detailed in RCCM than in ASME, except for support in Sub-sect H and penetration in Sub-sect P no mixing with jurisdiction in RCCM | | B2 |
| | jurisdictional boundary | | no strictly jurisdiction aspect in RCCM | | B4 |
| NB-1140 Electrical and Mechanical Penetration Assemblies | constructed in accordance with vessel rules | Subsection P | piping rules, not vessel rules except hatch | | B1 |
| | | B 1200 | ASME NB 8000 : equivalent | | |
| | | list of documents to be produced | | | A2 |
| | | B 1300 | ASME NB 8000 : equivalent | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| | | identification : marks and labels | | | A2 |
| **Article NB-2000 Material** | | **B 2000** | | | |
| | | B 2100: General | | | |
| | | B 2200: Application of Section II | | | |
| | Section II Part D Subpart 1 Tables 2A & 2B | Table B 2200 : list of applicable procurement specifications | more prescriptive in RCCM than ASME, mainly for pressure boundary | | B2 |
| | | B 2300: Susceptibility to intergranular corrosion | not in ASME | | B1 |
| | | B 2400: Cobalt content | not in ASME | | B1 |
| | | B 2500: Mechanical properties | | | B1 |
| NB-2100 General Requirements for Material | | | | | |
| NB-2110 Scope of Principal Terms Employed | definitions: material, pressure-retaining material, thickness (plates, forging, hollow forging, disk forging, flat ring forging, rectangular solid forging), casting (thickness for fracture toughness measurement or for heat treatment) | | included in MTS | thickness to be considered are included in the applicable Material Technical Specification; difference connected to Code organization | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-2120 Pressure-Retaining Material | | | | | |
| *NB 2121: Permitted material specification* | materials from Section II PartD Subpart 1 Tables 2A & 2B; except valve parts, lines and valves DN<DN25 --> NB 3671.4 for lines and NB 3500 for valves; welding and brazing | B 2200 Application of Section II<br>B 4000 Application of Section IV | applicable specification are listed in RCCM table B 2200<br>small equipments defined in A 4000 and Subsection E<br>class 1 DN<25 treated as the other pipes<br>provision for filler materials in Subsection V S2000 | RCCM B 2200 table : different equivalent specifications that consider operating conditions and potential degradations are implicitly covered | B2 |
| *NB 2122: Special requirements conflicting with permitted material specification* | in case of conflict with NCA 3856; SA453 and SA638stress rupture test not required under 427°C operating temp. | | no equivalent provision in RCCM | | B1 |
| *NB 2124: Size ranges* | no size limitation in the rules for construction, nearest specified range (NCA 3856) | | no equivalent provision in RCCM | | B1 |
| *NB 2125: Fabricated hubbed flanges* | machined from hot rolled or forged billet/ from ring with NB 2540 examination | RCCM Appendix Z V | no hubbed flange in class 1 piping, except for small piping and procurement in Section II | Code scope | B1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 2126: Finned tube* | integrally/welded materials | welding in Section IV, as amended in B 4000 | | Code organization | A2 |
| *NB 2127: Seal membrane material* | NB 2500 for t > 6mm | | MTS considers it | Code organization | A2 |
| *NB 2128: Bolting material* | SA 194 or one of section II nuclear material | B 2200 table | | | |
| NB-2130 Certification of Material | certified as required in NCA 3861 et 3862 : Material Test Report except from NCA 3861 | Section II - Material procurement specification | certification covered in RCCM ZU 700 | for French plants, connected to French regulation | B2 |
| NB-2140 Welding Material | see NB 2400 | B 4000 and Section IV | no technical content in ASME NB 2140 | | |
| NB-2150 Material Identification | see NCA 3856,not for small components | B 1300 | no technical content in ASME NB 2150 | | |
| NB-2160 Deterioration of Material in Service | outside the ASME scope; Owner responsibility in accordance with NCA 3250 in Design Spec | B 2200 MPS and B 3000 | not considered in ASME, covered in RCCM | ASME III has a limited scope | B2 |
| NB-2170 Heat Treatment to Enhance Impact Properties | CS, LAS, high alloy chromium may be Heat Treated by quenching or tempering; PWHT tempering temp. not less than 595°C | Section II MPS and Section IV S 7500 for PWHT | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-2180 Procedures for Heat Treatment of Material | temp survey and furnace calibration or measurement of material temperature by thermo-couples | Section II MPS | equivalent provision | | A2 |
| NB-2190 Nonpressure-Retaining Material | in support load path and no pressure retaining ==> see NF 2000<br>not in support load path and no pressure retaining, welded at or within 2t of P retaining NB 4430 repair by welding of structural steel rolled shapes | H 2000 Support<br>B 2200 table for non-pressure retaining parts | integrated in RCCM Section II MPS | | B2 |
| NB-2200 Material Test Coupons and Specimens for Ferritic Steel Material | | Section II + M 150 | | | |
| NB-2210 Heat Treatment Requirements | | | | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 2211: Test coupon heat treatment for ferritic materials* | tensile and KV same HT as the component (some exemption <50mm) under Certificate Holder and Material Organization; PWHT 80% of total time at temperature; test material, coupon and specimen performed in a single cycle | Section II + MPS + M 151 + Section IV + S 7500 | equivalent provision, but MPS more self-supported than ASME | different Code organization | A2 |
| *NB 2212: Test coupon heat treatment for quenched and tempered material* | cooling rate/ general procedure/ possible faster cooling rate | Section II MPS | equivalent provision, but MPS more self-supported than ASME | | A2 |
| NB-2220 Procedure for Obtaining Test Coupons and Specimens for Quenched and Tempered Material | | | | | |
| *NB 2221: General requirements* | General requirements- Coupon and specimen location/number of tension test coupons --> material specification or through following | Section II MPS | equivalent provision, but RCCM MPS more self-self-supported than ASME differences in number of test coupons for large parts and RCCM M140 Technical Qualification for some components | technical qualification of components is not required by ASME | A2 |
| *NB 2222: plates* | Plates | Section II MPS | | | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 2223: forging* | Forgings | Section II MPS | M140 Technical Qualification for some components | no technical qualification of components required by ASME | B1 |
| *NB 2224: Bar and bolting material* | Bar and bolting material | Section II MPS | | | A2 |
| *NB 2225: Tubular products and fittings* | Tubular products and fittings | Section II MPS | | | A2 |
| *NB 2226: Tensile test specimen location (for quenched and tempered ferritic steel castings)* | t > 50mm/longi center line 1/4 t separately cast test coupons not less than 3t x 3t x t from body of casting 1t x 1t x 3t 13mm and 1/4t from surface | Section II MPS | | | B2 |
| NB-2300 Fracture Toughness Requirements for Material | | Section II | | | |
| NB-2310 Material to Be Impact Tested | | Section II MPS | equivalent provision | | B2 |
| *NB 2311: Material for which impact testing is required* | pressure-retaining material and material welded except material (1) to (7) | | equivalent except differences in impact test machine strike radius | RCCM uses international standards for Cv | B2 |
| | (1) material with nominal section 16mm or less | | no impact test if not practicable | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A<br>B |
|---|---|---|---|---|---|
| | (2) bolting (studs, nuts, bolts) nominal size of 25mm or less<br>(3) bars 1 inch2 or less | | | | B2<br>B2 |
| | (4) pipe, tube, fittings, pumps and valves DN150 or smaller<br>(5) pumps, valves and fittings with all pipe connection of 16mm nominal thickness or less<br>(6) austenitic stainless steels, including hardened austenitic Grade 660 (UNS S66286) | | impact test required in RCCM if A% < 45% | in line with French regulatory requirement | B2<br>B2<br>B2 |
| NB-2320 Impact Test Procedures<br>*NB 2321: Type of tests*<br><br><br><br>*NB 2322: Test specimen* | <br>drop weight tests if required ASTM E 208-91<br>Charpy V -notch Tests if required SA 370<br>location of test specimen<br>orientation of Impact test specimen | Section III MC 1230 | use of ASTM E 208 Standard (1975)<br>equivalent provision, but different standards | new edition under review | B2<br>B2<br>B2<br>B2<br>B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-2330 Test Requirements and Acceptance Standards | | Section MPS and Section III MC 1240 | equivalent requirements | Code organization: RCCM MPS more self-supported | A2 |
| *NB 2331: Material for vessels* | test program : RTNDT<br>apply to base material/HAZ/weld<br>bar width or diam > 50mm<br>some nozzles or appurtenances in vessels<br>effect of irradiation<br>test temperature of hydrotest | Section II MPS | RTNDT systematically required by ASME, case by case by RCCM | | B2 |
| *NB 2332: Material for piping, pumps and valves* | 3 Cv tests at lowest service temperature for BM, W, HAZ with corresponding lateral expansion criteria from 0.5 to 1mm (nothing for 16mm or less) | Section II MPS | | | B2 |
| *NB 2333: Bolting material* | bolts, studs and nuts: 3 Cv at temperature not higher than preload temp. Or lowest service temp. (Table NB 23333-1) | Section II MPS | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-2340 Number of Impact Tests Required | | Section II MPS | more stringent requirements in RCCM | | |
| *NB 2341: Plates* | one test from each plate as HT | Section II MPS | | | B2 |
| *NB 2342: Forgings and castings* | one test each heat each HT lot<br>HT in a continuous type furnace<br>one test for each forging or casting of 450kg to 4500kg alternative to previous one<br>forging or casting > 4500kg 2 Cv and one drop weight; location selected equal number of specimens 180° apart. alternative tp previous one | Section II MPS | | | B2 |
| *NB 2343: Bars* | one test for each lot of bars > 650mm$^2$; lot definition < 2700kg | Section II MPS | | | B2 |
| *NB 2344: Tubular products and fittings* | one test on each lot; if welded with filler metal one test from the weld area; lot definition | Section II MPS | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 2345: Boiling Material* | one test from each lot of material; lot = one heat of material heat treated in one charge with limited mass | Section II MPS | | | B2 |
| *NB 2346: Test definition* | one test = RTNDT and CV if RTNDT required<br>one test = CV if RTNDT not required | Section II MPS | | | B2 |
| NB-2350 Retests | one retest at same temp. for CV; 3 requirements: average meets mini required, not more than 1below the min, not meeting the min but not lower than 14J or 0.13mm below specified requirements<br>retest = 2 additional specimens as near as possible to the failed specimens conditions | Section II MPS | equivalent requirements | | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-2360 Calibration of Instruments and Equipment | temperature instruments --> NCA 3858.2 (every 3 months) CV impact test machine --> NCA 3858.2 using ASTM E23-02a | MC 100 + ISO Standards | | | B2 |
| NB-2400 Welding Material | | Section IV - S 2000 | | | |
| NB-2410 General Requirements | all welding material except cladding and hard surfacing : requirement of material specification or ASME Section IX | S 2120 | | - Code organization : RCCM Section IV more self-supported<br>- in line with international regulations | A2 |
| | Certificate holder shall provide the organization performing the testing with specific information listed (1) --> (10) | | not covered in RCCM | | B1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-2420 Required Tests | each lot of covered, flux cored or fabricated electrode; each heat of bare electrodes, rods or wires for use with OFW, GMAW, GTAW, PAW EGW; each heat of consumable insert…. | S 2500 - data sheets in S 2800-2900 | equivalent requirements | | A2 |
| NB-2430 Weld Metal Tests | | S 2500 | equivalent requirements | | |
| *NB 2431: Mechanical properties test* | tensile and impact : General test requirements/ Standard tests requirements | | | | A2 |
| *NB 2432: Chemical Analysis Test* | Test method/ Requirements for chemical analysis | | | | |
| *NB 2433: Delta ferrite determination* | Method/Acceptance standard | S 2500 | Delong Diagram different in Fig. NB 2433.1-1 | | B2 |
| NB-2440 Storage and Handling of Welding Material | Suitable storage and handling; minimize moisture absorption by fluxes and cored, fabricated and coated electrodes | S 7200 | equivalent requirements | | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-2500 Examination and Repair of Pressure-Retaining Material | | Section II | | | |
| NB-2510 Examination of Pressure-Retaining Material | except pumps and valves DN50 or less/seamless pipe, tubes and fitting DN25 or less/forged and cast pumps and valves connections over DN50 to DN100 -->surface instead of volumetric | Section II MPS | | Code organization: RCCM Section II more self-supported | A2 |
| NB-2520 Examination After Quenching and Tempering | use of this subarticle | | | | A2 |
| NB-2530 Examination and Repair of Plate | | Section II MPS + Section III MC 2400 | equivalent requirements | | |
| *NB 2531: Required examination* | | MC 2411 | | | B2 |
| *NB 2532: Examination procedure* | | MC 2413 and MC 2414 | | | B2 |
| *NB 2537: Time of examination* | | MC 2413 and MC 4141 | | | B2 |
| *NB 2538: Elimination of surface defects* | | | | | B2 |
| *NB 2539: Repair by welding* | | | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-2540 Examination and Repair of Forgings and Bars | | Section II MPS + Section III MC 2300 | equivalent requirements | | |
| *NB 2541: Required examination* | | MC 2313, MC 2323, MC 2333, MC 2343 | | | B2 |
| *NB 2542: Ultrasonic examination* | Examination Procedure/Acceptance standards | MC 2311, MC 2313, MC 2321, MC 2323 | | | B2 |
| *NB 2545: Magnetic Particle Examination* | Examination Procedure/Acceptance standards | | | | B2 |
| *NB 2546: Liquid penetration examination* | Examination procedure/ Evaluation of Indications/ Acceptance standards | MC 4000 | | | B2 |
| *NB 2547: Time of examination* | | MC 2313, MC 2323, MC 2333, MC 2343 | | | B2 |
| *NB 2548: Elimination of surface defects* | | | | | B2 |
| *NB 2549: Repair by welding* | | | | | B2 |
| NB-2550 Examination and Repair of Seamless and Welded (Without Filler Metal)-Tubular Products and Fittings | | Section II MPS + Section III MC 2500 | equivalent requirements | | |
| *NB 2551: Required examination* | | MC 2510, MC 2530 | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 2552: Ultrasonic Examination* | | MC 2530 | | | B2 |
| *NB 2553: Radiographic examination* | | MC 3000 | | | B2 |
| *NB 2554: Eddy Current Examination* | | MC 6000 | | | B2 |
| *NB 2555: Magnetic Particle Examination* | | MC 5000 | | | B2 |
| *NB 2556: Liquid Penetrant Examination* | | MC 4000 | | | B2 |
| *NB 2557: Time of examination* | | | | | B2 |
| *NB 2558: Elimination of surface defects* | | | | | B2 |
| *NB 2559: Repair by welding* | | | | | B2 |
| NB-2560 Examination and Repair of Tubular Products and Fittings Welded With Filler Metal | | Section II MPS + Section III MC | equivalent requirements | | |
| *NB 2561: Required examination* | | MC 2510, MC 2530 | | | B2 |
| *NB 2562: Ultrasonic Examination* | | MC 2530 | | | B2 |
| *NB 2563: Radiographic examination* | | MC 3000 | | | B2 |
| *NB 2565: Magnetic Particle Examination* | | MC 5000 | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 2566: Liquid Penetrant Examination* | | MC 4000 | | | B2 |
| *NB 2567: Time of examination* | | | | | B2 |
| *NB 2568: Elimination of surface defects* | | | | | B2 |
| *NB 2569: Repair by welding* | | | | | B2 |
| NB-2570 Examination and Repair of Statically and Centrifugally Cast Products | | Section II MPS + Section III MC | equivalent requirements | | |
| *NB 2571: Required examination* | | MC 2510, MC 2530 | | | B2 |
| *NB 2572: Time of non-destructive examination* | | | | | B2 |
| *NB 2573: Provision for Repair of Base Material by Welding* | defect removal/ repair by welding/ qualification of welding procedure and welders/ blending of repair areas/ Examination of repair welds/ Heat Treatment after repair/ elimination of surface defects/ material report Describing Defects and Repairs | | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 2574: Ultrasonic examination of Ferritic Steel Castings* | Acceptance Standards | | | | B2 |
| *NB 2575: Radiographic Examination* | Examination/ Extent/ Examination procedure/ Procedure requirements/ Radiographic setup information | | | | B2 |
| *NB 2576: Liquid Penetrant Examination* | | | | | B2 |
| *NB 2577: Magnetic Particle Examination (for ferritic steel product only)* | | | | | B2 |
| NB-2580 Examination of Bolts, Studs, and Nuts | | Section II MPS + Section III MC | equivalent requirements | | |
| *NB 2581: Required examination* | | MC 2510, MC 2530 | | | B2 |
| *NB 2582: Visual Examination* | | | | | B2 |
| *NB 2583: Magnetic Particle Examination* | Examination Procedure/ Evaluation of Indications/ Acceptance Standard | MC 5000 | | | B2 |
| *NB 2584: Liquid Penetrant Examination* | Examination Procedure/ Evaluation of Indications/ Acceptance Standard | MC 4000 | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 2585: Ultrasonic examination (for size greater than 2")* | Ultrasonic Method/ Examination Procedure/ Calibration of Equipment/ Acceptance Standard | MC 2530 | | | B2 |
| *NB 2586: Ultrasonic examination (for size over 4")* | Ultrasonic Method/ Examination Procedure/ Calibration of Equipment/ Acceptance Standard | MC 2530 | | | B2 |
| *NB 2687: Time of examination* | | | | | B2 |
| *NB 2588: Elimination of surface defects* | | | | | B2 |
| *NB 2589: Repair by welding* | | | | | B2 |
| NB-2600 Material Organizations' Quality System Programs | | A 5000 : QA | | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-2610 Documentation and Maintenance of Quality System Programs | requirements of NCA 3800 and NCA 4000 (small product = pipe, tube, pipe fittings and flanges DN50 or less, bolting material nominal diameter 1" or less, bar nominal cross section 1 inch2 or less, pump and valve with inlet pipe DN50 or less, material exempted in NB 2121 (c) | | responsibilities defined in ASME NCA 3000 not addressed point by point in RCCM Quality system provisions covered by RCCM A 5000 and the Equipment Specification | Some Mandatory requirements covered by nonmandatory appendices | B2 |
| NB-2700 Dimensional Standards | Reference to NCA 7100-1 (A08) and table NB 3132-1 | A 1300 Standards | | | B2 |
| | | | | | |
| **Article NB-3000 Design** | | **B 3000** | | | |
| NB-3100 General Design | | B 3100 + Annexe ZIV | | | |
| | | B3110 : list of damage covered by RCCM : excessive deformation, plastic instability, buckling, progressive deformation, fatigue, rupture mainly for pressure boundary<br>B 3120 : operating condition and transient list classification in 4 categories | | | B1<br>B1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-3110 Loading Criteria | | B 3130 : Loading conditions | | | |
| *NB 3111: Loading conditions* | internal/external pressure, impact loads, weight including static and dynamic head of liquids, superimposed loads, wind, snow, vibration, earthquake, reaction of supports, temperature effects | B 3131 | | | A2 |
| *NB 3112: Design loadings* | design pressure, design temperature, design mechanical load, design stress intensity values | B 3132 | | | B2 |
| *NB 3113: Service conditions* | level A, B, C conditions | B 3120, B 3140 | | | B2 |
| NB-3120 Special Considerations | Corrosion, cladding, welding (dissimilar weld, fillet welded attachment), environmental effects, configuration (accessibility in connection with ASME Section XI) | B 3170 | - no welding in RCCM B 3170; - no cleaningless requirements, no lamellar tearing, no thermal fluctuation consideration in ASME Code | - emphasis are not put on same points in "special considerations" sub-article- a global equivalence has to be considered | A2 |
| *NB 3121: Corrosion* | | | | | B2 |
| *NB 3122: Cladding* | | | | | B2 |
| *NB 3123: Welding* | | | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 3124: Environmental effects* | | | | | B2 |
| *NB 3125: configuration* | | | | | B2 |
| NB-3130 General Design Rules | | | | | |
| *NB 3131: Scope* | | | | | A1 |
| *NB 3132: Dimensional Standards for Standard products* | | B 3611 + A 1300 | | | B2 |
| *NB 3133: Component under external pressure* | general, nomenclature, cylindrical shells and tubular products, spherical shells, stiffening rings for cylindrical shells, cylinders under axial compression | Annexe ZIV | | | A2 |
| *NB 3134: Leak Tightness* | | not in RCCM | | | B1 |
| *NB 3135: Attachments* | | B 3174 | | | B1 |
| *NB 3136: Appurtenance* | | not in RCCM | | | B1 |
| *NB 3137: Reinforcement of openings* | NB 3330 (vessel) and NB 3643 (pipe) | C 3300 + annexe ZA | | | B2 |
| | | B 3150 : category to criteria level | RCCM B 3150 out of ASME Scope (NCA 2140) | under discussion for RCCM future edition | B1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| | | B 3160 : Stress report description<br><br>B 3162 : thickness to consider in analysis | equivalent to ASME NCA 3260 | | A2<br><br>B1 |
| NB-3200 Design by Analysis | | B 3200 | | | |
| NB-3210 Design Criteria | | B 3210 | equivalent, but ASME open to Design Spec and consider piping in B 3200; not RCCM | | B2 |
| *NB 3211: requirements for acceptability* | protection against non-ductile failure | B 3260 + appendix ZG | protection against non-ductile and ductile failure; no equivalent exemption rules | | B2 |
| *NB 3212: Basis for Determining Stresses* | TRESCA : half of max - min | B 3220 | equivalent definitions | | A1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 3213: Term related to Stress Analysis* | stress intensity, gross structural integrity, local structural Discontinuity, normal stress, shear stress, membrane stress, bending stress, primary stress, load control stress, thermal stress, total stress, operational cycles, stress cycle, fatigue strength reduction factor, free end displacement, expansion stresses, strain, inelasticity, creep, plasticity, plastic analysis, plastic analysis, plastic analysis-collapse load, plasticity instabilities load, limit analysis, limit analysis-collapse load, collapse load-lower bound, plastic hinge, strain limiting load, test collapse load, ratcheting, shakedown, reversing dynamic , nonreversing dynamic l loads | B 3220 - B 3230 | equivalent definitions; B 3230 elastic analysis and B 3220 General RCCM definition are more associated with the corresponding potential damage | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 3214: Stress analysis* | | B 3230 | equivalent definitions | | A1 |
| *NB 3215: Derivation of stress intensities* | | B 3230 | | | A1 |
| *NB 3216: Derivation of stress différences* | constant principal stress direction, varying principal stress directions | B 3230 | | | A1 |
| *NB 3217* | Classification of stresses: tables NB 3217-1 and 2 | no tables in RCCM B 3200 | | | B1 |
| NB-3220 Stress Limits for Other Than Bolts | | | | | |
| *NB 3221: Design loadings* | general primary membrane stress intensity, local membrane stress intensity, primary membrane + primary bending stress intensity, external pressure | B 3230 | | | A1 |
| | | B 3233 : Level 0 service limits | max P and max T reference loading, Pm < Sm; Pm+Pb<1.5Sm | | B2 |
| *NB 3222: Level A service limits* | | B 3234 | equivalent but no exemption rules as NB 3222.4 d- 1) to 6) | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| | | | large differences in fatigue analysis Ke formula (NB3228.5 and B3234.6) | | B2 |
| *NB 3223: Level B service limits* | | | no level B service limits in RCCM, consider as level A | attached to old French regulation, will be move in the French regulatory requirement appendix in future edition | B1 |
| *NB 3224: Level C service limits* | | B 3235 | some differences NB 3224 has alternative primary stress limits, fatigue analysis is never required by NB 3224.5; different alternative values for piping in NB 3224.7 | | B2 |
| *NB 3225: Level D service limits* | | B 3236 | ASME appendix F versus RCCM appendix ZF | | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 3226: Testing limits* | | B 3237 | some differences in particular for Pm+Pb 1,35Sy in B 3237, same in NB 3226 if Pm<0.67Sy but for Pm>0.67Sy NB 3226 : Pm+Pb<2.15Sy-1.2Pm; clear request of 3Sm check for fatigue analysis NB3226 e); an alternative rule for stainless steels in B3237 e) | | B1 |
| *NB 3227: Special stress limits* | bearing load, pure shear, progressive distortion of nonintegral connections, triaxial stresses, nozzle piping transition, applications of elastic analysis for stresses beyond the yield strength requirements for specially designed welded seals | B 3238 | bearing load, pure shear, progressive distortion of nonintegral connections, triaxial stresses, nozzle piping transition (more precise in NB3227.5), applications of elastic analysis for stresses beyond the yield strength (possible modification of n between 0.3 and 0.5), requirements for specially designed welded seals | | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 3228: Application of plastic analysis* | | B 3240 | use of Sy instead of 1.5Sm for NB3228, criteria for level C and plastic instability in B3240, not in NB3228 | | A1 |
| *NB 3229: Design stress values* | | Annexe ZI (material properties) and ZIII (allowable stresses principle) | slightly different principle, but equivalent allowable stress values; possible differences in procurement check for Sy at room temperature (with no consequences on the allowable stress) | | A2 |
| NB-3230 Stress Limits for Bolts | | B 3250 | | | |
| *NB 3231: Design conditions* | | B 3251 | | | A1 |
| *NB 3232: Level A service limits* | | B 3252 : fatigue exemption rules NB 3222.4 d, | | | A2 |
| *NB 3233: Level B service limits* | | | no level B service limits in RCCM, all considered as level A | | B2 |
| *NB 3234: Level C service limits* | | B 3253 | | | A1 |
| *NB 3235: Level D service limits* | | B 3254 | | | A1 |
| | | B 3255 for tests | | | A1 |
| *NB 3236: Design stress intensity values* | | B 3256 | | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| | | B 3260 Fracture resistance<br>B 3261 General<br>B 3262 Reference Defect<br>B 3263 Criteria<br>B 3264 Methods | strongly different, all component have to be deep flaw "tolerant" in RCCM | | B2 |
| **Article NB-4000 Fabrication and Installation** | | **B 4000** | | | |
| NB-4100 General Requirements | | B 4100 | no technical specific provisions | | |
| NB-4110 Introduction | | B 4220 | | | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-4120 Certification of Materials and Fabrication by Certificate Holder | | B 2000 + M 151 + TR B 1200 + B 4220 + B 4230 + F 2000 | different rules connected to European and French regulation | - RCCM defines which examinations have to be performed, with which qualification, and corresponding acceptance criteria<br>- Who is responsible is defined by the applicable regulation : RCCM Appendix ZU in France that defines the responsibilities which are closed to international practices<br>- Use of RCCM with Finnish regulation achieves the same goal without, in this case, any needs of specific RCCM Appendix | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 4121: means of certification* | certification of treatments, tests and examinations, repetition of tensile or impact tests, repetition of surface examination after machining | - B 2200 and dedicated MPS<br>- M150 | - RCCM B 2200 defines which MPS can be used for each part of components; tests and examinations are defined in MPS<br>- RCCM M150 defines how the test can be satisfactory for heat treatment | - RCCM does not state one general rule for means of certification of material during manufacturing process<br>- each MPS, M150 and RCCM F chapter define which test or examination are required and when | B2 |
| *NB 4122: Material identification* | marking material | B 4320, B 1300, F 6000, F 2200 | | | B2 |
| *NB 4123: examinations* | reference to NB 5000 | | see NB 5000 comparison | | |
| *NB 4124: blank* | | | | | |
| *NB 4125: testing of welding and brazing material* | | S 2000 | | | B2 |
| NB-4130 Repair of Material | | Section II + S 7600 | | | |
| *NB 4131: elimination and repairs of defects* | | Section II MPS | | | B2 |
| *NB 4132: documentation of repair welds of base material* | | B 1300, S 7120, S 7420, S 7600 | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-4200 Forming, Fitting, and Aligning | | B 4340 + F 4000 | | | |
| NB-4210 Cutting, Forming, and Bending | | F 3000 + F 4100 | | | |
| *NB 4211: Cutting* | preheating | | | | B2 |
| *NB 4212: Forming and bending process* | | | | | B2 |
| *NB 4213: Qualification of forming process for impact property requirement* | exemption procedure qualification test, acceptance criteria for formed material, requalification | F 4000 | | | B2 |
| *NB 4214: Minimum thickness for fabricated material* | | | | | B2 |
| NB-4220 Forming Tolerances | | F 4200 | | | |
| *NB 4221: Tolerances for vessel shells* | minimum difference in cross-sectional diameters, maximum deviation in cross-sectional diameters, deviation from tolerances, tolerance deviations for pressure vessel parts fabricated from pipe | | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 4222: Tolerances for formed vessel heads* | maximum difference in cross-sectional diameters, deviation from specified shape | | | | B2 |
| *NB 4223: Tolerances for formed or bent piping* | minimum wall thickness, ovality tolerance | | | | B2 |
| NB-4230 Fitting and Aligning<br>*NB 4231: Fitting and aligning methods* | tack welds | F 4300 | | | B2 |
| *NB 4232: Alignment requirements when components are welded from 2 sides* | fairing offsets | | | | B2 |
| NB-4240 Requirements for Weld Joints in Components<br>*NB 4241: Cat A weld joints in vessels and longit weld joints in other components* | | B 3352, B 3660 | - weld classifications are different, with few technical differences, but globally equivalent<br>- as an example : only full penetration welds are acceptable by RCCM for low diameters and angle weld of nozzle; partial penetration welds are possible by ASME | globally equivalent | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 4242: Cat B weld joints in vessels and circumf weld joints in other components* | | | | | A2 |
| *NB 4243: Cat C weld joints in vessels and similar weld joints in other components* | | | | | A2 |
| *NB 4244: Cat D weld joints in vessels and similar weld joints in other components* | | | | | A2 |
| *NB 4245: Complete joint penetration welds* | | | | | B1 |
| *NB 4246: Piping branch connection* | | | | | B1 |
| NB-4250 Welding End Transitions — Maximum Envelope | | B 3683.1c) + B3683.4 + B 3683.5 | | | B2 |
| NB-4300 Welding Qualifications | | B 4231 + S 100, S 3000 | | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-4310 General Requirements | | B 4231 + S 3120 | | - ASME III refers to ASMEXI, RCCM to EN 15614<br>- these 2 specifications do not consider exactly the same parameters, but achieve an equivalent quality level, considering other aspects: welders qualifications, NDE associated, test coupons during manufacturing<br>- RCCM is in line with European industrial approach, with qualification by third parties | A2 |
| *NB 4311: Type of processes permitted* | stud welding restriction, capacitor discharge welding, inertia and continuous drive friction welding | S 3000 | no particular differences specific to this process | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-4320 Welding Qualifications, Records, and Identifying Stamps | | B 4231 + S1000 + A 3500 | | | |
| *NB 4321: Required qualifications* | | | | | B2 |
| *NB 4322: Maintenance and certification of records* | | | | | B2 |
| *NB 4323: Welding prior to qualification* | | | | | B2 |
| *NB 4324: Transferring qualification* | | | | | B2 |
| NB-4330 General Requirements for Welding Procedure Qualification Tests | | Section IV : S 3000 + Appendix SI | | | |
| *NB 4331: Conformance to section IX requirements* | | | RCCM refers to EN 15614; essential variables are different in Section IX and EN 15614; thickness range validity of qualification is different | no direct link with ISI Code | B2 |
| *NB 4332: not used* | | | | | B2 |
| *NB 4333: Heat treatment of qualification welds for ferritic materials* | | | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 4334: Preparation of test coupons and specimens: representing weld deposit, heat affected zone,* | | | Tests are different in ASME and RCCM (EN 15614) Codes:- RTNDT not for all materials in RCCM (some pressure parts); RTNDT for all materials in ASME- chemical analysis not required in ASME, but required in RCCM- no NDE required in ASME in contrary of to RCCM where all test during production must be performed for qualification | | B2 |
| *NB 4335: Impact test requirements : of weld metal, of HAZ* | | | - impact test in HAZ are mandatory in RCCM (EN 15614-1) | | B2 |
| *NB 4336: Qualification requirements for built-up weld deposits* | | | - weld deposits limits are different | | B2 |
| *NB 4337: Welding of instrument tubing* | | | | | B2 |
| NB-4340 (not used) | | | | | |
| NB-4350 Special Qualification Requirements for Tube-to-Tubesheet Welds | | S 3800 | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-4360 Qualification Requirements for Welding Specially Designed Welded Seals | | S 3520 | | Canopy seal | |
| *NB 4361: General requirements* | | | | | B2 |
| *NB 4362: Essential variables for automatic machine, and semi-automatic welding* | | | | | B2 |
| *NB 4363: Essential variables for manual welding* | | | Energy are different in RCCM (EN 15614-1) | | B2 |
| *NB 4364: not used* | | | | | |
| *NB 4365: not used* | | | | | |
| *NB 4366: Test assembly: automatic, manual, machine and semi-automatic welding* | | | | | B2 |
| *NB 4367: Examination of test assembly* | | | | | B2 |
| *NB 4368: Performance qualification tests* | | | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-4400 Rules Governing Making, Examining, and Repairing Welds | | | | | |
| NB-4410 Precautions to Be Taken Before Welding | | B 4420 + S 7200 | | | |
| *NB 4411: Identification, storage and handling of welding material* | | S 7200 | | | B2 |
| *NB 4412: Cleanliness and protection of welding surfaces* | | | | | B2 |
| NB-4420 Rules for Making Welded Joints | | B 4440 + S 1300 + S 7400 | | | |
| *NB 4421: Backing rings* | | | | | A2 |
| *NB 4422: Peening* | | | | | A2 |
| *NB 4423: Miscellaneous welding requirements* | | S 7300 + MC 4000 | | | A2 |
| *NB 4424: Surface of welds: general and preservice examination* | general and pre-service examination | | | | B2 |
| *NB 4425: Welding items of different diameters* | reference to design provisions | | equivalent requirements | | A2 |
| *NB 4426: Reinforcement of welds* | thickness of weld reinforcement for vessels, pumps and valves; thickness of weld reinforcement for piping | S 7461 | different but globally equivalent | | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 4427: Shape and size of fillet welds* | | B 3000 | | | B2 |
| *NB 4428: Sea welds of threated joints* | | | | | B1 |
| *NB 4429: Welding of clad parts* | | | | | B1 |
| NB-4430 Welding of Attachments | | S 7423 | integrated in RCCM design section | | |
| *NB 4431: Materials for attachments* | | | | | B2 |
| *NB 4432: Welding of structural attachments* | | | | | B2 |
| *NB 4433: Structural attachments* | | | | | B2 |
| *NB 4434: Welding of internal structural supports to clad components* | | | | | B2 |
| *NB 4435: Welding of nonstructural attachments and their removal* | | S 7710 | | | B2 |
| *NB 4436: Installation of attachments to piping systems after testing* | | | | | B1 |
| NB-4440 Welding of Appurtenances | | | | | B1 |
| NB-4450 Repair of Weld Metal Defects | | F 2600 + B 4450 + S 7600 | | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 4451: General requirements* | | | | | A2 |
| *NB 4452: Elimination of surface defects* | | | | | B2 |
| *NB 4453: Requirements for making repairs of welds* | defect removal, welding material, procedures, welders, examination of repair welds, heat treatment of repair welds | | | | B2 |
| NB-4500 Brazing | | not cover in RCC M | | | |
| NB-4510 Rules for Brazing | | | | | B1 |
| NB-4520 Brazing Qualification Requirements | | | | | |
| *NB 4521: Brazing procedure and performance qualification* | | | | | B1 |
| *NB 4522: Valve seat rings* | | | | | B1 |
| *NB 4523: Reheated joints* | | | | | B1 |
| *NB 4524: Maximum temperature limits* | | | | | B1 |
| NB-4530 Fitting and Aligning of Parts to Be Brazed | | | | | B1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-4540 Examination of Brazed Joints | | | | | B1 |
| NB-4600 Heat Treatment | | S 1300 - F 8000 | | reference to NF EN 10052 in RCCM (European Standard) | |
| NB-4610 Welding Preheat Requirements | | S 1320 | | | |
| *NB 4611: When preheat is necessary* | | | | | B2 |
| *NB 4612: Preheating methods* | | | | | B2 |
| *NB 4613: Interpass temperature* | | | | | B2 |
| NB-4620 Postweld Heat Treatment | | S 1340 + F 8000 + S 7540 + S 7620 | | | |
| *NB 4621: Heating and cooling methods* | | | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 4622: PWHT time and temperature requirements* | general requirements, time-temperature recording, definition of nominal thickness governing PWHT, holding time at temperature, PWHT requirements when different P-number materials are joined, PWHT for nonpressure retaining parts, exemptions to mandatory requirements, requirements for exempting PWHT of nozzles to component welds and branch to run piping welds, temper bead weld repair, repair welds to cladding after final postweld heat treatment, temper bead weld repair to disequivalent metal welds or buttering | | Globally equivalent, only few parameters changed: holding time identical, temperature range more limited in RCCM, equivalence of exemption rules | globally equivalent | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 4623: PWHT heating and cooling rate requirements,*<br>*NB 4624: Methods of PWHT* | furnace heating-one heat, furnace heating-more than one heat, local heating, heating items internally | | | | B2<br>B2 |
| NB-4630 Heat Treatment of Welds Other Than the Final Postweld Heat Treatment | | | | | B1 |
| NB-4640 not used | | | | | |
| NB-4650 Heat Treatment After Bending or Forming for Pipes, Pumps, and Valves<br>*NB 4651: Conditions requiring heat treatment after bending or forming* | | F 4123.7 | | | B2 |
| *NB 4652: Exemptions from heat treatment after bending or forming* | | | | | B2 |
| NB-4660 Heat Treatment of Electroslag Welds | | not used in RCC M | | | B1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-4700 Mechanical Joints | | F 7000 | | | |
| NB-4710 Bolting and Threading | | | | | |
| *NB 4711: Thread engagement* | | | | | B2 |
| *NB 4712: Thread lubricants* | | | | | B2 |
| *NB 4713: Removal of thread lubricants* | | | | | B2 |
| NB-4720 Bolting Flanged Joints | | | | | B1 |
| NB-4730 Electrical and Mechanical Penetration Assemblies | | | | | B2 |
| | | | | | |
| **Article NB-5000 Examination** | | **B 4000 + Section II + S 7000** | | | |
| NB-5100 General Requirements for Examination | | B 4200 | | | |
| NB-5110 Methods, Nondestructive Examination Procedures, and Cleaning | | B 4233, B4460, Section III | pre-service out of RCCM scope<br>personal qualification in MC 8000<br>cleaning in F 6000 | | |
| *NB 5111: Methods* | | MC 2133, MC 3133, MC 3312<br>MC 2122, MC 3122, MC 4122 | | | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 5112: NDE procedures* | | MC 3162 | | | A2 |
| *NB 5113: Post-examination cleaning* | | F 6000 | | | B1 |
| NB-5120 Time of Examination of Welds and Weld Metal Cladding<br>NB-5130 Examination of Weld Edge Preparation Surfaces | | S 7710, MC 3312, MC 4141<br>S 7300 | RCCM provisions detailed for each type of welds | | B2<br>A2 |
| NB-5140 Examination of Welds and Adjacent Base Material | | S 7710, MC 3312, MC 4141 | RCCM provisions cover ASME provisions | | B2 |
| NB-5200 Required Examination of Welds for Fabrication and Pre-service Baseline | | B 4430 + B 4460 and S 7000 | pre-service out of RCCM Code | | |
| NB-5210 Category A Vessel Welded Joints and Longitudinal Welded Joints in Other Components | | S 7710 | RCCM provisions detailed for each type of welds | | B2 |
| NB-5220 Category B Vessel Welded Joints and Circumferential Welded Joints in Piping, Pumps and Valves<br>*NB 5221: Vessel welded joints* | | S 7710 | RCCM provisions detailed for each type of welds | | <br>B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 5222: Piping , pump and valve circonf welded joints* | | | | | B2 |
| NB-5230 Category C Vessel Welded Joints and Similar Welded Joints in Other Components | | S 7710 | RCCM provisions detailed for each type of welds | | |
| *NB 5231: General requirements* | | | | | B2 |
| NB-5240 Category D Vessel Welded Joints and Branch and Piping Connections in Other Components | | S 7710 | RCCM provisions detailed for each type of welds | | |
| *NB 5241: General requirements* | | | | | B2 |
| *NB 5242: Full penetration butt welded nozzles branch and piping connections* | | | | | B2 |
| *NB 5243: Corner welded nozzles, branch and piping connections* | | | | | B2 |
| *NB 5244: Weld metal build up at openings for nozzles, branch and piping connections* | | MC 2700 | RCCM MC 2700 states methodology requirements which are not in ASME NB 5244 | | B1 |
| *NB 5245: Fillet welded and partial penetration welded joints* | | | | | B1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 5246: Oblique full penetration nozzles, branch and piping connections* | | | | | B1 |
| NB 5250 not used | | | | | |
| NB-5260 Fillet, Partial Penetration, Socket and Attachment Welded Joints<br>*NB 5261: Fillet, partial penetration and SW joints*<br>*NB 5262: Structural attachment welded joints* | | S 7710 | RCCM provisions detailed for each type of welds | | <br>B2<br>B2 |
| NB-5270 Special Welded Joints<br>*NB 5271: Welded joints of specially designed seals* | | S 7710, M 3312 | - RCCM provisions detailed for each type of welds<br>- RCCM MC 3312 defines methodology requirements which are not in ASME NB 5271 | | <br>B2 |
| *NB 5272: Weld metal cladding*<br>*NB 5273: Hard surfacing* | | MC 2700<br>S 8000 | RCCM MC 2700 defines methodology requirements which are not in ASME NB 5244 | | B2<br>B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 5274: Tube-to-tubesheet welded joints* | | | | | B2 |
| *NB 5274: Brazed joints* | | | not in RCCM | | B1 |
| *NB 5276: Inertia and continuous drive friction welds* | | | | | B1 |
| *NB 5277: Electron beam welds* | | | | | B1 |
| *NB 5278: Electroslag welds* | | | | | B1 |
| *NB 5279: Special exemptions* | | | | | B1 |
| NB-5280 Preservice Examination | | | not in RCCM | | |
| NB 5281: General requirements | | | | | B1 |
| NB 5282: Examination requirements | | | | | B1 |
| NB 5283: Components exempt from preservice examination | | | | | B1 |
| NB-5300 Acceptance Standards | | S 7710 | | | |
| NB-5320 Radiographic Acceptance Standards | | S 7714 | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-5330 Ultrasonic Acceptance Standards | | S 7714 + MC 2000 | RCCM MC 2000 gives the definition of the indication grouping. It's a complement to RCCM S 7714 | | |
| *NB 5331: Fabrication* | | | | | B2 |
| *NB 5332: Preservice examination* | | | not in RCCM | operation code : RSEM | B1 |
| NB-5340 Magnetic Particle Acceptance Standards | | S 7714 + MC 5000 | RCCM MC 5000 gives the definition of linear/rounded, it's a complement to RCCM S 7714 | | B2 |
| *NB 5341: Evaluation of indications* | | | | | B2 |
| *NB 5342: Acceptance standards* | | | | | B2 |
| *NB 5343: Preservice examination* | | | | | B1 |
| NB-5350 Liquid Penetrant Acceptance Standards | | S 7714 + MC 4000 | RCCM MC 4000 gives the definition of linear/rounded, it's a complement to RCCM S 7714 | | |
| *NB 5351: Evaluation of indications* | | | | | B2 |
| *NB 5352: Acceptance standards* | | | | | B2 |
| *NB 5353: Preservice examination* | | | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-5360 Eddy Current Preservice Examination of Installed Nonferromagnetic Steam Generator Heat Exchanger Tubing | | S 7714 + MC 6000 | RCCM MC 6000 defines requirements for reference tube | | B2 |
| NB-5370 Visual Acceptance Standards for Brazed Joints | | | not in RCCM | | B1 |
| NB-5380 Bubble Formation Testing | | MC 7400 | | | A2 |
| NB-5400 Final Examination of Vessels | | MC 7100 | | | |
| NB-5410 Examination After Hydrostatic Test | | | | | A2 |
| NB-5500 Qualifications and Certification of Nondestructive Examination Personnel | | B 4233 + MC 8000 | equivalent objectives, but different references | RCCM is in line with European approach and EN 473; third party are mandatory following regulation in force | |
| NB-5510 General Requirements | | MC 2121, MC 3121, MC 4121, MC 5121 | | | A2 |
| NB-5520 Personnel Qualification, Certification and Verification<br>*NB 5521: Qualification procedure* | | | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 5522: Certification of personnel* | | | | | B2 |
| *NB 5523: Verification of NDE personnel certification* | | | | | B2 |
| NB-5530 Records | | | | | B2 |
| **Article NB-6000 Testing** | | **B 5000** | | | |
| NB-6100 General Requirements | | B 5100 | | | |
| NB-6110 Pressure Testing of Components, Appurtenances and Systems | | | | | |
| *NB 6111: Scope of pressure testing* | preferred method : hydrostatic test, bolts, nuts, washers and gaskets exempted from pressure test | | | | A2 |
| *NB 6112: Pneumatic testing: limitations, precautions* | limitations, precautions | | not applicable for class 1 components | nonmandatory appendix ZU might be used under cover of interpretation sheet | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 6113: Witnessing of pressure test* | system pressure test, component and appurtenance pressure test, material pressure test | B 5211 : individual pressure test<br>B 5212: assemblies (or system) pressure test | witnessing by inspector is required; inspector is defined in A 2100 | witnessing under safety authority for class 1 components is defined in regulation in force (Appendix ZU for France) | B2 |
| *NB 6114: Time of pressure testing : system pressure test, component and appurtenance pressure test, material pressure test*<br>*NB 6115: Machining after pressure test* | | B 5211 | no un-scheduled machining acceptance , RCCM more general than ASME | | B2 |
| NB-6120 Preparation for testing<br>*NB 6121: Exposure of joints* | | B 5240 | more detailed in RCCM | | B2 |
| *NB 6122: Addition of temporary support*<br>*NB 6123: Restraint or isolation of expansion joints*<br>*NB 6124:Isolation of equipment not subjected to pressure test* | | | | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 6125: Treatment of flanged joints containing blanks*<br>*NB 6126: Precautions against test medium expansion* | | | | | |
| *NB 6127: Check of test equipment before applying pressure* | | | | | |
| NB-6200 Hydrostatic Tests | | B 5200 | | | |
| NB-6210 Hydrostatic Test Procedure<br>*NB 6211: Venting during fill operation* | | B 5240 | equivalent requirement | | A2 |
| *NB 6212: Test medium and test temperature* | | B 5240 | RTNDT +30°C in RCCM | | A2 |
| NB-6220 Hydrostatic Test Pressure Requirements<br>*NB 6221: Minimum hydrostatic test pressure* | | B 5220 | RCCM 2007 more stringent than ASME (higher pressure) | European regulatory requirement, RCCM 2008 equivalent to ASME with specific requirement from French regulation in Appendix ZU | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB 6222: Maximum permissible test pressure* | | | equivalent stress limits | | A2 |
| | | B 5223 Individual test pressure for valve<br>B 5225 Test pressure for safety device | not in ASME | reference to EN 12266-1 standard | B1 |
| | | B 5230 Documents to be drawn up before the hydrostatic test | not in ASME | covers in particular test procedure | B1 |
| *NB 6223: Hydrostatic test pressure holding time*<br>*NB 6224: Examination of leakage after application of pressure* | | B 5240 e)<br>B 5250 Acceptance criteria | more general requirement in RCCM | | B2<br>B2 |
| | | B 5260 Document to bee drawn up after the test<br>B 5300 Additional test on valves | covered in particular test certificate<br>not in ASME | <br>reference to EN 12666-1 | A2<br>B1 |
| NB-6300 Pneumatic Tests | | not covered in RCCM | | | |
| NB-6310 Pneumatic Testing Procedures<br>*NB 6311: General requirements*<br>*NB 6312: Test medium and test pressure*<br>*NB 6313: Procedure for applying pressure* | | | | | <br>B1<br>B1<br>B1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-6320 Pneumatic Test Pressure Requirements<br>*NB 6321: Minimum required pneumatic test pressure*<br>*NB 6322: Maximum permissible test pressure* | | | | | <br>B1<br>B1 |
| *NB 6323: Test pressure holding time*<br>*NB 6324: Examination for leakage after application of pressure* | | | | | B1<br>B1 |
| NB-6400 Pressure Test Gages | | B 5240 | | RCCM and ASME do not cover same range of measure (3 or 4 times Pt) | |
| *NB 6411: Type of gages to be used and their location* | | | | | B2 |
| *NB 6412: Range of indicating pressure gages*<br>*NB 6413: Calibration of pressure test gages* | | | | | B2<br>B2 |
| NB-6500 not used | | | | | |
| NB-6600 Special Test Pressure Situations | | | | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-6610 Components Designed for External Pressure | | Appendix Z IV | | | B1 |
| NB-6620 Pressure Testing of Combination Units<br>*NB 6221: Pressure chambers designated to operate independently* | | | not in RCCM | | B1 |
| *NB 6222: Common elements designed for a max differential pressure* | test condition derived from ΔP used in Design | | not in RCCM | | B1 |
| **Article NB-7000 Overpressure Protection** | | **B 6000** | | | |
| NB-7100 General Requirements | | | | | |
| NB-7110 Scope | | B 6112 Scope of application | Equivalent provisions | | |
| *NB-7111 Definitions* | | B 6113 Terms and definitions | Equivalent provisions. ASME refers to ASME PTC 25-2001 whereas RCC-M refers to EN-ISO 4126-1 | | A2 |
| NB-7120 Integrated Overpressure Protection | | B 6120 Integrated overpressure protection | Equivalent provisions | | A2 |
| NB-7130 Verification of the Operation of Reclosing Pressure Relief Devices | | B 6130 Verification of pressure relief valve reclosing | Equivalent provisions | | A2 |
| *NB-7131 Construction* | | B 6131 Construction | | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-7140 Installation | | B 6140 Installation | Equivalent provisions | | A2 |
| *NB 7141 Pressure Relieve Devices* | | B 6141 Direct Pressure Limit action Devices | RCC-M refers to EN 764-7 | | A2 |
| *NB-7142 Stop valves* | | B 6142 Stop valves | Equivalent provisions with EN 764-7 recognized as acceptable | | A2 |
| *NB-7143 Draining of pressure relieve devices* | | B 6143 Draining of pressure relief devices | Equivalent provisions | | A2 |
| NB-7150 Acceptable Pressure Relief Devices | | B 6150 Acceptable pressure relief devices | | | |
| *NB-7151 Pressure relief valves* | Reference to NB-7170 and NB-7500 | B 6151 Pressure relief valves | Equivalent provisions | | A2 |
| *NB-7152 Non-reclosing pressure relief devices* | Reference to NB-7170 and NB-7600 | B 6152 Non-reclosing pressure relief devices | Equivalent provisions | | A2 |
| NB-7160 Unacceptable Pressure Relief Devices | | B 7160 Unacceptable pressure relief devices | RCC-M includes ASME limitation | | |
| *NB-7161 Deadweight pressure relief valves* | | | | | A1 |
| NB-7170 Permitted Use of Pressure Relief Devices | | B 6170 Permitted use of direct pressure limitation devices | | | |
| *NB-7171 Safety valves* | | B 6171 Direct-operated pressure relief valves | RCC-M B 6171 covers ASME NB-7171, NB-7172 and NB-7173 | | A2 |
| *NB-7172 Safety relief valves* | | | | | B1 |
| *NB-7173 Relief valves* | | | | | B1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB-7174 Pilot operated pressure relief valves* | | B 6172 Pilot-operated pressure relief valves | Equivalent provisions | | A2 |
| *NB-7175 Power actuated pressure relief valves* | | B 6173 Power-actuated pressure relief valves | Equivalent provisions | | A2 |
| *NB-7176 Safety valves with auxiliary actuating devices* | | B 6174 Pressure relief valves with auxiliary actuating devices | Equivalent provisions | | A2 |
| *NB-7177 Pilot operated pressure relief valves with auxiliary actuating devices* | | B 6175 Pilot-operated pressure relief valves with auxiliary actuating devices | Equivalent provisions | | A2 |
| *NB-7178 Non-reclosing devices* | | B 6176 Non-reclosing pressure relief devices | Equivalent provisions | | A2 |
| | | B 6180 Additional requirements regarding safety accessories | Reliability, independence, redundancy, diversity and self-diagnosis principles according to European regulation | self-diagnosis principles according to European standardization (EN 764-7) | B1 |
| NB-7200 Overpressure Protection Report | | B 6200 Overpressure protection report | | | |
| NB-7210 Responsibility for Report | | B 6210 Responsibility | Equivalent provisions | | A2 |
| NB-7220 Content of Report | | B 6220 Content of report | RCC-M less detailed, but links to equipment hazards analysis and operating instructions for consistency | | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-7230 Certification of Report | | B 6230 Presentation of the overpressure protection report | No strict correspondence ASME refers to RPE activity, RCC-M refers to Safety report | Regulations define who have to assess the safety report, the hazard analysis (overpressure protection which is included in), the operating instructions; RCCM appendix ZU in France | B2 |
| NB-7240 Review of Report After Installation | | B 6240 Overpressure protection report updates | ASME provisions related to ASME organization | | B1 |
| NB-7250 Filing of Report | | A 3100, Appendices ZU and ZT | | | B1 |
| NB-7300 Relieving Capacity | | | | | |
| NB-7310 Expected System Pressure Transient Conditions | | B 6310 Normal, upset and emergency conditions | RCC-M requirements explicitly applicable to emergency conditions. | RCC-M 2007 integrates French 1999 regulation, grouped in RCCM appendix ZU for future RCCM edition | B2 |
| *NB 7311 Relieving capacity of Pressure Relief Devices* | | B 6311 Relieving Capacity for Direct Pressure Limitation Devices | 120% limit shall be met with one device considered unavailable (2 if 4 or more devices used) | Covers ASME NB-7311 to NB-7314 | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB-7312 Relieving capacity of pressure relief devices used with pressure-reducing devices* | | | | | B1 |
| *NB-7313 Required number and capacity of pressure relief devices*<br>*NB-7314 Required number and capacity of pressure relief devices for isolatable components* | | B 6312 Simultaneous isolation of direct pressure limitation devices and of pressure source | Equivalent provisions. RCC-M refers to EN 764-7 | RCC-M refers to EN 764-7 | B1<br>B2 |
| NB-7320 Unexpected System Excess Pressure Transient Conditions<br>*NB-7321 Relieving capacity of pressure relief devices* | | B 6320 Faulted conditions<br>B 6321 Relieving capacity for direct pressure limitation devices | ASME provisions dedicated to conditions for which level C service limits are specified. Those are covered in RCC-M B 6310. RCC-M provisions go beyond | | A2<br>B2 |
| NB-7400 Set Pressures of Pressure Relief Devices | | B 6400 Set pressure for direct pressure limitation devices | | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-7410 Set Pressure Limitations for Expected System Pressure Transient Conditions | | B 6410 Set pressure limitation for normal, upset and emergency conditions | RCC-M provisions also applicable to emergency conditions and more severe than ASME | RCC-M integrates French regulation, as a basis in this case | B2 |
| NB-7420 Set Pressure Limitation for Unexpected System Excess Pressure Transient Conditions | | B 6420 Set pressure limitation for faulted conditions | Examples given in ASME for unexpected conditions do not correspond to faulted conditions, and are covered in RCC-M B 6410. | | A2 |
| NB-7500 Operating and Design Requirements for Pressure Relief Valves | | B 6500 Design and operating specifications for pressure relief valves | | | |
| NB-7510 Safety, Safety Relief and Relief Valves | | B 6510 Direct-operated pressure relief valves | | | |
| *NB-7511 General requirements* | | B 6511 General | Reference made to EN ISO 4126-1 in RCC-M | | B2 |
| *NB-7512 Safety valve operating requirements* | | B 6512 Operating specifications | B 6512 covers ASME NB-7512 and NB-7513. Reference made to EN ISO 4126-1 | | B2 |
| *NB-7513 Safety relief and relief valve operating requirements* | | | | | B1 |
| *NB-7514 Credited relieving capacity* | Reference to NB-7700 | B 6513 Credited relieving capacity | Equivalent provisions | | A2 |
| *NB-7515 Sealing of adjustments* | | B 6514 Sealing settings | Equivalent provisions | | A2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-7520 Pilot Operated Pressure Relief Valves | | B 6520 Pilot-operated pressure relief valves | | | |
| *NB-7521 General requirements* | | B 6521 General requirements | Equivalent provisions, plus reference to EN ISO 4126-4 in RCC-M | | B2 |
| *NB-7522 Operating requirements* | | B 6522 Operating specifications | Equivalent provisions | | A2 |
| *NB-7523 Credited relieving capacity* | | B 6523 Credited relieving capacity | Equivalent provisions | | A2 |
| *NB-7524 Sealing of adjustments* | | B 6524 Sealing settings | Equivalent provisions | | A2 |
| NB-7530 Power Actuated Pressure Relief Valves | | B 6530 Power-actuated pressure relief valves | | | |
| *NB-7531 General requirements* | | B 6531 General | Equivalent provisions | | A2 |
| *NB-7532 Operating requirements* | | B 6532 Operating requirements | Equivalent provisions | | A2 |
| *NB-7533 Certified relieving capacity* | | B 6533 Certified relieving capacity | Equivalent provisions | | A2 |
| *NB-7534 Credited relieving capacity* | | B 653 Credited relieving capacity | Equivalent provisions | | A2 |
| *NB-7535 Sealing of adjustments* | | B 6535 Sealing settings | Equivalent provisions | | A2 |
| NB-7540 Safety Valves and Pilot Operated Pressure Relief Valves With Auxiliary Actuating Devices | | B 6540 Pressure relief valves and pilot-operated pressure-relief valves with auxiliary actuating devices | Reference to EN ISO 4126-1 in RCC-M | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB-7541 General requirements*<br>*NB-7542 Construction*<br>*NB-7543 Auxiliary device sensors and controls* | | | | | B2<br>B2<br>B2 |
| *NB-7544 Relieving capacity*<br>*NB-7545 Response time* | | | | | B2<br>B2 |
| NB-7550 Alternative Test Media<br>*NB-7551 General requirements* | | B 6550 Alternative test media<br>B 6551 General | | | <br>B1 |
| *NB-7552 Correlation*<br>*NB-7553 Verification of correlation procedure*<br>*NB-7554 Procedure* | | B 6552 Correlation<br>B 6553 Verification of the correlation parameters<br>B 6554 Procedure | | | B1<br>B1<br>B1 |
| | | B 6560 Acceptance tests | Tests to be performed according to EN ISO 4126 in addition to B 5000 | no pressure test or leaktightness test in ASME | B2 |
| NB-7600 Non-reclosing Pressure Relief Devices | | B 6600 Non-reclosing pressure-relief devices | No specific provisions in RCC-M as these devices are not used for class 1 equipments | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-7610 Rupture Disk Devices | | | | no specific provisions in RCCM as these devices are not uses for class 1 equipment | |
| *NB-7611 Burst pressure tolerance* | | | | | B1 |
| *NB-7612 Tests to establish stamped burst pressure* | | | | | B1 |
| NB-7620 Installation | | | | no specific provisions in RCCM as these devices are not uses for class 1 equipment | |
| *NB-7621 Provisions for venting or draining* | | | | | B1 |
| *NB-7622 Systems obstructions* | | | | | B1 |
| *NB-7623 Rupture disk devices at the outset side of pressure relief valves* | | | | | B1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| NB-7700 Certification | | B 6700 Determination of flow capacity | Two approaches acceptable in RCC-M either ASME NB-7700 or EN ISO 4126, parts 1 to 6 | - RCCM considers regulation in force for safety devices<br>- in France, as in Europe, RCCM appendix ZU defines the requirements, which include non-reclosing pressure relief devices (bursting disks) | |
| NB-7710 Responsibility for Certification of Pressure Relief Valves | | | | | B2 |
| NB-7720 Responsibility for Certification of Non-reclosing Pressure Relief Devices | | | | | B2 |
| NB-7730 Capacity Certification Pressure Relief Valves — Compressible Fluids | | | | | |
| *NB-7731 General requirements*<br>*NB-7732 Flow model test method*<br>*NB-7733 Slope method*<br>*NB-7734 Coefficient of discharge method* | | | | | B2<br>B2<br>B2<br>B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB-7735 Single valve method* | | | | | B2 |
| *NB-7736 Proration of capacity* | | | | | B2 |
| *NB-7737 Capacity conversions* | | | | | B2 |
| *NB-7738 Laboratory acceptance of pressure relieving capacity tests* | | | | | B2 |
| *NB-7739 Laboratory acceptance of demonstration of function tests* | | | | | B2 |
| NB-7740 Capacity Certification of Pressure Relief Valves — Incompressible Fluids | | | | | |
| *NB-7741 General requirements* | | | | | B2 |
| *NB-7742 Valve designs in excess of test facility limits* | | | | | B2 |
| *NB-7743 Slope method* | | | | | B2 |
| *NB-7744 Coefficient of discharge method* | | | | | B2 |
| *NB-7745 Single valve method* | | | | | B2 |
| *NB-7746 Laboratory acceptance of pressure relieving capacity tests* | | | | | B2 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| *NB-7747 Proration of capacity*<br>*NB-7748 Capacity conversions*<br>*NB-7749 Laboratory acceptance of demonstration of function tests* | | | | | B2<br>B2<br>B2 |
| NB-7800 Marking, Stamping and Data Reports | | B 1300, A 3000 (A 3804), non-mandatory appendices ZU, ZZ, ZT, ZY | - certificate of compliance with RCCM does not involve third party like MDR<br>- stamping, marking are context-dependent | RCCM considers that marking w/o stamping are related to particular regulation | |
| NB-7810 Pressure Relief Valves<br>*NB-7811 Marking and stamping*<br>*NB-7812 Report form for pressure relief valves* | | | | | *B1*<br>*B1* |
| NB-7820 Rupture Disk Devices<br>*NB-7821 Rupture disks*<br>*NB-7822 Disk holders (if used)* | | | | | B1<br>B1 |
| NB-7830 Certificate of Authorization to Use Code Symbol Stamp | | | | | B1 |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-8000 Nameplates, Stamping and Reports** | | | | | |
| NB-8100 General Requirements | Reference to NCA 8000 | B 1300, A 3800 | | RCCM considers that marking w/o stamping are related to particular regulation | B1 |
| **Appendices** | | **Annexes Z** | | | **NC** |
| **Mandatory appendices** | | **Mandatory annexes** | | | |
| Appendix I : Design Stress Intensity Values, allowable stresses, material properties and design curves | | Annex ZI : Material properties to be used in design | Equivalent provisions | | |
| Appendix II :Experimental stress analysis | | Annex ZII : Experimental stress analysis | Equivalent provisions | | |
| Appendix III : Basis for establishing design stress intensity values and allowable stress values | | Annex ZIII : Determination of allowable stress | Technically equivalent provisions | | |
| Appendix IV : Approval of new materials under the ASME Boiler and Pressure Vessel Code | | M 113 New methods of manufacturing parts, new materials: qualification | ASME appendix only applicable within ASME framework | no need in RCCM | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| Appendix V : Certificate holders' data report forms, instructions, and application forms for certificates of authorization for use of Code symbol stamps | | No correspondence | ASME appendix only applicable within ASME framework | no need in RCCM | |
| Appendix VI : Rounded indications | | S 7714 | RCC-M provisions adequate, but less detailed | | |
| Appendix VII : Charts and tables for determining shell thickness of cylindrical and spherical components under external pressure | | Annex ZIV : Design rules for components subjected to external pressure | Technically equivalent provisions | | |
| Appendix XI : Rules for bolted flange connections for class 2 and 3 components and class MC vessels | | Annex ZV : Design of circular bolted flange connections | Technically equivalent provisions | | |
| Appendix XII : Design considerations for bolted flange connections | | No correspondence | ASME provisions are more explanations than provisions to be met | | |
| Appendix XIII : Design based on stress analysis for vessels designed in accordance with NC-3200 | | Integrated in RCC-M C.3200 | Technically equivalent | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| Appendix XIV : Design based on fatigue analysis for vessels designed in accordance with NC-3200 | | Integrated in RCC-M C.3200 | Technically equivalent | | |
| Appendix XVIII : Capacity conversions for pressure relief valves | | No correspondence | | | |
| Appendix XIX : Integral flat head with a large opening | | No correspondence | | | |
| Appendix XX : Submittal of technical inquiries to the boiler and pressure vessel committee | | No correspondence | ASME appendix only applicable within ASME framework | no need in RCCM | |
| Appendix XXI : Adhesive attachment of nameplates | | No correspondence | nonmandatory requirements in RCCM within the scope of third party assessment | regulation in force, RCCM Appendices ZT and ZY in France | |
| Appendix XXII : Design of reinforcement for cone-to-cylinder junction under external pressure | | No correspondence | | | |
| Appendix XXIII : Qualifications and duties of specialized professional Engineers | | No correspondence | ASME appendix only applicable within ASME framework | no need in RCCM | |
| | | Annex ZVI : Design rules for linear support | RCC-M rules covered in ASME NF subsection | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| **Nonmandatory Appendices** | | **Nonmandatory Annexes** | | | |
| Appendix A : Stress analysis methods | | No correspondence | | | |
| Appendix B : Owner's design specification | | No correspondence | | no need in RCCM | |
| Appendix C : Certificate holder's design report | | No correspondence | | no need in RCCM | |
| Appendix D : Non-mandatory preheat procedures | | Covered in RCC-M F.8000 | | | |
| Appendix E : Minimum bolt cross-sectional area | | No direct correspondence | | | |
| Appendix F : Rules for evaluation of service loadings with level D service limits | | Annex ZF : Rules associated with level D criteria | | | |
| Appendix G : Protection against non-ductile failure | | Annex ZG : Fast fracture analysis | | | |
| Appendix J : Owner's design specification for Core Support Structures | | No correspondence | | | |
| Appendix K : Tolerances | | No correspondence | | | |
| Appendix L : Class FF flange design for class 2 and 3 components and class MC vessels | | No correspondence | | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| Appendix M : Recommendations for control of welding, post-weld heat treatment and nondestructive examination of welds | | Integrated in RCC-M S.7000 | RCC-M provisions more self-contained | | |
| Appendix N : Dynamic analysis methods | | No correspondence | | | |
| Appendix O : Rules for design of safety valve installations | | No correspondence | | | |
| Appendix P : Contents of certified material test reports | | No correspondence | | | |
| Appendix Q : Design rules for clamp connections | | No correspondence | | | |
| Appendix R : Determination of permissible lowest service metal temperature from TNDT for classes 2 and MC construction | | No direct correspondence | | | |
| Appendix S : Pump shaft design methods | | No correspondence | | | |
| Appendix T : Recommended tolerances for reconciliation of piping systems | | No correspondence | | | |

## Appendix A: RCC-M vs. ASME Comparison Table (cont.)

| ASME NB Paragraphs | Brief Description of Paragraph Content | RCCM Corresponding Paragraphs | Brief Description of Differences | Comments | A B |
|---|---|---|---|---|---|
| Appendix U : Rules for pump internals<br>Appendix W : Environmental effects on components<br>Appendix X : Evaluation of the design of rectangular and hollow circular cross section welded attachments on class 1, 2 and 3 piping<br>Appendix Y : Interruption of Code work | | No correspondence<br>No correspondence<br>No correspondence<br>No direct correspondence | | | |
| | | Annex ZA : Rules for determination of reinforcements of openings in class 1 vessel<br>Annex ZD : Fatigue Analysis of geometric discontinuities | Integrated in ASME NB-3300<br>No direct correspondence in ASME NB-3200 | | |
| | | Annex ZE : Alternative rules for piping under level A requirements<br>Annex ZH : Alternative rules for usage factor evaluation<br>Annex ZS : Constructive requirements linked to in-service inspection | Equivalent provisions to those in RCC-M B.3600 or ASME NB-3600<br>Equivalent provisions to those in RCC-M B.3200 or ASME NB-3200<br>No direct correspondence in ASME Code | | |

# APPENDIX B1: JSME VERSUS ASME SECTION III DETAILED COMPARISON TABLE

**Appendix B1: JSME vs ASME Comparison Table**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-1100 SCOPE | | |
| NB-1110 ASPECTS OF CONSTRUCTION COVERED BY THESE RULES | PVB-1110 does not contain rules for marking, stamping and preparation of report by Certificate Holder. Not required by MITI. | B-2 |
| NB-1120 TEMPERATURE LIMITS | PVB-1120 | A-2 |
| NB-1130 BOUNDARIES OF JURISDICTION APPLICABLE TO THIS SUBSSECTION | | |
| NB-1131 Boundary of Components | GNR-1230 does not require that the Design Specification define the boundary of a component. JSME does not define the first threaded joint in screwed connections as the boundary of a component, as does NB-1131(c). Not required by MITI. | B-2 |
| NB-1132.Boundary Between Components and Attachments<br>NB-1132.1 Attachments<br>NB-1132.2 Jurisdictional Boundary | GNR-1230 does not distinguish between different types of attachments. It treats all attachments the same, regardless of their function. JSME does not address fasteners used for attachment or optional expansion of the component boundary. Other Japanese standards are used to impose welding qualification and NDE requirements for important attachments, such as what ASME calls structural attachments. | B-2 |
| NB-1140 ELECTRICAL AND MECHANICAL PENETRATION ASSEMBLIES | GNR-1110 is equivalent. | A-2 |
| NB-2100 GENERAL REQUIREMENTS FOR MATERIAL | | |
| NB-2110 Scope of Principal Terms Employed | JSME does not define these terms in detail compared to ASME. | B-1 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-2120 Pressure-Retaining Material<br>NB-2121 Permitted Material Specifications | PVB-2110 (For weld metal, see NB-2400.) Based on MITI Ordinance. | B-2 |
| NB-2122 Special Requirements Conflicting with Permitted Material Specifications | JSME does not have similar provisions. Such provisions are assumed. | B-1 |
| NB-2124 Size Ranges | JSME does not have similar provisions. Not required by MITI. | B-1 |
| NB-2125 Fabricated Hubbed Flanges | JSME does not have similar provisions. Such provisions are assumed. | B-1 |
| NB-2126 Finned Tubes<br>NB-2126.1 Integrally Finned Tubes<br>NB-2126.2 Welded Finned Tubes | Not applicable to Class 1 vessels. | — |
| NB-2127 Seal Membrane Material | JSME does not have similar provisions. Such provisions are assumed. | B-1 |
| NB-2128 Bolting Material | PVB-2110 does not specify requirements for washers. Such provisions are assumed. | B-2 |
| NB-2130 Certification of Material | JSME Code does address material certification. Other Japanese Standards (JIS) apply. | B-1 |
| NB-2140 Welding Material | PVB-2500 requires only that weld metals have strength not less than the base materials. Based on MITI Ordinance. | B-2 |
| NB-2150 Material Identification | Only ISO-9001 applies. | B-1 |
| NB-2160 Deterioration of Material in Service | JSME does not have this provision. Code Case NC-CC-002 addresses prevention of SCC. Other Japanese Codes address irradiation embrittlement. | B-1 |
| NB-2170 Heat Treatment to Enhance Impact Properties | PVB-2112 is equivalent. | A-2 |
| NB-2180 Procedures for Heat Treatment of Material | Only ISO-9001 applies. | B-1 |
| NB-2190 Non-Pressure-Retaining Material | PVB-2110 is the same except for weld repair of structural steel rolled shapes to SA-6. | B-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-2200 MATERIAL TEST COUPONS AND SPECIMENS FOR FERRITIC STEEL MATERIAL | | |
| NB-2210 Heat Treatment Requirements<br>NB-2211 Test Coupon Heat Treatment for Ferritic Material | PVB-2210, -2221 are equivalent. | A-2 |
| NB-2212 Test Coupon Heat Treatment for Quenched and Tempered Material<br>NB-2212.1 Cooling Rates<br>NB-2212.2 General Procedures | PVB-2210, -2221 are equivalent. | A-2 |
| NB-2220 Procedure for Obtaining Test Coupons and Specimens for Quenched and Tempered Material<br>NB-2221 General Requirements<br>NB-2222 Plates<br>NB-2222.1 Number of Tension Test Coupons<br>NB-2222.2 Orientation and Location of Coupons<br>NB-2222.3 Requirements for Separate Test Coupons<br>NB-2223 Forgings<br>NB-2223.1 Location of Coupons<br>Nb-2223.2 Very Thick and Complex Forgings<br>NB-2223.3 Coupons from Separately Test Forgings<br>NB-2223.4 Test Specimens for Forgings<br>NB-2224 Bar and Bolting Material<br>NB-2225 Tubular Products and Fittings<br>NB-2225.1 Location of Coupons<br>NB-2225.2 Separately Produced Coupons Representing Fittings<br>NB-2226 Tensile Test Specimen Location(for Quenched and Tempered Ferritic Steel Castings) | PVB-2221, -2222 are equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-2300 Fracture Toughness Requirements for Material | | |
| NB-2310 Material to be Impact Tested<br>NB-2311 Material for Which Impact Testing is Required<br>NB-2320 Impact Test Procedures<br>NB-2321 Types of Tests<br>NB-2321.1 Drop Weight Tests<br>NB-2321.2 Charpy V-Notch Tests<br>NB-2322 Test Specimens<br>NB-2322.1 Location of Test Specimens<br>NB-2322.2 Orientation of Impact Specimens<br>NB-2330 Test Requirements and Acceptance Standards<br>NB-2331 Material for Vessels<br>NB-2332 Material for Piping、Pumps、and Valves、Excluding Bolting Material<br>NB-2333 Bolting Material<br>NB-2340 Number of Impact Tests Required<br>NB-2341 Plates<br>NB-2342 Forging and Castings<br>NB-2343 Bars<br>NB-2344 Tubular Products and Fittings<br>NB-2345 Bolting Material<br>NB-2346 Test Definitions<br>NB-2350 Retests<br>NB-2360 Calibration of Instruments and Equipment | PVB-2310, -2311, -2321, -2322, -2330, -2331, -2331.1, -2332, -2333, -2333.1, -2333.2 are equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-2400 Welding Material<br>NB-2410 General Requirements<br>NB-2420 Required Tests<br>NB-2430 Weld Material Tests<br>NB-2431 Mechanical Properties Test<br>NB-2431.1 General Test Requirements<br>NB-2431.2 Standard Test Requirements<br>NB-2432 Chemical Analysis Test<br>NB-2432.1 Test Method<br>NB-2432.2 Requirements for Chemical Analysis<br>NB-2433 Delta Ferrite Determination<br>NB-2433.1 Method<br>NB-2433.2 Acceptance Standards<br>NB-2440 Storage and Handling of Welding Material | PVB-2510 requires only that weld metals have strength not less than the base materials, and adequate fracture toughness, as stipulated in N-1110 of JSME S NB1-2007. Based on MITI Ordinance. [N-1040 (JSME Rules on Welding, Part 1)]<br>As in NB-2400, welding material is qualified based on qualification of WPS. In accordance with performance requirement of Part 2 of JSME S NB1-2007, "Rules on Welding for Nuclear Power Plants." MITI Notification No. 501 that is a basis for the JSME Code for Design refers to ASME Sec. III. However MITI Ordinance No. 81 that is a basis for the JSME Code for Welding does not refer to ASME Sec. III; is based on Japanese industry experience. The structure of MITI Ordinance No. 81 is different from that of ASME Sec. III. | B-1 other than NB-2410<br>NB-2410: B-2 |
| NB-2500 Examination and Repair of Pressure-Retaining Material | | |
| NB-2510 Examination of Pressure-Retaining Material | GTN-2000, -3000, -4000, -5000, -6000, -7000, -8000 are equivalent. | A-2 |
| NB-2520 Examination after Quenching and Tempering | Not Specified in JSME. Not required by MITI. | B-1 |
| [NB-2530 Examination and Repair of Plate]<br>NB-2531 Required Examination | PVB-2411, -2412 are equivalent for vessels. | B-2 |
| [NB-2532 Examination Procedures]<br>NB-2532.1 Straight Beam Examination<br>NB-2532.2 Angle Beam Examination | GTN-2000, -3000 are equivalent for vessels. | NB-2532.1:A-2<br>NB-2532.2:B-1 |
| NB-2537 Time of Examination | ASME requires UT of plate, and RT/MT/PT of repair welds, after heat treatment. PVB-2413 allows UT/RT before heat treatment and does not require RT/MT/PT of repair welds. | B-2 |
| NB-2538 Elimination of Surface Defects | Not specified in JSME. JIS standards apply. | B-1 |
| NB-2539 Repair by Welding<br>NB-2539.1 Defect Removal | PVB-2411, -2412 are equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-2539.2 Qualification of Welding procedures and Welders<br>NB-2539.3 Blending of Repaired Areas | (For welding qualifications, see NB-4300.)<br>For blending of repair areas, JIS standards apply. | B-1 |
| NB-2539.4 Examination of Repair Welds<br>NB-2539.5 Heat Treatment After Repairs<br>NB-2539.6 Material Report Describing Defects and Repairs | PVB-2411, -2412 are equivalent. | A-2 |
| NB-2539.7 Repair of Cladding by Welding | Not Specified in JSME; base metal requirements are applied. | B-1 |
| [NB-2540 Examination and Repair of Forging and Bars]<br>NB-2541 Required Examination | ASME requires UT and MT/PT for all bars.<br>PVB-2411 same, except no UT for bars ≤ 50 mm diameter. | B-2 |
| [NB-2542 Ultrasonic Examination]<br>NB-2542.1 Examination Procedure<br>NB-2542.2 Acceptance Standards | GTN-2260, -2265, -3260 & PVB-2412<br>For bars, ASME requires straight UT. JSME requires no UT for bars ≤ 50 mm diameter, straight UT for bars < 50 mm and < 100 mm; and for > 100 mm, straight UT in axial and radial directions. For forgings, NB-2542.2 is less restrictive than PVB-2412 or -2421 (for vessel shell sections), because it applies the acceptance criteria of NB-2532.1 to the straight UT. Non-cylindrical bars are not specifically addressed in PVB-2411. | B-2 |
| [NB-2545 Magnetic Particle Examination]<br>NB-2545.1 Examination Procedure | GTN-5000 & PVB-2412 are equivalent. | A-2 |
| NB-2545.2 Evaluation of Indications | GTN-5000 is equivalent. | A-2 |
| NB-2545.3 Acceptance Standards | GTN-6320 & PVB-2425 are almost equivalent. | B-2 |
| [NB-2546 Liquid Penetrant Examination]<br>NB-2546.1 Examination Procedure<br>NB-4526.2 Evaluation of Indications | GTN-7311 is equivalent. | A-2 |
| NB-2546.3 Acceptance Standards | GTN-7320 & PVB-2426 are almost equivalent. | B-2 |
| NB-2547 Time of Examination | PVB-2413 does not require hollow forgings or bars to be examined after boring. Not required by MITI. | B-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-2548 Elimination of Surface Defects | Not specified in JSME. JIS standards apply. | B-1 |
| NB-2549 Repair by Welding | PVB-2412 is equivalent. | A-2 |
| [NB-2550 Examination and Repair of Seamless and Welded(Without Filler Metal)Tubular Products and Fittings]<br>NB-2551 Required Examination<br>NB-2552 Ultrasonic Examination<br>NB-2553 Radiographic Examination<br>NB-2554 Eddy Current Examination | GTN-2000, -3000, -4000, PVB-2400<br>For pipe or tube, PVB-2411 is equivalent, except that, for pipe and tubing 2-1/2 in. (37 mm) OD and larger, NB-2551 requires angle UT in four directions. PVB-2411 permits substitution of ET for UT.<br>JSME does not have a category for fittings; therefore, forging requirements are applied to fittings.<br>For fittings up to NPS 6 (DN 150), PVB-2411 requires UT; NB-2551 does not require UT.<br>For fittings over DN 150, NB-2552 requires straight and angle UT; PVB-2411 requires either but not both. ASME permits RT in lieu of UT; JSME does not. Required by MITI Notification 501.<br>NB-2552(c) requires reference specimens of the same heat-treated condition; JSME does not.<br>NB-2552(d) requires UT calibration checks every 4 hr; JSME does not. | B-2 |
| NB-2555 Magnetic Particle Examination<br>NB-2556 Liquid Penetrant Examination | GTN-6000 & GTN-7000 are equivalent. | A-2 |
| NB-2557 Time of Examination | NB-2557 requires examination after final heat treatment, especially including quenching and tempering, and after boring. GTN-5130 & PVB-2413 do not stipulate time of examination in relationship to boring or heat treatment, except that both ASME and JSME require MT and PT after machining. | B-2 |
| NB-2558 Elimination of Surface Defects<br>NB-2559 Repair by Welding | Not specified in JSME. JIS standards apply. | B-1 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-2560 Examination and Repair of Tubular Products and Fittings Welded with Filler Metal]<br>NB-2561 Required Examinations<br>NB-2562 Ultrasonic Examination<br>NB-2563 Radiographic Examination | NB-2560 requires straight UT of plate or 4-way angle UT after forming. PVB-2411 requires straight UT. Similar differences shown under NB-2552 and -2553 apply to NB-2562 and -2563. Otherwise equivalent. | B-2 |
| NB-2565 Magnetic Particle Examination<br>NB-2566 Liquid Penetrant Examination | PVB-2411 is equivalent. | A-2 |
| NB-2567 Time of Examination | NB-2567 generally requires examination after final heat treatment, especially including quenching and tempering and after boring. PVB-2411 does not stipulate time of examination in relationship to boring or heat treatment, except that both ASME and JSME require MT and PT after machining. NB-2567 permits RT of pipe fabrication welds before PWHT; JSME requires RT after PWHT. Both require MT or PT after PWHT. | B-2 |
| NB-2568 Elimination of Surface Defects<br>NB-2569 Repair of Welding | Not specified in JSME. JIS standards apply. | B-1 |
| NB-2570 Examination and Repair of Statically and Centrifugally Cast Products | Equivalent | A-2 |
| NB-2571 Required Examinations | PVB-2411 is equivalent. | A-2 |
| [NB-2572 Time of Nondestructive Examination]<br>NB-2572.1 Acceptance Examination<br>NB-2573 Provisions for Repair of Base Material by Welding<br>NB-2573.1 Defect Removal<br>NB-2573.2 Repair of Welding | PVB-2413 is equivalent. | A-2 |
| NB-2573.3 Qualification of Welding Procedures and Welders<br>NB-2573.4 Blending of Repaired Areas | (For welding qualifications, see NB-4300.)<br>For blending of repair areas, JIS standards apply. | B-1 |
| NB-2573.5 Examination of Repair Welds<br>NB-2573.6 Heat Treatment After Repairs<br>NB-2573.7 Elimination of Surface Defects | PVB-2413 is equivalent | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-2573.8 Material Report Describing Defects and Repairs | Not specified in JSME. JIS standards require documentation of repair welds. | B-1 |
| NB-2574 Ultrasonic Examination of Ferritic Steel Castings<br>NB-2574.1 Acceptance Standards | If UT is performed in lieu of RT, NB-2574 requires straight UT if possible, otherwise angle UT. PVB-2421, -2422 require straight or angle UT. | B-2 |
| [NB-2575 Radiographic Examinations]<br>NB-2575.1 Examination | GTN-4000, -4180 are equivalent. | A-2 |
| NB-2575.2 Extent | PVB-2411 is equivalent. | A-2 |
| NB-2575.3 Examination Procedure | GTN-4142, -4153, -4200, -4231, -4240, -4311, -4312 are equivalent. | A-2 |
| NB-2575.4 Procedure Requirements | Not specified in JSME. JIS standards apply. | B-1 |
| NB-2575.5 Radiographic Setup Information | GTN-4000 is equivalent. | A-2 |
| NB-2575.6 Acceptance Criteria | GTN-4400, -4410, -4500, -4510 are equivalent. | A-2 |
| NB-2576 Liquid Penetrant Examination | GTN-7000 is equivalent. | A-2 |
| NB-2577 Magnetic Particle Examination (for Ferritic Steel Products Only) | GTN-6000 is equivalent. | A-2 |
| NB-2580 EXAMINATION OF BOLTS, STUDS, AND NUTS<br>NB-2581 Required Examination<br>NB-2582 Visual Examination | NB-2581, -2582 require visual examination; PVB-2411 does not. NB-2581 thru -2584 require MT or PT of bolting over 1 in. (25 mm); PVB-2411 requires MT or PT of all sizes. Both require straight UT in the radial direction from 50 mm to 100 mm and straight UT in both the radial and axial directions over 100 mm. | NB-2581: B-2<br>NB-2582: B-1 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-2583 Magnetic Particle Examination (for Ferritic Steel Bolting Material Only)<br>NB-2583.1 Examination Procedure<br>NB-2583.2 Evaluation of Indications<br>NB-2583.3 Acceptance Standard<br>NB-2584 Liquid Penetrant Examination<br>NB-2584.1 Examination Procedure<br>NB-2584.2 Evaluation of Indications<br>NB-2584.3 Acceptance Standard | NB-2583.2 permits surface conditioning and reexamination, or use of alternative methods to better characterize an indication. GTN-6000 does not permit reexamination for MT; GTN-7000 permits reexamination for PT; alternative methods are not addressed.<br>NB-2583.3, -2584.3 permit linear axial indications up to 25 mm long. PVB-2426 permits the same indications, provided they are determined (subjectively by the examiner) to not be cracks. | B-2 other than NB-2584.2<br>NB-2584.2:A-2 |
| NB-2585 Ultrasonic Examination for Sizes Greater Than 2 in. (50 mm)<br>NB-2585.1 Ultrasonic Method | GTN-2000, -3000 are equivalent. | A-2 |
| NB-2585.2 Examination Procedure | ASME requires 2.25MHz and 1 in.$^2$ (650 mm$^2$) transducer; GTN-2000, -3000 require 0.4-15MHz and do not specify transducer size. | B-2 |
| NB-2585.3 Calibration of Equipment<br>NB-2585.4 Acceptance Standard | GTN-2000, -3000 are equivalent. | A-2 |
| NB-2586 Ultrasonic Examination for Sizes Over 4 in. (100 mm)<br>NB-2586.1 Ultrasonic Method | GTN-2000, -3000 are equivalent. | A-2 |
| NB-2586.2 Examination Procedure | NB-2586.2 requires 2.25MHz and ½ to 1-1/8 in. (13-29 mm) dia. transducer; GTN-2000, -3000 require 0.4-15MHz and do not specify transducer size. | B-2 |
| NB-2586.3 Calibration of Equipment | NB-2586.3 requires one test bar at least ½ of length of production part. GTN-2241 requires three test bars of different lengths (1/4L+75mm, 1/2L+75mm, 150mm), due to MITI Notification 501. | B-2 |
| NB-2586.4 Acceptance Standard | GTN-2000, -3000 are equivalent. | A-2 |
| NB-2587 Time of Examination | NB-2587 requires examination after final material spec. heat treatment and visual exam after machining.<br>PVB-2413 requires UT in bar form and MT or PT after machining, without regard for heat treatment condition. | B-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-2588 Elimination of Surface Defects | Not specified in JSME. NB-2588 is redundant and unnecessary. | B-1 |
| NB-2589 Repair by Welding | PVB-2412 is equivalent. | A-2 |
| NB-2600 MATERIAL ORGANIZATIONS' QUALITY SYSTEM PROGRAMS<br>NB-2610 DOCUMENTATION AND MAINTENANCE OF QUALITY SYSTEM PROGRAMS | MO quality program is not addressed by JSME. | B-1 |
| NB-2700 DIMENSIONAL STANDARDS | Not Specified in JSME; other standards are used without being mandated. | B-1 |
| [NB-3100 General Requirements]<br>[NB-3110 Loading Criteria]<br>NB-3111 Loading Conditions | Design Loadings not specified in JSME; must be specified in Design Specification. | B-1 |
| NB-3112 Design Loadings<br>NB-3112.1 Design Pressure<br>NB-3112.2 Design Temperature<br>NB-3112.3 Design Mechanical Loads | GNR-2120 is equivalent. | A-2 |
| NB-3112.4 Design Stress Intensity Values | PVA-3000, PVB-1120 are equivalent. | A-2 |
| NB-3113 Service Conditions | GNR-2110 is equivalent. | A-2 |
| [NB-3120 Special Considerations]<br>NB-3121 Corrosion | PVB-3410 is equivalent. | A-2 |
| NB-3122 Cladding<br>NB-3122-1 Primary Stresses<br>NB-3122-2 Design Dimensions<br>NB-3122-3 Secondary and Peak Stresses<br>NB-3122-4 Bearing Stresses | PVB-3420 is equivalent. | A-2 |
| NB-3123 Welding<br>NB-3123.1 Dissimilar Welds<br>NB-3123.2 Fillet Welded Attachments | JSME does not address thermal expansion effects of dissimilar metal welds or fillet welded attachments. | B-1 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3124 Environmental Effects | JSME does not address property changes due to environmental effects. | B-1 |
| NB-3125 Configuration | JSME does not address design for accessibility for in-service inspection. | B-1 |
| NB-3130 General Design Rules<br>NB-3131 Scope<br>NB-3132 Dimensional Standards for Standard Products | Dimensional standards are not specified in JSME; other standards are used without being mandated. | B-1 |
| NB-3133 Components Under External Pressure<br>NB-3133.1 General | PVB-3200, -3210, -3220 are equivalent. | A-2 |
| NB-3133.2 Nomenclature | JSME specifies nomenclature in location of use. | B-1 |
| NB-3133.3 Cylindrical Shells and Tubular Products | PVB-3210 is equivalent. | A-2 |
| NB-3133.4 Spherical Shells | PVB-3220 is equivalent. | A-2 |
| NB-3133.5 Stiffening Rings for Cylindrical Shells | JSME does not address stiffening rings for Class 1 vessels. NB-3133.5 is probably never used. | B-1 |
| NB-3133.6 Cylinders Under Axial Compression. | PVB-3117 is equivalent. | A-2 |
| NB-3134 Leak Tightness | PHT-1000 does not address this requirement. NB-3134 is probably not necessary for Class 1 vessels. | B-2 |
| NB-3135 Attachments | Guideline to GNR-1230 is equivalent. | A-2 |
| NB-3136 Appurtenances | Not addressed by JSME. | B-1 |
| NB-3137 Reinforcement for Openings | PVB-3500; See NB-3330. | — |
| [NB-3200 Design by Analysis]<br>NB-3210 Design Criteria<br>NB-3211 Requirements for Acceptability | PVB-3110, -3120, -2300, -2310 are equivalent. | A-2 |
| NB-3212 Basis for Determining Stresses | GNR-2130 is equivalent. | A-2 |
| [NB-3213 Terms Relating to Stress Analysis]<br>NB-3213.1 Stress Intensity | GNR-2130 is equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3213.2 Gross Structural Discontinuity<br>NB-3213.3 Local Structural Discontinuity<br>NB-3213.4 Normal Stress<br>NB-3213.5 Shear Stress | These terms are not defined by JSME. | B-1 |
| NB-3213.6 Membrane Stress<br>NB-3213.7 Bending Stress<br>NB-3213.8 Primary Stress<br>NB-3213.9 Secondary Stress<br>NB-3213.10 Local Primary Membrane Stress<br>NB-3213.11 Peak Stress | GNR-2130 is equivalent. | A-2 |
| NB-3213.12 Load Controlled Stresses | Definition of term not used by JSME. | B-1 |
| NB-3213.13 Thermal Stress | GNR-2130 is equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3213.14 Total Stress<br>NB-3213.15 Operational Cycle<br>NB-3213.16 Stress Cycle<br>NB-3213.17 Fatigue Strength Reduction Factor<br>NB-3213.18 Free End Displacement<br>NB-3213.19 Expansion Stresses<br>NB-3213.20 Deformation<br>NB-3213.21 Inelasticity<br>NB-3213.22 Creep<br>NB-3213.23 Plasticity<br>NB-3213.24 Plastic Analysis<br>NB-3213.25 Plastic Analysis—Collapse Load A<br>NB-3213.26 Plastic Instability Load<br>NB-3213.27 Limit Analysis<br>NB-3213.28 Limit Analysis—Collapse Load<br>NB-3213.29 Collapse Load—Lower Bound<br>NB-3213.30 Plastic Hinge<br>NB-3213.31 Stain Limiting Load<br>NB-3213.32 Test Collapse Load<br>NB-3213.33 Ratcheting<br>NB-3213.34 Shakedown<br>NB-3213.35 Reversing Dynamic Loads<br>NB-3213.36 Non-reversing Dynamic Loads<br>NB-3214 Stress Analysis | These terms are not defined by JSME. | B-1 |
| NB-3215 Derivation of Stress Intensities | PVA-3100 & GNR-2130 are equivalent. | A-2 |
| NB-3216 Derivation of Stress Differences<br>NB-3216.1 Constant Principal Stress Direction | Explanation for GNR-2130 is equivalent. | A-2 |
| NB-3216.2 Varying Principal Stress Direction | Variation of principal stress direction is not considered in JSME Code. NB-3216.2 probably never applies and is therefore probably unnecessary. | B-1 |
| NB-3217 Classification of Stresses | PVA-3100 is equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-3220 STRESS LIMITS FOR OTHER THAN BOLTS]<br>NB-3221 Design Loadings | PVB-3110 is equivalent. | A-2 |
| NB-3221.1 General Primary Membrane Stress Intensity<br>NB-3221.2 Local Membrane Stress Intensity<br>NB-3221.3 Primary Membrane (General or Local) Plus Primary Bending Stress Intensity | PVB-3111 is equivalent. | A-2 |
| NB-3221.4 External Pressure | PVB-3210 is equivalent. | A-2 |
| NB-3222 Level A Service Limits | PVB-3111, -3112, -3113, -3114 are equivalent. | A-2 |
| NB-3222.1 Primary Membrane Plus Bending Stress Intensity | PVB-3111 is equivalent. | A-2 |
| NB-3222.2 Primary Plus Secondary Stress Intensity | PVB-3112 is equivalent. | A-2 |
| NB-3222.3 Expansion Stress Intensity | Not applicable to vessels. | B-1 |
| NB-3222.4 Analysis for Cyclic Operation | PVB-3140, PVB-3114 are equivalent. | A-2 |
| NB-3222.5 Thermal Stress Ratchet | PVB-3113 is equivalent. | A-2 |
| NB-3222.6 Deformation Limits | Not addressed by JSME; NB-3222.6 is superfluous. | B-1 |
| NB-3223 Level B Service Limits | PVB-3111, -3112, -3113, -3114 are equivalent. | A-2 |
| NB-3224 Level C Service Limits | PVB-3111 is equivalent. | A-2 |
| NB-3224.1 Primary Stress Limits | PVB-3111 is equivalent. | A-2 |
| NB-3224.2 External Pressure | PVB-3210, -3220 are equivalent. | A-2 |
| NB-3224.3 Special Stress Limits | PVB-3160, -3300 are equivalent. | A-2 |
| NB-3224.4 Secondary and Peak Stresses<br>NB-3224.5 Fatigue Requirements | Equivalent | A-2 |
| NB-3224.6 Deformation Limits<br>NB-3224.7 Piping Requirements | Not addressed by JSME; NB-3224.6 is superfluous. | B-1 |
| NB-3225 Level D Service Limits | PVB-3111, -3200, -3210, -3220 are equivalent. | A-2 |
| NB-3226 Testing Limits | PVB-3111, -3200, -3210, -3220 are equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3227 Special Stress Limits<br>NB-3227.1 Bearing Loads<br>NB-3227.2 Pure Shear | <br>PVB-3116 is equivalent.<br>PVB-3115 is equivalent. | A-2 |
| NB-3227.3 Progressive Distortion of Non-integral Connections | Not considered in JSME Code. NB-3227.3 probably never applies. | B-1 |
| NB-3227.4 Triaxial Stresses | Not considered in JSME Code. NB-3227.4 probably never applies. | B-1 |
| NB-3227.5 Nozzle Piping Transition | Within the limits of reinforcement, NB-3227.5 requires all external loads and moments (combining mechanical and thermal external loads), including those attributable to restrained free end displacement of the attached pipe, are combined into Pm. In PVA-3100 guideline, "Classification of Stress Intensity in Vessels for Some Typical Cases," mechanical external loads are distinguished from thermal external loads, and only mechanical external loads are included in Pm. The additional conservatism of NB-3227.5 is not required by MITI. | B-2 |
| NB-3227.6 Applications of Elastic Analysis for Stresses Beyond the Yield Strength | Not addressed by JSME. NB-3227.6 probably adds no value to Class 1 vessel analysis. | B-1 |
| NB-3227.7 Requirements for Specially Designed Welded Seals | PVB-3150, -3151, -3152 are equivalent. | A-2 |
| NB-3228 Applications of Plastic Analysis<br>NB-3228.1 Limit Analysis | PVB-3160 does not impose the requirements for minimum thickness and strain limit of NB-3228.1.<br>For the Test Condition, PVB-3160 also requires $P_c \leq 0.8P_{cr}$ and Yield Strength = $S_y$ | B-2 |
| NB-3228.2 Experimental Analysis<br>NB-3228.3 Plastic Analysis | JSME does not permit use of Experimental Analysis or Plastic Analysis. | B-1 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3228.4 Shakedown Analysis | JSME Code Case NC-CC-005 "Alternative Structural Evaluation Criteria for Class 1 Vessels Based on Elastic-Plastic Finite Element Analysis" permits evaluation of shakedown by applying elastic-plastic FEM analysis, assuming elastic-perfectly-plastic solid. | B-2 |
| NB-3228.5 Simplified Elastic-Plastic Analysis | PVB-3300 is equivalent, except that it provides $K_e$ values for evaluation of fatigue for $S_n$ values above $3S_m$ that are about 50% lower than the ASME values. The basis for the lower JSME values is documented in, "Evaluation of Conservatism in the Simplified Elastic-Plastic Analysis Using Analysis Results," PVP-Vol.407, Pressure Vessel and Piping Code and Standards, ASME, 2000, p. 255, Asada S., Nakamura T., Asada Y. | B-2 |
| NB-3229 Design Stress Values | JSME S NJ1-2008, "Rules on Materials for Nuclear Facilities," is equivalent. | A-2 |
| [NB-3230 STRESS LIMITS FOR BOLTS]<br>NB-3231 Design Conditions<br>NB-3232 Level A Service Limits<br>NB-3232.1 Average Stress<br>NB-3232.2 Maximum Stress<br>NB-3232.3 Fatigue Analysis of Bolts<br>NB-3233 Level B Service Limits<br>NB-3234 Level C Service Limits<br>NB-3235 Level D Service Limits<br>NB-3236 Design Stress Intensity Values | PVB-3120, -3121, -3122, -3130 are equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-3300 VESSEL DESIGN]<br>[NB-3310 GENERAL REQUIREMENTS]<br>[NB-3311 Acceptability]<br>[NB-3320 DESIGN CONSIDERATIONS]<br>NB-3321 Design and Service Loadings<br>NB-3322 Special Considerations<br>NB-3323 General Design Rules<br>[NB-3324 Tentative Pressure Thickness]<br>NB-3324.1 Cylindrical Shells<br>NB-3324.2 Spherical Shells | Not addressed by JSME. JSME treats these explanatory provisions as unnecessary. | B-1 |
| [NB-3330 OPENINGS AND REINFORCEMENT]<br>NB-3331 General Requirements for Openings | ASME permits any type of opening; PVB-3510 permits only circular or ellipsoidal openings. Based on MITI Notification 501. | B-2 |
| [NB-3332 Reinforcement Requirements for Openings in Shells and Formed Heads]<br>NB-3332.1 Openings Not Requiring Reinforcement | NB-3332(b) allows some unreinforced openings with less separation than does PVB-3650, which requires that openings whose centers are farther apart than $1.5(d_1+d_2)$ must also be farther than $2.5\sqrt{(Rt)}+0.5(d_1+d_2)$ to be unreinforced. PVB-3650 requires that the unreinforced openings be farther apart than does NB-3332, by the sum of their radii. Based on MITI Notification 501. | B-2 |
| NB-3332.2 Required Area of Reinforcement | PVB-3511(3) is equivalent. | A-2 |
| NB-3333 Reinforcement Required for Openings in Flat Heads | PVB-3511(3)C is equivalent. | A-2 |
| NB-3334 Limits of Reinforcement<br>NB-3334.1 Limit of Reinforcement Along the Vessel Wall | PVB-3511, -3513 are equivalent. | A-2 |
| NB-3342.2 Limit of Reinforcement Normal to the Vessel Wall | PVB-3511(1)b is equivalent. | A-2 |
| [NB-3335 Metal Available for Reinforcement | PVB-3511(2), PVB-3514(1) are equivalent. | A-2 |
| NB-3336 Strength of Reinforcing Material | PVB-3514 is equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-3337 Attachment of Nozzles and Other Connections<br>NB-3337.1 General Requirements.<br>NB-3337.2 Full Penetration Welded Nozzles.<br>NB-3337.3 Partial Penetration Welded Nozzles | Refer to NB-4244. | — |
| [NB-3338 Fatigue Evaluation of Stresses in Openings]<br>NB-3338.1 General. | NB-3338.1 allows Experimental Stress Analysis, and JSME does not. Based on MITI Notification 501. | B-1 |
| NB-3338.2 Stress Index Method | PVB-3510(4), -3540, -3541, -3542.1 have slightly different dimensional ratio limits than does NB-3338.2. These differences probably have no effect on Class 1 vessel design. Based on MITI Notification 501. | B-2 |
| [NB-3339 Alternative Rules for Nozzle Design]<br>NB-3339.1 Limitations<br>NB-3339.2 Nomenclature<br>NB-3339.3 Required Reinforcement Area<br>NB-3339.4 Limits of Reinforcing Zone<br>NB-3339.5 Strength of Reinforcing Material Requirements<br>NB-3339.6 Transition Details<br>NB-3339.7 Stress Indices | PVB-3550, -3551, -3352, -3553, -3554, -3555, -3556 limit these provisions to nozzles in cylindrical shells, whereas NB-3339.1 includes nozzles in spherical shells and formed heads.<br>PVB-3552 generally requires more area reinforcement for values of $d/\sqrt{(Rt_r)}$ between 0.2 and 0.4 than does NB-3339.3, based on use of the formula in WRC Bulletin 133.<br>The following formulae produce nearly-identical results.<br>ASME — $A_r = [4.05(d/\sqrt{(Rt_r)})^{1/2}-1.81]dt_r$<br>JSME — $A_r = [3.75(d/\sqrt{(Rt_r)})-0.75]dt_r$<br>Based on MITI Notification 501. | B-2 |
| NB-3340 ANALYSIS OF VESSELS | Refers reader to NB-3214. | — |
| [NB-3350 DESIGN OF WELDED CONSTRUCTION]<br>NB-3351 Welded Joint Category<br>NB-3351.1 Category A<br>NB-3351.2 Category B<br>NB-3351.3 Category C<br>NB-3351.4 Category D | [JSME Rules on Welding, Part 1], N-0020 is equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3352 Permissible Types of Welded Joints<br>NB-3352.1 Joints of Category A<br>NB-3352.2 Joints of Category B<br>NB-3352.3 Joints of Category C<br>NB-3352.4 Joints of Category D | PVB-4211 - See NB-4241<br>PVB-4212 - See NB-4242<br>PVB-4213 - See NB-4243<br>PVB-4214 - See NB-4244<br>All are equivalent. | A-2 |
| — | PVB-4215 Other Joints - Only specified in JSME. | B-1 |
| NB-3354 Structural Attachment Welds | See NB-4430 | — |
| NB-3355 Welding Grooves | PVB-4211, -4212, -4213, -4214, -4215 - See NB-4240 | — |
| NB-3357 Thermal Treatment | See NB-4620 | — |
| [NB-3360 SPECIAL VESSEL REQUIREMENTS<br>[NB-3361 Category A or B Joints Between Sections of Unequal Thickness | NB-3361 requires a tapered transition if the thickness difference exceeds ¼ of the thickness of the thinner section, with no limit on the transition length.<br>N-1060, -1070 [JSME Rules on Welding, Part 1] and PVB-4231, -4232 specify a minimum 3-to-1 taper, with minimum radii of at least ½ of the thickness of the thinner section. | B-2 |
| [NB-3362 Bolted Flange Connections] | NB-3362 recommendation is not in JSME. | B-1 |
| [NB-3363 Access Openings] | Not addressed in JSME. | B-1 |
| [NB-3364 Attachments] | Refers reader to NB-3135. | B-1 |
| [NB-3365 Supports] | General statement requires designer to consider support loads. JSME expects this subject to be addressed in the Design Specification. | B-1 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| — | Nonmandatory Appendix 4-B, Fluid-elastic Vibration Evaluation of U-bend Tubes in Steam Generators (JSME Standard S 016-2002, Guideline for Fluid-elastic Vibration Evaluation of U-bend Tubes in Steam Generators) - JSME established this nonmandatory standard to prevent hydroelastic vibration of U-shaped steam generator tubes, based on service experience. – Not addressed in ASME Section III | B-1 |
| — | Nonmandatory Appendix 5-A, Evaluation of Flow-Induced Vibration (JSME Standard S 012-1998, Guide Line for Evaluation of Flow-Induced Vibration of a Cylindrical Structure in a Pipe) - JSME established this nonmandatory standard to prevent fatigue damage of a cylindrical structure in a pipe due to flow-induced vibration, based on service experience. – Not addressed in ASME Section III | B-1 |
| — | Nonmandatory Appendix 5-B, Evaluation of High-Cycle Thermal Fatigue (JSME Standard S 017-2003, Guide Line for Evaluation of High-Cycle Thermal Fatigue of a Pipe) - JSME established this nonmandatory standard to prevent high-cycle thermal fatigue damage of pipe due to thermal striping or mixture of different-temperature water, based on service experience. – Not addressed in ASME Section III | B-1 |
| [NB-4100 General Requirements]<br>NB-4110 Introduction | PVB-1110 is equivalent. | A-2 |
| [NB-4120 Certification of Material and Fabrication by Certificate Holder]<br>NB-4121 Means of Certification | Material certification and accreditation of fabricators are not addressed by JSME. Only ISO-9001 applies. | B-1 |
| NB-4122 Material Identification | Material certification and accreditation of fabricators are not addressed by JSME. Only ISO-9001 applies. | B-1 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-4123 Examinations | JIS Z2305 requires qualification and certification of all examination personnel, including those performing workmanship examinations. ASME exempts workmanship examinations from similar requirements. | B-1 |
| NB-4125 Testing of Welding and Brazing Material | See NB-2400. | B-2 |
| [NB-4130 Repair of Material]<br>NB-4131 Elimination and Repair of Defects | PVB-2412 is similar to NB-4131. However, PVB-2412 always requires MT or PT of a defect removal cavity, while NB-2558, -2658 require use of the method that found the defect. Required by MITI Notification 501. NB-2500 requires RT of major repairs, while PVB-2412 requires RT for plate or pipe, or UT for castings, forgings, bars, or bolts. | B-2 |
| NB-4132 Documentation of Repair Welds of Base Material | Not addressed by JSME. | B-1 |
| [NB-4200 Forming, Fitting and Aligning]<br>NB-4210 Cutting, Forming and Bending<br>NB-4211 Cutting<br>NB-4212 Forming and Bending Processes<br>NB-4213 Qualification of Forming Processes for Impact Property Requirements | NB-4213 permits qualification of forming processes, rather than testing the formed material. JSME PVB-2222 and PVB-2310 require testing of cold-formed or hot-formed material, respectively, after forming. | B-1 other than NB-4213<br>NB-4213: B-2 |
| NB-4214 Minimum Thickness of Fabricated Material | Refers user to NB-4130. | B-1 |
| [NB-4220 Forming Tolerances]<br>NB-4221 Tolerance for Vessel Shells | PVB-4110 has the same requirement for deviation from theoretical form, but does not have a requirement applicable to external pressure. | B-2 |
| NB-4222 Tolerances for Formed Vessel Heads | JSME does not address tolerances for formed heads. | B-2 |
| NB-4223 Tolerances for Formed or Bent Piping | Not applicable to Class 1 vessels. | B-1 |
| [NB-4230 Fitting and Aligning]<br>NB-4231 Fitting and Aligning Methods | Not addressed by JSME. | B-1 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-4232 Alignment Requirements When Components Are Welded From Two Sides | PVB-4231 (JSME Rules on JSME Rules on Welding, Part 1: N-1060) requires slightly smaller offsets than those permitted by NB-4232. Based on the former regulatory requirement of MITI Ordinance 81. | B-2 |
| NB-4233 Alignment Requirements When Inside Surfaces Are Inaccessible | Not addressed by JSME. | B-1 |
| [NB-4240 Requirements For Weld Joints in Components]<br>NB-4241 Category A Weld Joints In Vessels and Longitudinal Weld Joints in Other Components | PVB-4211 is equivalent. | A-2 |
| NB-4242 Category B Weld Joints in Vessels and Circumferential weld Joints in Other Components | PVB-4212, PPB-4010 are equivalent. | A-2 |
| NB-4243 Category C Weld Joints in Vessels and Similar Weld Joints in Other Components | PVB-4213 is equivalent. | A-2 |
| NB-4244 Category D Weld Joints in Vessels and Similar Weld Joints in Other Components | PVB-4214, -4215 are equivalent, except that JSME does not provide examples of oblique connections. | B-2 |
| NB-4245 Complete Joint Penetration Welds | Not explicitly stated in JSME, but JSME is equivalent. | B-1 |
| NB-4246 Piping Branch Connections | Not applicable to Class 1 vessels. | B-2 |
| NB-4250 Welding End Transitions-Maximum Envelope | PPB-4010 is equivalent, except that it does not address configuration requirements for pre-service inspection. | B-2 |
| [NB-4300 Welding Qualifications]<br>[NB-4310 General Requirements]<br>NB-4311 Types of Processes Permitted | [JSME Rules on Welding, Part 2] Article 2 – JSME does not address or permit stud welding, capacitor discharge welding, and inertia and continuous drive friction welding. Regulatory approval is required for their use. | B-2 |
| NB-4320 Welding Qualifications, Records and Identifying Stamps<br>NB-4321 Required Qualifications<br>NB-4322 Maintenance and Certification of Record<br>NB-4323 Welding Prior to Qualifications<br>NB-4324 Transferring Qualifications | [JSME Rules on Welding, Part 2] Article 1 - Accreditation of fabricators is not addressed by JSME. Only ISO-9001 applies. | B-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-4330 General Requirements for Welding Procedure Qualification Tests]<br>NB-4331 Conformance to Section IX Requirements | [JSME Rules on Welding, Part 2] Article 1 is equivalent. | A-2 |
| NB-4333 Heat Treatment of Qualification Welds for Ferritic Materials | NB-4333 requires simulated PWHT at 80% of production time.<br>[JSME Rules on Welding, Part 2] Article 3 requires 100%. Based on MITI Notification 501. | B-2 |
| NB-4334 Preparation of Test Coupons and Specimens | [JSME Rules on Welding, Part 2] Article 5 is equivalent. | A-2 |
| NB-4335 Impact Test Requirements | [JSME Rules on Welding, Part 2] Article 3(22), 4(2)<br>[JSME Rules on Welding, Part 1] Table 11, Notes (5)<br>Equivalent except as follows.<br>JSME permits use of subsize specimens for thin material; ASME does not. JSME specifies use of -33C for the impact tests. | B-2 |
| NB-4336 Qualification Requirements for Built-Up Weld Deposits | JSME Rules on Welding is equivalent. | B-1 |
| NB-4337 Welding of Instrument Tubing | Not applicable to Class 1 vessels. | B-1 |
| NB-4350 Special Qualification requirements for Tube-to-Tubesheet Welds | [JSME Rules on Welding, Part 2] Article 5(2)c is equivalent. | A-2 |
| [NB-4360 Qualification Requirements for Welding Specially designed Welds Seals]<br>NB-4361 General Requirements<br>NB-4362 Essential Variables for Automatic, Machine and Semiautomatic Welding<br>NB-4363 Essential Variables for Manual Welding<br>NB-4366 Test Assembly<br>NB-4367 Examination of Test Assembly<br>NB-4368 Performance Qualification Test | JSME requires welding of seals of tube-to-tube sheet to be qualified as demonstration mockup of tube-to-tube sheet. Qualified welding procedure for butt weld may be used to specially designed seals. | B-1 |
| [NB-4400 Rules Governing Making, Examining and Repairing Welds]<br>[NB-4410 Precautions to be Taken Before Welding]<br>NB-4411 Identification, Storage, and Handling of Welding Material | Accreditation of fabricators is not addressed by JSME. Only ISO-9001 applies. | B-1 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-4412 Cleanliness and Protection of Welding Surfaces | [JSME Rules on Welding, Part 1] N-1030 is equivalent. | A-2 |
| [NB-4420 Rules for Making Welded Joints]<br>NB-4421 Backing Rings | PVB-4211(2) is equivalent. | A-2 |
| NB-4422 Peening | Peening is not controlled or otherwise addressed by JSME. | B-1 |
| NB-4423 Miscellaneous Welding Requirements | JSME does not address these welding precautions. | B-1 |
| NB-4424 Surfaces of Welds | NB-4424 permits limited undercut or concavity; [JSME Rules on Welding, Part 1] N-1080 does not. Based on the former regulatory requirement of MITI Ordinance 81. | B-2 |
| NB-4425 Welding Items of Different diameters | PPB-4010(2) is equivalent. | A-2 |
| NB-4426 Reinforcement of Welds | [JSME Rules on Welding, Part 1] N-1080, N-5140 permits less weld reinforcement than ASME, especially for very thin and very thick welds. Based on the former regulatory requirement of MITI Ordinance 81. Note: ASME weld reinforcement is further limited by Section XI performance demonstration requirements for pre-service and in-service inspection. | B-2 |
| NB-4427 Shape and Size of Fillet Welds | PPB-4010(1)b [JSME Rules on Welding, Part 4] No.4-1-23 requires a minimum fillet throat of 0.85tn. NB-4427 requires 0.77tn. Based on the former regulatory requirement of MITI Ordinance 81. Note: generally applicable only to piping connections. | B-2 |
| NB-4428 Seal Welds of Threaded Joints | Qualified welding procedure for butt weld may be used to specially designed seals. | B-1 |
| NB-4429 Welding of Clad Parts | JSME does not address this welding precaution. | B-1 |
| [NB-4430 Welding of Attachments]<br>NB-4431 Materials for Attachments | PVB-2110 is equivalent. | A-2 |
| NB-4432 Welding of Structural Attachments | PVB-4215(5) is equivalent. | A-2 |
| NB-4433 Structural Attachments | PVB-4215(5) is equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-4434 Welding of Internal Structural Supports to Clad Components | JSME does not address this provision. It is probably rarely applicable. | B-1 |
| NB-4435 Welding of Nonstructural Attachments and Their Removal | PVB-4215(5) requires continuous fillet attachment welds. NB-4435 permits continuous or intermittent fillet or partial penetration attachment welds. Based on MITI Notification 501.<br>JSME does not address application or removal of nonstructural temporary attachments. Not required by MITI. | B-2 |
| NB-4436 Installation of Attachments to Piping Systems After Testing | Not applicable to Class 1 vessels. | B-1 |
| NB-4440 Welding of Appurtenances | JSME does not specify similar weld joint details. JSME requires use of a welding procedure appropriate to a Category C or D joint. | B-1 |
| NB-4450 Repair of Weld Metal Defects<br>NB-4451 General Requirements<br>NB-4452 Elimination of Surface Defects<br>NB-4453 Requirements for Making Repairs of Welds | JSME does not address repair of welds, based on the assumption that it will be done properly. | B-1 |
| NB-4500 Brazing<br>NB-4510 Rules for Brazing<br>NB-4511 Where Brazing May Be Used<br>NB-4512 Brazing Material<br>NB-4520 Brazing Qualification Requirements<br>NB-4521 Brazing Procedure and Performance Qualification<br>NB-4522 Valve Seat Rings<br>NB-4523 Reheated Joints<br>NB-4524 Maximum Temperature Limits<br>NB-4530 Fitting and Aligning of Parts to Be Brazed<br>NB-4540 Examination of Brazed Joints | Not addressed by JSME. Not addressed by MITI. Brazing is probably never used in a Class 1 vessel (or any other Class 1 application). | B-1 |
| [NB-4600 Heat Treatment]<br>[NB-4610 Welding Preheat Requirements]<br>NB-4611 When Preheat Is Necessary | [JSME Rules on Welding, Part 2] Article 3 (5) is equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-4612 Preheating Methods<br>NB-4613 Interpass Temperature | JSME does not address these general precautions. | B-1 |
| [NB-4620 Postweld Heat Treatment]<br>NB-4621 Heating and Cooling Methods | [JSME Rules on Welding, Part 1] N-1090 is equivalent. | A-2 |
| NB-4622 PWHT Time and Temperature Requirements | [JSME Rules on Welding, Part 1] N-1090 does not specify time-temperature recordings, however those are necessary to evaluate PWHT time and temperature requirements.<br>JSME requires all points on an item being heat treated to be within a 50°C range.<br>For heat treatment at lower temperatures, JSME is less conservative than ASME, resulting in JSME heat treatment times as much as 70% less than those of Table NB-4622.4(c)-1. JSME also permits heat treatment of P-No. 1 materials as much as 60°C lower than does ASME. Based on MITI Ordinance 81.<br>NB-4622.5 requires heat treatment of dissimilar metal welds at the higher of the required temperatures. JSME permits use of either temperature. Based on MITI Ordinance 81.<br>JSME does not address some of the PWHT exemptions in NB-4622, so could be more conservative in this regard. The exemptions would rarely, if ever, be used for a Class 1 vessel. | B-2 |
| NB-4623 PWHT Heating and Cooling Rate Requirements | [JSME Rules on Welding, Part 1] Table 5 is equivalent. | A-2 |
| NB-4624 Methods of Postweld Heat Treatment | [JSME Rules on Welding, Part 1] Table 5 imposes a maximum limit on furnace temperature (300°C) when an item is inserted. NB-4624 does not have a similar limit, but relies on the heatup rate limitation of NB-4623. JSME requires the temperature-controlled band to include 3T on each side of the weld, where NB-4624 requires the lesser of 1T or 50 mm. Based on MITI Ordinance 81. | B-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-4630 Heat Treatment of Welds Other Than The Final Postweld Heat Treatment | Not specified in JSME, but similar in principle. | B-1 |
| [NB-4650 Heat Treatment After Bending or Forming for Pipes, Pumps and Valves]<br>NB-4651 Conditions Requiring Heat Treatment After Bending or Forming<br>NB-4652 Exemptions From Heat Treatment After Bending or Forming | Not applicable to Class 1 vessels. | B-1 |
| NB-4660 Heat Treatment of Electroslag Welds | The JSME Code does not have provisions for heat treatment of electroslag welds. | B-1 |
| NB-4700 Mechanical Joints<br>NB-4710 Bolting and Threading<br>NB-4711 Thread Engagement<br>NB-4712 Thread Lubricants<br>NB-4713 Removal of Thread Lubricants<br>NB-4720 Bolting Flanged Joints<br>NB-4730 Electrical and Mechanical Penetration Assemblies | The JSME Code does not have requirements for mechanical joints. | B-1 |
| [NB-5100 General Requirements for Examination]<br>[NB-5110 Methods, Nondestructive Examination Procedures and Cleaning]<br>NB-5111 Methods | [JSME Rules on Welding, Part 1] N-1100 is equivalent. | A-2 |
| NB-5112 Nondestructive Examination Procedures | Not addressed by JSME. These provisions are mostly administrative. | B-1 |
| NB-5113 Post-Examination Cleaning | Not addressed by JSME, based on the assumption that it will be done properly. | B-1 |
| NB-5120 Time of Examination of Welds and Weld Metal Cladding | Not addressed by JSME. Not required by MITI. | B-1 |
| NB-5130 Examination of Weld Edge Preparation Surfaces | [JSME Rules on Welding, Part 1] N-1030(3), Tables 9 & 10 are more restrictive than NB-5130. They require examination of thinner materials and are generally more restrictive regarding acceptance of linear indications. Based on former METI Ordinance 81. | B-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-5140 Examination of Welds and Adjacent Base Material<br>[NB-5200 Required Examination of Welds for Fabrication and Pre-service Baseline]<br>NB-5210 Category A Vessel Welded Joints and Longitudinal Welded Joints in Other Components<br>[NB-5220 Category B Vessel Welded Joints and Circumferential Welded Joints in Piping, Pumps and Valves]<br>NB-5221 Vessel Welded Joints<br>NB-5222 Piping, Pump and Valve Circumferential Welded Joints<br>[NB-5230 Category C Vessel Welded Joints and Similar Welded Joints in Other Components]<br>NB-5231 General requirements<br>[NB-5240 Category D Vessel Welded Joints and Branch and Piping Connections in Other Components]<br>NB-5241 General Requirements<br>NB-5242 Full Penetration Butt Welded Nozzles, Branch and Piping Connections<br>NB-5243 Corner Welded Nozzles, Branch and Piping Connections<br>NB-5244 Weld metal Buildup at Openings for Nozzles, Branch and Piping Connections<br>NB-5245 Fillet Welded and Partial Penetration Welded Joints | [JSME Rules on Welding, Part 1] Table 2 is equivalent. | A-2 |
| NB-5246 Oblique Full Penetration Nozzles, Branch and Piping Connections | JSME does not address oblique full-penetration nozzles. | B-1 |
| [NB-5260 Fillet, Partial Penetration, Socket and Attachment Welded Joints]<br>NB-5261 Fillet, Partial Penetration, and Socket Welded Joints<br>NB-5262 Structural Attachment Welded Joints<br>[NB-5270 Special Welded Joints]<br>NB-5271 Welded Joints of Specially Designed Seals<br>NB-5272 Welded Metal Cladding | [JSME Rules on Welding, Part 1] Table 2 is equivalent. | A-2 |
| NB-5273 Hard Surfacing | Not applicable to Class 1 vessels. | B-1 |
| NB-5274 Tube-to-Tubesheet Welded Joints | [JSME Rules on Welding, Part 1] Table 2 is equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-5275 Brazed Joints | Not applicable to Class 1 vessels. | B-1 |
| NB-5276 Inertia and Continuous Drive Friction Welds<br>NB-5277 Electron Beam Welds<br>NB-5278 Electroslag Welds | Not addressed by JSME. | B-1 |
| NB-5279 Special Exceptions | [JSME Rules on Welding, Part 1] Table 2 specifies similar alternative examination requirements, but for specific weld joint configurations. Based on former MITI Ordinance 81. | B-2 |
| [NB-5280 Preservice Examination]<br>NB-5281 General Requirements<br>NB-5282 Examination Requirements<br>NB-5283 Components Exempt From Preservice Examination | [JSME Rules on Fitness-for- Service, Part I] IA-2100 is equivalent. | A-2 |
| [NB-5300 Acceptance Standards]<br>NB-5320 Radiographic Acceptance Standards | [JSME Rules on Welding, Part 1] Table 7 is slightly more restrictive. Based on MITI Ordinance 81. | B-2 |
| [NB-5330 Ultrasonic Acceptance Standards]<br>NB-5331 Fabrication | [JSME Rules on Welding, Part 1] Table 8 is equivalent. | A-2 |
| NB-5332 Preservice Examination | The JSME Fitness-for- Service Code requires preservice examination, but that does not have acceptance standards, because the objective of preservice examination is to document the baseline condition, and not to evaluate flaws. This is identical to ASME Section XI, but less restrictive than ASME Section III. | B-1 |
| [NB-5340 Magnetic Particle Acceptance Standards]<br>NB-5341 Evaluation of Indications | [JSME Rules on Welding, Part 1] Table 9 requires use of JIS G 0565. Based on MITI Ordinance 81. Examination methodologies and characterization of indications are equivalent. | B-2 |
| NB-5342 Acceptance Standards | [JSME Rules on Welding, Part 1] Table 9 specifies slightly more restrictive acceptance criteria. Based on MITI Ordinance 81. | B-2 |
| NB-5343 Preservice Examination | See comparison to NB-5332. | B-1 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-5350 Liquid Penetrant Acceptance Standards]<br>NB-5351 Evaluation of Indications<br>NB-5352 Acceptance Standards | [JSME Rules on Welding, Part 1] Table 10 specifies slightly more restrictive acceptance criteria. Based on MITI Ordinance 81. | B-2 |
| NB-5353 Preservice Examination | See comparison to NB-5332. | B-1 |
| NB-5360 Eddy Current Preservice Examination of Installed Nonferromagnetic Steam Generator Heat Exchanger Tubing | PVB-2424 specifies acceptance criteria, based on Japanese research results. NB-5360 defers to the Owner. | B-2 |
| NB-5370 Visual Acceptance Standards for Brazed Joints | Not applicable to Class 1 vessels. | B-1 |
| NB-5380 Bubble Formation Testing | PHT-6012 is equivalent. | A-2 |
| [NB-5400 Final Examination of Vessels]<br>NB-5410 Examination After Hydrostatic Test | Not required by JSME. Not required by MITI. | B-2 |
| [NB-5500 Qualifications and Certification of Nondestructive Examination Personnel]<br>NB-5510 General Requirements<br>[NB-5520 Personnel Qualification, Certification and Verification]<br>NB-5521 Qualification Procedure<br>NB-5522 Certification of Personnel<br>NB-5523 Verification of Nondestructive Examination Personnel Certification<br>NB-5530 Records | GTN-2130, 3130, 5140 requirements are similar to applicable portions of ISO-9001. JSME does not address accreditation of fabricators or NDE personnel qualification requirements. | B-1 other than NB-5510<br>NB-5510: B-2 |
| [NB-6100 GENERAL REQUIREMENTS]<br>[NB-6110 PRESSURE TESTING OF COMPONENTS, APPURTENANCES, AND SYSTEMS] | | |
| NB-6111 Scope of Pressure Testing | PHT-1020 is equivalent. | A-2 |
| NB-6112 Pneumatic Testing<br>NB-6112.1 Pneumatic Test Limitations | PHT-1111.1 does not have the permissive statement of NB-6112.1(b) regarding low-pressure air leak testing. | NB-6112.1(a): A-2<br>NB-6112.1(b): B-1 |
| NB-6112.2 Precautions to be Employed in Pneumatic Testing | PHT-1111.2 is equivalent. | A-2 |
| NB-6113 Witnessing of Pressure Tests | JSME does not address the ANI. | B-1 |
| NB-6114 Time of Pressure Testing<br>NB-6114.1 System Pressure Test | PHT-1112.1 is equivalent. | A-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-6114.2 Component and Appurtenance Pressure Test | PHT-1112.2 permits substitution of the system pressure test for the component pressure test, without imposing limitations similar to those in NB-6114.2. | B-2 |
| NB-6114.3 Material Pressure Test | PHT-1112.3 is equivalent. | A-2 |
| NB-6115 Machining After Pressure Test | JSME does not address machining after the pressure test. | B-1 |
| [NB-6120 PREPARATION FOR TESTING]<br>NB-6121 Exposure of Joints | PHT-1121 is equivalent. | A-2 |
| NB-6122 Addition of Temporary Supports | PHT-1122 is equivalent. | A-2 |
| NB-6123 Restraint or Isolation of Expansion Joints | PHT-1123 is equivalent. | A-2 |
| NB-6124 Isolation of Equipment Not Subjected to Pressure Test | PHT-1124 is equivalent. | A-2 |
| NB-6125 Treatment of Flanged Joints Containing Blanks | PHT-1125 is equivalent. | A-2 |
| NB-6126 Precautions Against Test Medium Expansion | PHT-1126 is equivalent. | A-2 |
| NB-6127 Check of Test Equipment Before Applying Pressure | PHT-1127 is equivalent. | A-2 |
| [NB-6200 HYDROSTATIC TESTS]<br>[NB-6210 HYDROSTATIC TEST PROCEDURE]<br>NB-6211 Venting During Fill Operation | JSME does not address this requirement. | B-1 |
| NB-6212 Test Medium and Test Temperature | Appendix 4-1 contains similar provisions for protection against brittle failure during the hydrostatic test. JSME does not address venting or alternative liquids. | B-1 |
| [NB-6220 HYDROSTATIC TEST PRESSURE REQUIREMENTS]<br>NB-6221 Minimum Hydrostatic Test Pressure | PHT-2111, PHT-2121 are equivalent. | B-2 |
| NB-6222 Maximum Permissible Test Pressure | PHT-2130 requires stress evaluation only if test pressure exceeds 106% of minimum test pressure. | B-2 |
| NB-6223 Hydrostatic Test Pressure Holding Time | PHT-4010 requires 3 minute test for valves vs. 10 minutes of NB-6223. | B-2 |
| NB-6224 Examination for Leakage After Application of Pressure | PHT-5010 does not address use of the ANI, or leakage through temporary seals. Based on MITI Ordinance 81. | B-2 |

**Appendix B1: JSME vs ASME Comparison Table (cont.)**
**Summary Table of Difference on Technical Requirements between JSME and ASME**

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-6300 PNEUMATIC TESTS]<br>[NB-6310 PNEUMATIC TESTING PROCEDURES]<br>NB-6311 General Requirements | References NB-6100. | B-1 |
| NB-6312 Test Medium and Test Temperature | Appendix 4-1 contains similar provisions for protection against brittle failure during the hydrostatic test. | B-1 |
| NB-6313 Procedure for Applying Pressure | Not addressed by JSME. | B-1 |
| [NB-6320 PNEUMATIC TEST PRESSURE REQUIREMENTS]<br>NB-6321 Minimum Required Pneumatic Test Pressure | PHT-2112 is equivalent. PHT-2122 does not have separate provisions for valves. | B-2 |
| NB-6322 Maximum Permissible Test Pressure | PHT-2130 requires stress evaluation only if test pressure exceeds 106% of minimum test pressure. | B-2 |
| NB-6323 Test Pressure Holding Time | PHT-4010 requires 3 minute test for valves vs. 10 minutes of NB-6223. | B-2 |
| NB-6324 Examination for Leakage After Application of Pressure | PHT-5010 is equivalent. | B-2 |
| [NB-6400 PRESSURE TEST GAGES]<br>NB-6411 Types of Gages to Be Used and Their Location<br>NB-6412 Range of Indicating Pressure Gages<br>NB-6413 Calibration of Pressure Test Gages | No equivalent JSME requirements; other standards are applied. | B-1 |
| [NB-6600 SPECIAL TEST PRESSURE SITUATIONS]<br>[NB-6610 COMPONENTS DESIGNED FOR EXTERNAL PRESSURE] | PHT-3000, -3010, -3011, -3012, -3020 allow 1.1 DP pneumatic test in lieu of 1.25 DP hydrotest. | B-2 |
| [NB-6620 PRESSURE TESTING OF COMBINATION UNITS]<br>NB-6621 Pressure Chambers Designed to Operate Independently<br>NB-6622 Common Elements Designed for a Maximum Differential Pressure | Not addressed by JSME. Not required by MITI. | B-1 |
| NB-7000 OVERPRESSURE PROTECTION | These requirements are system-related and not related to Class 1 vessels. | — |

# APPENDIX B2: JSME VERSUS ASME SECTION III DETAILED COMPARISON FOR CLASS 1 PIPING, PUMPS AND VALVES

## Appendix B2: JSME vs ASME Comparison Table

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-3400 PUMP DESIGN]<br>[NB-3410 GENERAL REQUIREEMENTS FOR CETRIFUGAL PUMPS]<br>NB-3400 Scope | PMB-1110<br>PMB-1110 and its interpretation<br>JSME defines (a) casing, (b) pump inlet and outlet, (c) pump cover, (d) clamping rings, (f) related bolting and (j) mounting feet as the boundary.<br>However, JSME doesn't define the boundary such as NB-3411.1(e) seal housing and seal glands, (g) pump internal heat exchanger piping and (h) pump auxiliary nozzle connections up to the face of the first flange.<br>Regarding NB-3411.1(i) piping identified with the pump and external to and forming part of the pressure-retaining part, JSME doesn't include them in the scope of pump design.<br>JSME Code was first developed mainly based on MITI Notification No. 501.<br>MITI Notification No. 501 defined pressure retaining boundary from the viewpoints that it is important the pressure retaining parts should not damaged and pumped fluid should not leak outside.<br>Leakage is restricted by the labyrinth, and the bearing etc. of the pump, even if parts were damaged. MITI Notification No. 501 didn't define these parts as subject to regulation.<br>Regarding NB-3411.2 Exceptions, these are not specified in JSME. However, these exceptions can be distinguished base on the above definition. | B-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3412 Acceptability | PMB-3210<br>JSME doesn't have such a classification according to connection size. | B-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| | JSME requires (a) or (b) below.<br>(a) The design shall satisfy the requirements of casing structural strength of PMB-3300, casing cover structural strength of PMB-3400 and bolting strength of PMB-3500.<br>(b) The design shall satisfy the requirements of Class 1 Vessel of PVA-3010, PVA-3011, PVA-3020, PVA-3030, PVB-3110 to PVB-3140 and PVB-3300 | |
| NB-3414 Design and Service Condition | PMB-3210<br>The vessel design of JSME is applicable to the Pump design of JSME. Therefore, JSME is equivalent to ASME | A-2 |
| NB-3415 Loads from Connected Piping | JSME does not define the loadings that are considered in design.<br>However, GNR-2221 requires that Design Specification shall provide them. | B-1 |
| NB-3417 Earthquake Loadings | JSME doesn't have this provision.<br>JEAG 4601(1984)/ JEAC 4601(2008) specify the evaluation method and allowable values. | B-1 |
| NB-3418 Corrosion | In JSME, corrosion or erosion is not defined in the design phase.<br>However, in maintenance phase, the requirement against piping corrosion or erosion is specified in another standard (JSME S CA1-2005) | B-1 |
| NB-3419 Cladding | JSME doesn't suppose the use of cladding for pump. | B-1 |
| [NB-3420 DEFINITIONS]<br>NB-3421 Radially Split Casing<br>NB-3422 Axially Sprit Casing<br>NB-3423 Single and Double Volute Casings<br>NB-3424 Seal Housing<br>NB-3425 Typical Examples of Pump types | JSME dose not define these items. Definitions are specified according to need. Moreover, JIS B 0131"Glossary of terms for turbo pumps" provides fundamental terms | B-1 |
| [NB-3430 DESIGN REQUIREMENTS FOR CENTRIFUGAL PUMPS] | JSME doesn't have welding requirement for pump. JSME | B-1 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3431 Design of Welding | follows the former MITI Notification 501. | |
| NB-3432 Cutwater Tip Stresses | JSEM does not request stress analysis on the cutwater tips of volute casings.<br>However, JSME requests radius at the cutwater tips of volute casings shall be the same or more than the required minimum radius. (Refer to the comparison between NB3441.3 and JSME.) | B-1 |
| NB-3433 Reinforcement of Pump Casing Inlets and Outlets | | |
| NB-3433.1 Axially Oriented Inlets and Outlets<br>NB-3433.2 Radially Oriented Inlets and Outlets<br>NB-3433.3 Tangential Oriented Inlets and Outlets | Regarding NB-3433.1(a), NB-3433.2 and NB3433.3, JSME doesn't request reinforcement of openings. Regarding NB-3433.1(b), JSME includes in the JSME PMB-3320 interpretation. | B-1 |
| NB-3433.4 Minimum Inlet and Outlet Wall Thicknesses | PMB-3320<br>Regarding expression of Minimum Inlet and Outlet wall Thickness, Minimum wall thickness 't' is used in stead of 'tm' in JSME PMB-3320.<br>'t' is adopted for determination of the distance 'ℓ' for ease in calculation, because there isn't so much of a difference between the value of 'ℓ' calculated from 'tm' and the value of 'ℓ' calculated from 't'. | B-2 |
| NB-3434 Bolting | PMB-3500<br>JSME has requirements of design by rule. (ASME has requirements of design by analysis.)<br>Mean stress due to design pressure or due to bolt load for gasket seating shall not exceed maximum allowable stress value S. | B-2 |
| NB-3435 piping | In JSME code, the boundary between the pump and the connected piping with the pump is defined at a weld joint that is nearest to the pump in the piping.<br>Piping in a pump assembly is regulated as not pump but piping. | B-1 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| | JSME doesn't specify requirement for external pressure.<br>JSME follows the former MITI Notification 501. | |
| NB-3436 Attachments | JSME defines attachment, which connected to the inside or outside of the pressure-retaining portion of a component.<br>JSME follows the former MITI Notification 501. | B-1 |
| NB-3437 Pump Cover | PMB-3400<br>JSME requires analysis.<br>PMB-3410 providdes as well as stress analysis of PVB-3111(1) in the design requirements for class 1 vessel.<br>(Maximum allowable stress values S are applied in stead of design stress intensity values Sm.)<br>Regarding flat heads, minimum thickness can be calculated by the following equation in JSME:<br>$t = d\sqrt{\frac{KP}{S}}$ | B-2 |
| NB-3438 Supports | JSME doesn't have this provision in pump design, however, another chapter "SSB" for Class 1 supports is applied for pump support design. | B-1 |
| [NB-3440 DESIGN OF SPECIFIC PUMP TYPES]<br>NB-3441 Standard Pump Types | PMB-3110<br>JSME has definition of applicable pump types.<br>However, JSME doesn't have definition of type A, B, D, E and J, because these pump types are not applied as Class 1 Pump. | B-2 |
| NB-3441.1 Design of type A pumps<br>NB-3441.2 Design of type B pumps | JSME doesn't have definition of type A and B, because these pump types are not applied as Class 1 Pump in Japan. | B-1 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3441.3 Design of type C pumps | | |
| (a) Casing Wall Thickness | PMB-3310<br>Regarding type C<br>- Expression of Minimum Wall Thickness t uses (1/S) in JSME Code in stead of (0.63/Sm) in ASME.<br>JSME defines the value 't' as follows.<br>$t = \frac{PA}{2S}$ | B-2 |
| (b) Splitter Wall Thickness<br>(c) Crotch Radius | PMB-3330<br>JSME PMB-3330 has the same requirements as (b) Splitter Wall Thickness and (c) Crotch Radius. | A-2 |
| (d) Bottom of Casing | PMB-3310<br>JSME PMB-3310 has the similar requirement as (d) (1). (please refer to the above explanation)<br>However, JSME doesn't have the same requirements as (d) (2) and (3). JSME follows the former MITI Notification 501. | B-2 |
| NB-3441.4 Design of type D pumps<br>NB-3441.5 Design of type E pumps | JSME doesn't have definition of type D and, because these pump types are not applied as Class 1 Pump in Japan. | B-1 |
| NB-3441.6 Design of type F pumps | PMB-3310<br>Regarding type F, JSME PMB-3310 requires Minimum Wall Thickness as follows.<br>$t = \frac{PA}{2S}$<br>JSME follows the former MITI Notification 501. | B-2 |
| NB-3442 Special Pump Types-Type J Pumps | JSME doesn't have definition of type J, because this pump type is not applied as Class 1 Pump. | B-1 |
| [NB-3500 VALVE DESIGN]<br>NB-3510 ACCEPTABILITY | VVB-1000<br>VVB-1100 | A-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3511 General Requirements | VVB-3010(1) | A-2 |
| [NB-3512 Acceptability Large Valves]<br>NB-3512.1 Standard Design Rules | VVB-3010(2)<br>VVB-3010(2) | A-2 |
| NB-3512.2 Alternative Design Rules | JSME does not permit to apply design by analysis to Class 1 valve. JSME follows the former MITI Notification 501. | B-1 |
| [NB-3513 Acceptability of Small Valves]<br>NB-3513.1 Standard Design Rules | VVB-3010(3)<br>VVB-3010(3) | A-2 |
| NB-3512.2 Alternative Design Rules | JSME does not have this provision. JSME follows the former MITI Notification 501. | B-1 |
| NB-3515 Acceptability of Metal Bellows and Metal Diaphragm Stem Sealed Valves | VVB-3010(4) | A-2 |
| [NB-3520 DESIGN CONSIDERATIONS]<br>NB-3521 Design and Service Loadings | JSME does not permit to apply design by analysis to Class 1 valve. JSME follows the former MITI Notification 501. | B-1 |
| NB-3524 Earthquake | JSME does not have this provision. JEAG 4601(1984)/ JEAC 4601(2008) requirements are applied. | B-1 |
| NB-3525 Levels A and B Service Limits | JSME does not clearly mention this provision, but this is considered in actual design. | B-1 |
| [NB-3526 Level C Service Limits]<br>NB-3526.1 Pressure-Temperature Ratings<br>NB-3526.2 Pipe Reaction Stress<br>NB-3526.3 Primary Stress and Secondary Stress | VVB-3350<br>VVB-3350(1)<br>VVB-3350(2)<br>VVB-3350(2) | A-2 |
| NB-2526.4 Secondary and Peak Stresses | JSME does not clearly mention this provision, but this is considered in actual design. | B-1 |
| NB-3527 Level D Service Limits | JSME does not clearly mention this provision, but this is considered in actual design. | B-1 |
| [NB-3530 GENERAL RULES] | | |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-3531 Pressure-Temperature Ratings and Hydrostatic Tests]<br>NB-3531.1 Pressure-Temperature Ratings<br>NB-3531.2 Hydrostatic Tests | VVB-3100<br>VVB-3100<br>PHT-2100 | A-2 |
| NB-3531.3 Allowance for Variation From Design Loadings | JSME does not clearly mention this provision, but this is considered in actual design. | B-1 |
| NB-3532 Design Stress Intensity Values | VVB-3300 | A-2 |
| NB-3533 Marking | JSME does not have this provision. J EM1423* are applied. (*: Japan Electrical Manufacturer's Association Standard, "Inspection of nuclear power plant valves") | B-1 |
| NB-3534 Nomenclature | JSME does not have this provision. Most of the nomenclatures are the same, but some of them are different. | B-1 |
| [NB-3540 DESIGN OF PRESSURE-RETAINING PARTS]<br>NB-3541 General Requirements for Body Wall Thickness | VVB-3210 | A-2 |
| NB-3542 Minimum Wall Thickness of Listed<br>The tables of the ASME B16.34 | VVB-3210(1)<br>VVB-3110 The tables of Appendix (Appendix table 1-1, 3) | A-2 |
| NB-3543 Minimum Wall Thickness of Valves of Nonlisted Pressure Rating | VVB-3210(1) | A-2 |
| [NB-3544 Body Shape Rules]<br>NB-3544.1 Fillets for External Internal Intersections and Surfaces<br>NB-3544.2 Penetrations of Pressure-Retaining Boundary<br>NB-3544.3 Attachments<br>NB-3544.4 Body Internal Contours<br>NB-3544.5 Out-of-Roundness | VVB-3410<br>VVB-3411<br>VVB-3412<br>VVB-3413<br>VVB-3414<br>VVB-3415 | A-2 |
| NB-3544.6 Doubly Curved Sections | JSME does not have this provision. This is not used in Japan | B-1 |
| NB-3544.7 Flat Sections | VVB-3416 | A-2 |
| NB-3544.8 Body End Dimensions | JSME does not have this provision. Most of the nomenclatures are the same, but some of them are | B-1 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| | different. | |
| NB-3544.9 Openings for Auxiliary Connections | JSME does not have this provision. Most of the nomenclatures are the same, but some of them are different. | B-1 |
| [NB-3545 Body Primary and Secondary Stress Limits] | VVB-3310 | A-2 |
| NB-3545.1 Primary Membrane Stress Due to Internal Pressure | VVB-3320<br>JSME have this provision except (a)(6) and (b), but these are considered in actual design. | B-2 |
| NB-3545.2 Secondary Stresses | VVB-3330, VVB-3340<br>JSME have this provision except (b). JSME requires to evaluate the tensile, bending and torsion stresses due to pipe reaction force, while ASME requires bending stress only. JSME follows the former MITI Notification 501. | B-2 |
| NB-3545.3 Fatigue Requirements | VVB-3360 | A-2 |
| [NB-3546 Design Requirements for Valve Parts Other Than Bodies]<br>NB-3546.1 Body-to-Bonnet Joints | VVB-3390<br>(a) JSME does not have this provision. However, in JSME code, body-to-bonnet(as Flanged joint) shall be designed in according with JIS.<br>(b) JSME does not have this provision.<br>JSME accepts the use of bolted body-to-bonnet joints only. | B-2 |
| NB-3546.2 Valve Disk | VVB-3380 | A-2 |
| NB-3546.3 Other Valve Parts | JSME doesn't have (a) because these are not pressure retaining parts. JSME follows the former MITI Notification 501.<br>JSME doesn't have (b) and (c), but they are considered in actual design. | B-1 |
| NB-3546.4 Fatigue Evaluation | JSME does not have this provision. JSME follows the former MITI Notification 501. | B-1 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3550 CYCLIC LOADING REQUIREMENTS | | |
| NB-3551 Verification of Adequacy for Cyclic Conditions | JSME does not clearly mentioned this provision, but actual design is being considered. | B-1 |
| NB-3552 Excluded Cycles | VVB-3370<br>JSME does not have these provisions except (b) temperature variations.<br>And as for (b), JSME excludes cycles of temperature variations less than 17 C for Carbon steel and less than 14 C for Stainless steel.<br>JSME has made technical judgment to establish the requirement based on available research and development results. | B-2 |
| NB-3553 Fatigue Usage | VVB-3370 | A-2 |
| NB-3554 Cyclic Stress Calculations | VVB-3370(1) | A-2 |
| NB-3560 DESIGN REPORTS<br>NB-3561 General Requirements<br>NB-3562 Design Report for Valves Larger Than NPS4(DN100)<br>NB-3563 Design Report Requirements for NPS4 and Smaller(＜DN100) Valves | JSME does not have this provision, but this is considered in actual design. ISO-9001 is applied to the QA activities in Japan. | B-1 |
| [NB-3590 PRESSURE RELIEF VALVE DESIGN] | | |
| [NB-3591 Acceptability]<br>NB-3591.1 General<br>NB-3591.2 Definitions<br>NB-3591.3 Acceptability of Small Liquid Relief Valves<br>NB-3591.4 Acceptability of Safety and Safety Relief Valves | SRV-3010<br>JIS(Japan Industrial Standards) requirements are applied for Pressure Relief Valve Design. | B-2 |
| [NB-3592 Design Considerations]<br>NB-3592.1 Design Condition<br>NB-3592.2 Stress Limits for Specified Service Loading | JSME does not have this provision.<br>JIS(Japan Industrial Standards) requirements are applied. | B-1 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3592.3 Earthquake | JSME does not have this provision.<br>JEAG 4601(1984)/ JEAC 4601(2008) are applied. | B-1 |
| NB-3593.1 Hydrostatic Test | PHT-2600 | A-2 |
| NB-3593.2 Marking | JSME does not have this provision.<br>JIS(Japan Industrial Standards) requirements are applied. | B-1 |
| [NB-3594 Design of Pressure Relief Valve Parts]<br>NB-3594.1 Body<br>NB-3594.2 Bonnet (Yoke)<br>NB-3594.3 Nozzle<br>NB-3594.4 Body-to-Bonnet Joint<br>NB-3594.5 Disk<br>NB-3594.6 Spring Washer<br>NB-3594.7 Spindle (Stem)<br>NB-3594.8 Adjusting Screw<br>NB-3594.9 Spring | JSME does not have this provision.<br>JIS (Japan Industrial Standards) requirements are applied. | B-1 |
| [NB-3595 Design Report]<br>NB-3595.1 General Requirement | JSME does not have this provision. ISO-9001 is applied to the QA activities in Japan. | B-1 |
| [NB-3600 Piping Design]<br>[NB-3610 General Requiremen]<br>NB-3611 Acceptability<br>NB-3611.1 Stress Limits<br>NB-3611.2 Acceptability When Stress Exceed Stress Limits<br>NB-3611.3 Conformance to NB-3600 | PPB-3100, PPB-3110,<br>PPB-3111, PPB-3112 | A-2 |
| NB-3611.4 Dimensional Standards | Other Japanese Standard（JIS）is applied | B-1 |
| NB-3611.5 Prevention of Nonductile Fracture | PPB-2310, PPB-2330 | A-2 |
| [NB-3612 Pressure-Temperature Ratings]<br>NB-3612.1 Standard Piping Products | Other Japanese Standard（JIS）is applied | B-1 |
| NB-3612.2 Piping Products Without Specific Ratings | ASME and JSME have differences as follows; | B-1 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| | ASME<br>Piping products without specifies rating can be applied after conducting the pressure design and testing.<br>JSME<br>Piping products expect flange don't have concept of pressure-temperature ratings.<br>The pressure design are applied to Piping products. | |
| NB-3612.4 Consideration for Local Conditions and Transients | JSME does not have requirement on this section.<br>It is the requirement for function of the plant, so it is already confirmed under the applied ministerial ordinance or manufacture's practice.<br>Protection from excessive pressure is equivalent to JSME code case NC-CC-001(2006), "Over Pressure Protection" | B-1 |
| [NB-3613 Allowance]<br>Nb-3613.1 Corrosion or Erosion | JSME does not have this provision.<br>ASME and JSME have differences as follows;<br>ASME<br>Corrosion or erosion is defined in the design phase.<br>JSME<br>Corrosion or erosion is not defined in the design phase, but actual design is being considered.<br>Additionally, for the maintenance phase, the requirement is specified under another standard (JSME S CA1-2005, "Rules on Pipe Wall Thinning Measurement"). | B-1 |
| NB-3613.2 Threading and Grooving | JSME does not have a requirement of Threading and Grooving.<br>Since, threading and grooving are not applied for the actual plants. | B-1 |
| NB-3613.3 Mechanical Strength | JSME doesn't clearly mention this provision, but actual design is being considered. | B-1 |
| [NB-3620 Dynamic Effects]<br>NB-3621 Design and Service Loadings | GNR-2200<br>JSME does not define the loadings that shall be considered | B-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3622.1 Impact | in design, however, GNR-2200 requires that Design Specification shall provide them. | |
| NB-3622.2 Reversing Dynamic Loads | | |
| NB-3622.3 Vibration | | |
| NB-3622.4 Nonreversing Dynamic Loads | | |
| NB-3623 Weight Effects | | |
| NB-3623.1 Live Weight | | |
| NB-3623.2 Dead Weight | | |
| [NB-3624 Thermal Expansion and Contraction Loads]<br>NB-3624.1 Loadings, Displacements, and Restraints | | |
| Nb-3624.2 Analysis of Thermal Expansion and Contraction Effects | | |
| Nb-3624.2 Analysis of Thermal Expansion and Contraction Effects | | |
| NB-3625 Stress Analysis | PPB-3111 (2) | A-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3630 Piping Design and Analysis Criteria | PPB-3111、PPB-3112、<br>PVB-3140<br>[NB-3630(a)]<br>Equivalent to PPB-3111(1)<br>[NB-3630(b)]<br>Equivalent to PPB-3111(2)<br>[NB-3630(c)]<br>Equivalent to PPB-3112<br>[NB-3630(d)]<br>Equivalent to PVB-3111(2) expect as follows; (equivalent to PVB-3140, exception provision in terms of fatigue evaluation)<br>ASME<br>Piping of NPS1(DN25) or less may be designed in according with the design requirements of NC(Class 2)<br>JSME<br>JSME doesn't have such exemption for piping of NPS1 or less. | B-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-3640 Pressure Design]<br>[NB-3641 Straight Pipe]<br>NB-3641.1 Straight Pipe Under Internal Pressure | PPB-3411 (1)、<br>PPB-3411(3)<br>Although NB-3641 is equivalent to PPB-3411(1),<br>ASME and JSME have difference as follows;<br>In ASME eq.(1), additional thickness A is added (to ensure allowance). A is not considered in JSME eq.(PPB-1.1), but it mentions the minimum required wall thickness for Carbon Steel pipe in PPB-3411(3).<br>The equation of the minimum wall thickness for inner diameter such as ASME eq.(2) is not specified in JSME.<br>（JSME requirement takes safety side.）<br>JSME dose not define the allowable working pressure of pipe such as ASME eq.(3). | B-2 |
| NB-3641.2 Straight Pipe Under External Pressure | PPB-3411 (2)<br>Equivalent to PPB-3411(2) expect as follows ;<br>ASME designates the different calculation procedures (see the left column NB-3133.3) depending on the ratio of $D_0/T$ values.<br>JSME doesn't have the evaluation equation for the ratio of $D_0/T$ values less than 10.<br>JSME states that wall thickness shall be determined by following equation independent of the ratio of $D_0/T$.<br>$t = \frac{3P_e D_o}{4B}$ | B-2 |
| [NB-3642 Curved Segments of Pipe]<br>NB-3642.1 Pipe Bends | PPB-3412<br>[NB-3642.1 (a) and (c)]<br>Equivalent to PPB-3412.<br>[NB-3642.1 (b)]<br>JSME doesn't have the provision, but it is just a reference. | B-2 |
| NB-3642.2 Elbows | PPB-3415 | B-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| | Equivalent to PPB-3415 except as follows ;<br>Neither JSME nor JIS has the requirement for Crotch region for short elbow. | |
| [NB-3643 Intersections]<br>NB-3643.1 General Requirements | PPB-3421<br>[NB-3643.1 (a)]<br>Equivalent to PPB-3421(1)<br>[NB-3643.1 (b)]<br>Equivalent to PPB-3421(2)<br>[NB-3643.1 (c),(d) and (e)]<br>JSME does not have the provisions. However, item (c),(d) is the general requirement. Item(e) specifies the limitation where intersecting pipes are jointed with the angle between 60°and 120°. | B-2 |
| NB-3643.2 Branch Connections | PPB-3415, PPB-4010<br>[NB-3643.2 (a) and (b)]<br>Equivalent to PPB-3415.<br>[NB-3643.2 (c)]<br>JSME doesn't have the provision, but extruded outlet pipe is not applied.<br>Additionally, extruded outlet pipe is not used for actual plants.<br>[NB-3643.2 (d)]<br>Equivalent to Fig. PPB-4000-4(7) and (8). ASME is applied partial penetration weld, but JSME is not applied. （JSME requirement takes safety side.） Full penetration is required in both figures. | B-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3643.3 Reinforcement for Openings | PPB-3422, PPB-3424<br>[NB-3643.3 (a)]<br>Equivalent to PPB-3422 and PPB-3424.<br>Some nomenclatures are used only for either ASME or JSME.<br>Most of the nomenclatures are the same, but some of them are different. | B-2 |
| NB-3643.3 Reinforcement for Openings (cont.) | [NB-3643.3 (b)(1)(a) and (c)]<br>Equivalent to PPB-3422<br>[NB-3643.3 (b)(1)(b)]<br>JSME requirement (PPB-3422(2)c.) for Openings not requiring reinforcement is different from ASME NB-3643.3(b) as follows.<br>ASME : p≧1.0(d1+d2)<br>JSME : p≧Max(P1,P2)<br>P1=1.5(d1+d2)<br>P2=2.5√(Rt)+0.5(d1+d2)<br>where p is a arc length on the inside of the pipe wall between two opening's centers.<br>[NB-3643.3 (b)(2)]<br>Equivalent to the equation PPB-2.13(PPB-3424).<br>[NB-3643.3 (b)(3)]<br>JSME doesn't have the provision.<br>However, it is a general requirement. | B-2 |
| | [NB-3643.3 (c)(1)(a), (b)]<br>Equivalent to PPB-3424(1) a.(a).<br>However, JSME does not have the limitation as "in the corroded condition".<br>[NB-3643.3 (c)(1)(c)]<br>Equivalent to PPB-3424(2) b.(4).<br>However, JSME does not have the equation "<br>$r + T_b / \sin\alpha + T_r$". | |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3643.3 Reinforcement for Openings (cont.) | [NB-3643.3 (c)(2)(a)]<br>Equivalent to the Table PPB-3424-1 in PPB-3424(1)a.(b). However, ASME does not have Fig.PPB-3424-1(4) in JSME.<br>[NB-3643.3 (c)(2)(b)]<br>The equation in item (2)(b) shows the differences from the one in JSME. (see below underlined part).<br>However, JSME states cos θ=0.866(60°) so that it takes conservative value.<br>ASME : $0.5\sqrt{r_n T_b}$<br>$= 0.5\sqrt{\left(r_i + 0.5T'_b + \underline{\underline{0.5y\cos\theta}}\right)\left(T'_b + 0.667y\right)}$<br>$r_n = r_i + 0.5T'_b + 0.5y\cos\theta$<br>$T_b = T'_b + 0.667y$<br>$T'_b$ : wall thickness of branch pipe<br>$y$ : incline offset length<br>θ : angle formed by vertical axis and slope of branch connection<br>JSME : $0.5\sqrt{r_m t_n}$<br>$= 0.5\sqrt{\left(r_i + 0.5t_p + \underline{\underline{0.333x}}\right)\left(t_p + 0.667x\right)}$<br>$r_m = r_i + 0.5t_n$<br>$t_n = t_p + 0.667x$<br>$t_p$ : wall thickness of branch pipe<br>$x$ : incline offset length<br>Additionally, ASME does not have Fig.PPB-3424-1(6) in JSME. | B-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3643.3 Reinforcement for Openings (cont.) | [NB-3643.3 (d)(1)(a)]<br>Almost equivalent to PPB-3424(1) b.(a).<br>However, JSME dose not requires Corrosion Allowance be considered.<br>[NB-3643.3 (d)(1)(b) and (c)]<br>Equivalent to PPB-3424(1) b.(b).<br>[NB-3643.3 (d)(2)]<br>Equivalent to PPB-3424(3).<br>[NB-3643.3 (d)(3)]<br>JSME code has the additional request to ASME as shown below.<br>ASME see the left column (3)<br>JSME In the case of the available ranges for reinforcement are overlapped, the distance between two openings shall be over 1.5 times of the average of diameters of these openings.<br>And, the available area for reinforcement between these openings shall be equal to 50% or more than the area required for reinforcement of these openings.<br>（refer to PPB-3424(2)）<br>[NB-3643.3 (d)(4)]<br>Equivalent to PPB-3424(1)b..<br>[NB-3643.3 (e)]<br>Equivalent to PPB-3424(6) and PPB-3424(7).<br>[NB-3643.3 (f)]<br>JSME doesn't have this provision.<br>However, JSME is not applied extruded outlet pipe.<br>And, Extruded outlet pipe is not used in the actual plants. | B-2 |
| NB-3644 Miters | [NB-3644]<br>JSME doesn't have this provision. However, JSME does not apply Miters. And, Miters are not used for the actual plants. | B-1 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3646 Closures | PPB-3413, PPB-3415.2,<br>PPB-3420, PPB-3423, PPB-4000<br>[NB-3646 (a)]<br>Although ASME states that closures (blind flanges, threaded or welded plugs or caps) shall be manufactured in accordance with Table NCA-7100-1, JSME doesn't have any specific description on this. However, the requirements of blind flanges are described in JSME PPB-3413 (plain plate) as well as caps are in JSME PPB-3415.2 (paneling).<br>[NB-3646 (b)]<br>JSME does not define the requirement that closures may be made in accordance with the rules for Class 2 vessels.<br>The evaluation eq. for closures (PPB-3415.2) is equivalent to NC-3324.6, 3324.7, 3324.8, 3133.4. The evaluation eq. for plates (PPB-3413) is equivalent to NC3325. These equations are almost the same as the ones for Class 2 component.<br>instrument etc.. and its diameter is 20mm or less may not comply with the above provision.<br>ASME : ASME dose not have the applicable condition of opening on head (panel), and has the definition for the required thickness of a head depends on the opening location on head. | B-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3646 Closures (cont.) | The applicable condition of opening on head (panel) has difference between JSME and ASME as follows; （JSME : PPB-3423）<br>JSME : The opening on torispherical head shall not be located except in an entirely within the spherical portion of a torispherical head.<br>The opening on an ellipsoidal head shall not be located except in an entirely within a circle, the center of which coincides with the center of the head and the diameter of which is equal to 80% of the shell diameter.<br>However, the opening for mounting a monitoring [NB-3646 (c)]<br>The design requirements for welding joint are equivalent to PPB-4000 (corresponds to NB-4240) However, ASME states that if the size of opening is greater than the one half the ID of the closure, the opening should be considered as a reducer. On the other hand, JSME does not define the requirement.<br>[NB-3646(d) and (e)]<br>Equivalent to PPB-3420. | B-2 |
| [NB-3647 Pressure Design of Flanged Joint and Blanks]<br>NB-3647.1 Flanged Joints | PPB-3414<br>[NB-3647.1(a)]<br>Equivalent to PPB-3414.<br>[NB-3647.1(b)]<br>In ASME code, non standard flanged joints shall be designed in according with XI-3000. In JSME code, non standard flanged joints shall be designed in according with JIS B 8265. XI-3000 and JIS B 8265 state almost the same evaluation. | B-2 |
| NB-3647.2 Permanent Blanks | JSME does not have the provision.<br>Additionally, Permanent Blanks are not used for the actual plants. | B-1 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3647.3 Temporary Blanks | JSME doesn't take Temporary Blanks as the item needs to comply with the Codes. | B-1 |
| NB-3648 Reducer | PPB-3415.1<br>[NB-3648]<br>Equivalent to PPB-3415.1<br>However, JSME states that this item takes the same pressure evaluation as Class 2 Vessel. (PVC-3124.1). | B-2 |
| NB-3649 Pressure Design of Other Piping Products | PPB-3415、PPB-1210<br>[NB-3649]<br>Design of other standard piping products is equivalent to PPB-3415.<br>JSME doesn't have the requirements for both the experimental stress analysis in Appendix Ⅱ and an ANSI B16.9 type burst test for other non standard piping products.<br>Analysis requirement is equivalent to PPB-1210. | B-2 |
| NB-3649.1 Expansion Joints | ASME has been working on this provision.<br>JSME does not approve the requirement for expansion joints in Class 1 piping.<br>And JSME does not have a plan to develop a provision for this item. | B-1 |
| [NB-3650 ANALYSIS OF PIPING PRODUCTS]<br>[NB-3651 General Requirement] | PPB-3500<br>PPB-3510 | A-2 |
| NB-3651.1 Piping Products for Which Stress Indices Are Given | | |
| NB-3651.2 Piping Products for Which Stress Indices Are Not Given | | |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3651.3 Attachments | GNR-1230<br>JSME GNR-1230 defines the boundaries between components and attachments that are welded on the components.<br>However, JSME doesn't require about the design of attachments. | B-2 |
| [NB-3652 Consideration of Design Condition] | PPB-3520 | A-2 |
| [NB-3653 Consideration of Level A Service Limits] | PPB-3530 | A-2 |
| NB-3653.1 Satisfaction of Primary Plus Secondary Stress Intensity Range | PPB-3531 | A-2 |
| NB-3653.2 Satisfaction of Peak Stress Intensity Range | PPB-3532 | A-2 |
| NB-3653.3 Alternating Stress Intensity | PPB-3533 | A-2 |
| NB-3653.4 Use of Design Fatigue Curve | PPB-3534 | A-2 |
| NB-3653.5 Cumulative Damage | PPB-3535 | A-2 |
| NB-3653.6 Simplified Elastic-Plastic Discontinuity Analysis | PPB-3536<br>【NB-3653.6】<br>NB-3653.6 is almost equivalent to PPB-3536, except for description about Ke Factor.<br><br>JSME apply the Ke Factor that is based on the Japanese R&D results. (See ATTACHMENT C-23, Comparison between ASME/JSME Codes for of Class 1 Vessel) | B-2 |
| [NB-3654 Consideration of Level B Service Limits] | PPB-3530 | A-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3654.1 Permissible Pressure<br>NB-3654.2 Analysis of Piping Components | 【NB-3654.1】<br>JSME doesn't have this provision.<br>JSME Code (Rules on Design and Construction) was first developed mainly based on MITI Notification No. 501 which is detailed technical rules for structural design of nuclear components established by the regulatory authority. In developing MITI Notification No. 501, they sifted through ASME Section III and adopted provisions therein that were judged necessary from the regulator's point of view.<br>With these backgrounds, there are number of provisions that exist in ASME Section III but not in JSME Code.<br><br>【NB-3654.2】<br>NB-3654.2 a) defines the requirements for Level B Service Limits, but JSME PPB-3530 defines the requirements for "Level A and B" Services Limits.<br><br>NB-3564.2 b) defines the evaluation criteria about reversing dynamic loads, but JSME doesn't define the evaluation criteria (In Japan, JEAG 4601* defines the method of seismic evaluation criteria. However, this guide defines requirement for Level C and D Service Limits, but not defines for Level B Service Limits).<br><br>*: JEAG 4601 (1984), "Technical Guides for Aseismic Design of Nuclear Power Plants", has been revised to JEAC 4601 (2008), "Technical Code for Seismic Design of Nuclear Power Plants" | B-1 |
| [NB-3655 Consideration of Level C Service Limits]<br>NB-3655.1 Permissible Pressure | PPB-3550<br>PPB-3551 | A-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3655.2 Analysis of Piping Components | PPB-3552<br>【NB-3655.1】<br>NB-3655.1 is equivalent to PPB-3551.<br><br>【NB-3655.2】<br>PPB-3655.2 defines the evaluation criteria about reversing dynamic loads, but JSME doesn't define the evaluation criteria. (In Japan, JEAG4601 defines Seismic evaluation criterion. The allowable stress of sum of primary and secondary stress is 3Sm in JEAG4601, but 4.2Sm in ASME. Also, the allowable stress of primary stress is 3Sm in JEAC4601 (2008)) | B-2 |
| NB-3655.3 Deformation Limits | 【NB-3655.3】<br>JSME doesn't have this provision.<br>(In actual design, if there is a needs for deformation limits, evaluation will be conducted) | B-1 |
| [NB-3656 Consideration of Level D Service Limits] | PPB-3560<br>PPB-3561<br>PPB-3562<br>【NB-3656 (a)】<br>NB-3656(a) is equivalent to PPB-3560, 3561 and 3562.<br><br>【NB-3656(b)】<br>PPB-3656 (b) defines the evaluation criteria about reversing dynamic loads, but JSME doesn't have this provision. (In Japan, JEAG4601 and JEAC4601 (2008) defines Seismic evaluation criterion. The allowable stress of sum of primary and secondary stress is 3Sm in JEAG4601 and JEAC4601 (2008), but 6Sm in ASME. In addition, if not involve the short period mechanical loads, JEAC4601 (2008) doesn't require for evaluation of primary stress due to earth quake) | B-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-3657 Test Loading] | JSME Code does not have this requirement. However, in actual design, components are designed considering about Test Loadings. | B-1 |
| [NB-3658 Analysis of Flanged Joints]<br>NB-3658.1 Design Limits, Level A and B Service Limits<br>NB-3658.2 Level C Service Limits<br>NB-3658.3 Level D Service Limits<br>NB-3658.4 Test Loading | PPB-3414<br>JSME PPB-3414 requires that Flanges are designed by using the equivalent pressure that is converted from moment loadings of Flanges.<br>ASME defines the allowable moments for flanged joints in Level A to D Service Limits. | B-2 |
| [NB-3660 DESIGN OF WELDS] | | |
| [NB-3661 Welded Joints]<br>NB-3661.1 General Requirement | PPB-4010<br>【NB-3661.1】<br>JSME doesn't have this provision. Those activities that are ordinarily expected to be performed if not specified.<br>【NB-3661.2】<br>NB-3661.2 and NB-4427 corresponds to JSME PPB-4010. However, there are discrepancies about dimension requirements between NB-4427 and PPB-4010. (See ATTACHMENT D-33, Comparison between ASME/JSME Codes for Class 1 Vessel) | B-1 |
| NB-3661.2 Sockets Welds | | B-2 |
| NB-3661.3 Fillet Welds and Partial Penetration | | B-1 |
| [NB-3670 SPECIAL PIPING REQUIREMENTS]<br>[NB-3671 Flanged Joints]<br>NB-3671.1 Flanged Joints<br>NB-3671.2 Expanded Joints<br>NB-3671.3 Threaded Joints | PPB-3430 | A-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3671.4 Flared, Flareless, and Compression Joints<br>NB-3671.5 Caulked Joints<br>NB-3671.6 Brazed and Soldered Joints<br>NB-3671.7 Sleeve Coupled and Other Patented Joints | 【NB-3671.4～7】<br>JSME doesn't have these provisions. (NB-3671.4 – 7). In Japan, these joints (Flared joints etc) are not applied for Class 1piping. | B-1 |
| [NB-3672 Expansion and Flexibility] | NB-3672 describes the general requirements about thermal expansion and flexibility.<br>JSME doesn't have this provision, but these requirements are considered in actual design. | B-1 |
| NB-3672.1 Properties | PPB-3700 | A-2 |
| NB-3672.2 Unit Thermal Expansion Range | PPB-3723 | A-2 |
| NB-3672.3 Moduli of Elasticity | PPB-3724 | A-2 |
| NB-3672.4 Poison's Ratio | PPB-3725 | A-2 |
| NB-3672.5 Stresses | NB-3672.5-8 describes the requirements about thermal expansion and flexibility.<br>JSME doesn't have these provisions, but these requirements are considered in actual design. | B-1 |
| NB-3672.6 Method of Analysis | | |
| NB-3672.7 Basic Assumptions and Requirements | | |
| NB-3672.8 Cold Springing | | |
| [NB-3674 Design of Pipe Supporting Elements] | NB-3674 describes that Support shall be designed in accordance with NF<br>JSME doesn't describe this requirement. However, Supports are designed in accordance with the requirements of "JSME SSB" (JSME SSB define the requirement of Supporting design) | B-1 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-3677 Pressure Relief Piping]<br>NB-3677.1 General Requirements<br>NB-3677.2 Piping to Pressure Relieving Safety Device<br>NB-3677.3 Discharge Piping from Pressure Reliving Safety Device | NB-3677 stipulates the requirements for pressure relief piping.<br>JSME doesn't have these provisions. (In JSME, the requirements of overpressure protection are defined in Code Case NC-CC-001 (2006), but not described in details).<br>However, NB-3677.1,2 and 3 are general requirements, and these requirements are considered in actual design in Japan. | B-1 |
| [NB-3680 STRESS INDICES AND FLEXIBILITY FACTORS] | PPB-3800 | A-2 |
| [NB-3681 Scope] | PPB-3810 | A-2 |
| [NB-3682 Definition of Stress Indices and Flexibility Factors] | NB-3682 defines about Stress Indices and Flexibility Factors.<br>The interpretation of JSME PPB-3860 describes about definitions of Flexibility Factors, but not describes about Stress Indices. However, definitions of Stress Indices are generally recognized and used in actual design. | B-1 |
| [NB-3683 Stress Indices for Use With NB-3650 (TABLE NB-3681(a)-1) ] | PPB-3812.1 | A-2 |
| NB-3683.1 Nomenclature<br>(a) Dimentions<br>(b) Material Properties | In JSME, nomenclatures of Stress Indices are defined in each chapter (equation). | B-1 |
| (c) Connecting Welds | PPB-3812<br>NB-3683.1 defines that Flush Weld shall be accordance with Fig.NB-3683.1 (c)-1.<br>In JSME, PPB-3812.1-1 classify Flush Weld such as "no mismatch of connection surface", "mismatch of connection surface is less than 0.1 times of piping thickness" and so on. | B-2 |
| (d) Loadings | Interpretation PPB-3520 | A-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| NB-3683.2 Applicability of Indices-General | PPB-3812.1<br>PPB-3815<br>PPB-3816<br>PPB-3817<br>NB-3683.2 is equivalent to PPB-3812.1-1, PPB-3851 and PPB-3816.<br><br>【NB-3683.2(a)】<br>1); JSME doesn't have this provision.<br>However, This is general requirements and considered in actual design.<br>2); Equivalent to PPB-3817<br><br>【NB-3683.2(b)(1)】<br>Equivalent to remarks (2) of table PPB-3812.1-1.<br><br>【NB-3683.2(b)(2)】<br>JSME doesn't have this provision.<br>NB-3683.2 (b) (2) is requirement about the piping has the discontinuities in radius. However, such piping is not used for Class 1 piping in Japan.<br><br>【NB-3683.2(c)】<br>JSME doesn't have this provision.<br>NB-3683.2(c) is applied when Do/t is 50 to 100. However, Do/t of Class 1 piping is about 5 to 20. So this requirement is not applied to class 1 piping. | B-2 |
| NB-3683.3 Straight Pipe Remote From Welds | JSME doesn't have this provision.<br>However, NB-3683.3 is general requirements, and it is considered in actual design in Japan. | B-1 |
| NB-3683.4 Welds | PPB-3812.1 | A-2 |
| (a) Longitudinal Butt Welds | PPB-3812.1 | A-2 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| (b) Girth Butt Welds | PPB-3812.1<br>NB-3683.4(a) and (b) is equivalent to PPB-3812.1<br>NB-3638.4 (b) is requirement for the piping whose wall thickness is less than 6mm. So this requirement is not applied for Class 1 piping, because wall thickness of Class 1 piping is greater than 6mm (25A Sch160 is 6.4mm) | B-2 |
| (c) Girth Fillet Welds | PPB-3812.1<br>NB-3638.4(c) is equivalent to table PPB-3812.1-1. | A-2 |
| NB-3683.5 Welded Transitions | PPB-3812.2<br>In JSME PPB-3812.2, there are differences in stress indices of welded transitions. JSME follows the former MITI Notification 501. | B-2 |
| NB-3683.6 Concentric and Eccentric Reducers | PPB-3812.3 | A-2 |
| NB-3683.7 Curved Pipe or Butt Welding Elbows | PPB-3812.4 | A-2 |
| NB-3683.8 Branch Connections Per NB-3643 | PPB-3813<br>In JSME PPB-3813, there are differences in as follows.<br>There are differences in formulas for computation about C2b and K2b<br>When C2b only applied to calculation, JSME is more conservative than ASME. When it is applied as C2b×K2b, JSME is equivalent to ASME.<br>JSME follows the former MITI Notification 501. | B-2 |
| NB-3683.9 Butt Welding Tees | PPB-3814 | A-2 |
| [NB-3684 Stress Indices for Detailed Analysis] | JSME doesn't describe about Stress Indices for Detailed Analysis.<br>However, JSME PPB-3810 defines "Stress Indices shall be obtained by theoretical or experimental analysis".<br>Therefore, JSME allow using the Stress Indices for Detailed Analysis. | B-1 |

## Appendix B2: JSME vs ASME Comparison Table (cont.)

### Summary Table of Difference on Technical Requirements between JSME and ASME

| ASME B&PV Code 2007 Edition | JSME Code 2008 Edition | Classification |
|---|---|---|
| [NB-3685 Curved Pipe or Welding Elbows] | JSME doesn't describe about Stress Indices for curved pipe or elbows.<br>However, JSME PPB-3810 defines "Stress Indices shall be obtained by theoretical or experimental analysis".<br>Therefore, JSME allow using the Stress Indices for Detailed Analysis. | B-1 |
| NB-3685.2 Nomenclature (Fig NB-3685.2-1) | | |
| NB-3685.3 Stress From Stress Indices | | |
| NB-3685.4 Classification of Stresses | | |
| [NB-3686 Flexibility Factors[See NB-3682(c) for Definition] ] | PPB-3860 | A-2 |
| NB-3686.1 Straight Pipe | PPB-3861 | A-2 |
| NB-3686.2 Curved Pipe and Welding Elbows | PPB-3862<br>PPB-3865 | A-2 |
| NB-3686.3 Miter Bends | 【NB-3686.3】<br>JSME doesn't have this provision.<br>However, Miter Bends shall not be used for Class 1 piping. | B-1 |
| NB-3686.4 Welding Tee or Branch | 【NB-3686.4】<br>NB-3686.4 describes the calculation method of flexibility Factor of branch connection that doesn't meet the dimensional limitations of NB-3683.8. JSME doesn't have this provision.<br>However, the branch connection that doesn't meet the requirement of PPB-3813 is normally not used | B-1 |
| NB-3686.5 Branch Connections in Straight Pipe | PPB-3865 | A-2 |
| [NB-3690 DIMENSIONAL REQUIREMENTS FOR PIPING PRODUCTS] | JSME doesn't have this provision.<br>However, in actual design, standard-piping products in accordance with Japanese Standard (JIS) is used. | B-1 |
| [NB-3691 Standard Piping Products] | | |
| [NB-3692 Nonstandard Piping Products] | | |

# Appendix C: KEPIC Versus ASME Section III Detailed Comparison Table

## Appendix C1: KEPIC MNB Versus ASME Section III NB

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-1110 | ASPECTS OF CONSTRUCTION COVERED BY THESE RULES | MNB 1110 | Only numbering system (e.g., NB-1110(a) is same as MNB 1110(1) ) through entire MNB | A1<br>(We will not comment on this difference, hereinafter.) |
| NB-1120 | TEMPERATURE LIMITS | MNB 1120 | ASME : the temperature limit in the applicability column shown in Section II, Part D, Subpart 1, Tables 2A, 2B and 4<br>KEPIC : the temperature limit in the applicability column shown in KEPIC-MDP, Appendices ⅡA, ⅡB, and Ⅳ<br>(KEPIC-MDP is equivalent to ASME Sec. II Part D)<br>ASME : 700°F (370°C), 800°F (425°C)<br>KEPIC : 700°F (371°C), 800°F (427°C)<br>(Difference of numerical value for SI unit in due to soft conversion policy)<br>ASME : Figs. I-9.2 and I-9.3<br>KEPIC : KEPIC-MNZ Figs. I-9.2 and I-9.3<br>(KEPIC-MNZ is equivalent to ASME Sec.III Appendices) | A1<br>(ASME NB's original reference was substitute with equivalent code or standard such as KEPIC, Korean Law, collective standard, etc. If the substitute has a difference in technical or administrative requirement, we will comment for the difference. However, we will comment to '**Reference Substitution (R/S)**' on this difference, hereinafter.) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-1120 (cont.) | | | | (KEPIC was applied soft conversion policy between British Unit and SI unit. Therefore we will comment to '**Soft Conversion (S/C)**' on this difference, hereinafter. However the values for US Customary Unit are the same as ASME Section III Div.1 NB.) |
| NB-1131 | Boundary of Components | MNB 1131 | | A1 |
| NB-1132 | Boundary Between Components and Attachments | MNB 1132 | | A1 |
| NB-1132.1 | Attachments | MNB 1132.1 | | A1 |
| NB-1132.2 | Jurisdictional Boundary | MNB 1132.2 | ASME : Figures NB-1132.2-1 through NB-1132.2-3<br>KEPIC : Figures MNB 1132.2-1 through MNB 1132.2-4 | A1<br>(It seems to editorial error for figure number) |
| FIG. NB-1132.2-1 | ATTACHMENTS IN THE COMPONENT SUPPORT LOAD PATH THAT DO NOT PERFORM A PRESSURE-RETAINING FUNCTION | FIG MNB 1132.2-1 | ASME : NF<br>KEPIC : KEPIC-MNF<br>(KEPIC-MNF is equivalent to ASME Sec.III NF) | A1(R/S) |
| FIG. NB-1132.2-4 | ATTACHMENTS WITHIN THE REACTOR PRESSURE VESSEL (CORE SUPPORT STRUCTURES) THAT DO NOT PERFORM A PRESSURE- | FIG MNB 1132.2-4 | ASME : NG<br>KEPIC : KEPIC-MNG<br>(KEPIC-MNG is equivalent to ASME Sec.III NG) | A1(R/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | RETAINING FUNCTION | | | |
| NB-1140 | ELECTRICAL AND MECHANICAL PENETRATION ASSEMBLIES | MNB 1140 | | A1 |
| NB-2110(1) | SCOPE OF PRINCIPAL TERMS EMPLOYED (1) | MNB 2110(1) | ASME : The term *material* as used in this Subsection is defined in NCA-1220. The term *Material Organization* is defined in NCA-9000<br>KEPIC : The term material as used in this Subsection is defined in KEPIC-MNA 1220. The term Material Organization is defined in MNA 1340 | A1(R/S)<br>Although KEPIC-MNA is developed equivalently with NCA, there are some different cases from ASME NCA, such as contents. Detailed comparison between ASME NCA and KEPIC-MNA is submitted in 'Comparison Table between ASME Section III NCA (2007) and KEPIC MNA (2008)' in last year. |
| NB-2110(2) | SCOPE OF PRINCIPAL TERMS EMPLOYED (2) | MNB 2110(2) | | A1 |
| NB-2110(3) | SCOPE OF PRINCIPAL TERMS EMPLOYED (3) | MNB 2110(3) | | A1(S/C) |
| NB-2121 | Permitted Material Specifications | MNB 2121 | ASME : an SFA specification in Section II, Part C, except as otherwise permitted in Section IX<br>KEPIC : a KEPIC-MDW specification in KEPIC-MQ, except as otherwise permitted in KEPIC-MDW<br>(KEPIC-MDW is equivalent to ASME Sec. II, Part C and KEPIC-MQ is equivalent to ASME Sec.IX) | A1(R/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-2122 | Special Requirements Conflicting With Permitted Material Specifications | MNB 2122 | ASME : the material specification requirements (NCA-3856)<br>KEPIC : the material specification requirements (KEPIC-MNA 4350) | A1(R/S) |
| NB-2124 | Size Ranges | MNB 2124 | ASME : the composition and mechanical properties shown for the nearest specified range (NCA-3856)<br>KEPIC : the composition and mechanical properties shown for the nearest specified range (KEPIC-MNA 4350) | A1(R/S) |
| NB-2125 | Fabricated Hubbed Flanges | MNB 2125 | ASME : Appendix XI-3130<br>KEPIC : KEPIC-MNZ, Appendix XI 3130 | A1(R/S)<br>KEPIC MNZ is the subsection for Appendices of KEPIC-MN. |
| NB-2126.1 | Integrally Finned Tubes | MNB 2126.1 | ASME : Section II, Part D, Subpart 1, Tables 2A and 2B, and Subpart 2, Tables Y-1, Y-2 and U,<br>KEPIC : KEPIC-MDP, Appendices ⅡA and ⅡB, Ⅴ, Ⅵ, and Ⅶ | A1(R/S) |
| NB-2126.2 | Welded Finned Tubes | MNB 2126.2 | | A1(R/S) |
| NB-2127 | Seal Membrane Material | MNB 2127 | | A1(R/S) |
| NB-2128 | Bolting Material | MNB 2128 | ASME : Section II, Part D, Subpart 1, Table 4. Material for nuts shall conform to SA-194 or to the requirements of one of the specifications for nuts or bolting listed in Section II, Part D, Subpart 1, Table 4<br>KEPIC : KEPIC-MDP, Appendices IV. Material for nuts shall conform to MDF A194 or to the | A1(R/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | | | requirements of one of the specifications for nuts or bolting listed in KEPIC-MDP, Appendices IV | |
| NB-2130 | CERTIFICATION OF MATERIAL | MNB 2130 | ASME : All material used in construction of components shall be certified as required in NCA-3861 and NCA-3862. Certified Material Test Reports are required for pressure-retaining material except as provided by NCA-3861.<br>KEPIC : All material used in construction of components shall be certified as required in KEPIC-MNA 4390, MNA 6410, MNA 6420 and MNA 6430. Certified Material Test Reports are required for pressure-retaining material except as provided by MNA 4390. | A1(R/S) |
| NB-2140 | WELDING MATERIAL | MNB 2140 | | A1 |
| NB-2150 | MATERIAL IDENTIFICATION | MNB 2150 | ASME : the requirements of NCA-3856<br>KEPIC : the requirements of KEPIC-MNA 4350 | A1(R/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-2160 | DETERIORATION OF MATERIAL IN SERVICE | MNB 2160 | ASME : It is the responsibility of the Owner to select material suitable for the conditions stated in the Design Specifications (NCA-3250),<br>KEPIC : It is the responsibility of the Owner to select material suitable for the conditions stated in the Design Specifications (KEPIC-MNA 3240 and MNA 6110),<br><br>ASME : Any special requirement shall be specified in the Design Specifications (NCA-3252 and NB-3124).<br>KEPIC : Any special requirement shall be specified in the Design Specifications (KEPIC-MNA 6111 and MNB 3124). | A1(R/S)<br>The Contents of NCA-3250 is separated with KEPIC-MNA 3240 and 6110, and the requirements for Div.2 of NCA are separated to KEPIC-SNA which is the subsection of general requirements for Concrete Containment.<br><br>A1(R/S) |
| NB-2170 | Seal Membrane Material | MNB 2170 | | A1(S/C) |
| NB-2180 | PROCEDURES FOR HEAT TREATMENT OF MATERIAL | MNB 2180 | | A1 |
| NB-2190 | NONPRESSURE-RETAINING MATERIAL | MNB 2190 | ASME : SA-6<br>KEPIC : MDF A 6 | A1(R/S) |
| NB-2211 | Test Coupon Heat Treatment for Ferritic Material | MNB 2211 | | A1(S/C) |
| NB-2212.1 | Cooling Rates | MNB 2212.1 | | A1 |
| NB-2212.2 | General Procedures | MNB 2212.2 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-2221 | General Requirements | MNB 2221 | | A1 |
| NB-2222.1 | Number of Tension Test Coupons | MNB 2222.1 | ASME : SA-20, except that from carbon steel plates weighing 42,000 lb (19,000 kg) and over and alloy steel plates weighing 40,000 lb (18,000 kg)<br>KEPIC : MDF A 20, except that from carbon steel plates weighing 42,000 lb (19,051 kg) and over and alloy steel plates weighing 40,000 lb (18,144 kg) | A1(R/S, S/C) |
| NB-2222.2 | Orientation and Location of Coupons | MNB 2222.2 | | A1 |
| NB-2222.3 | Requirements for Separate Test Coupons | MNB 2222.3 | | A1 |
| NB-2223.1 | Location of Coupons | MNB 2223.1 | | A1 |
| NB-2223.2 | Very Thick and Complex Forgings | MNB 2223.2 | | A1 |
| NB-2223.3 | Coupons From Separately Produced Test Forgings | MNB 2223.3 | | A1 |
| NB-2223.4 | Test Specimens for Forgings | MNB 2223.4 | | A1 |
| NB-2224 | Bar and Bolting Material | MNB 2224 | | A1 |
| NB-2225.1 | Location of Coupons | MNB 2225.1 | | A1 |
| NB-2225.2 | Separately Produced Coupons Representing Fittings | MNB 2225.2 | | A1 |
| NB-2226 | Tensile Test Specimen Location (for Quenched and Tempered Ferritic Steel Castings) | MNB 2226 | | A1(S/C) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-2311 | Material for Which Impact Testing Is Required | MNB 2311 | | A1(S/C) |
| NB-2321.1 | Drop Weight Tests | MNB 2321.1 | | A1 |
| NB-2321.2 | Charpy V-Notch Tests | MNB 2321.2 | ASME : SA-370<br>KEPIC : KEPIC-MDF A 370 | A1(R/S) |
| NB-2322.1 | Location of Test Specimens | MNB 2322.1 | | A1 |
| NB-2322.2 | Orientation of Impact Test Specimens | MNB 2322.2 | | A1 |
| NB-2331 | Material for Vessels | MNB 2331 | ASME : Section XI<br>KEPIC : KEPIC-MI<br>(KEPIC-MI is equivalent to ASME section XI in the case of this requirement. For reference, KEPIC-MI selectively adopted the requirements for PWR and the Examination Category B of ASME Sec. XI. Furthermore, IWP and IWW of ASME Sec. XI Div.1 are excluded from KEPIC-MI.) | A1(R/S) |
| NB-2332 | Material for Piping, Pumps, and Valves, Excluding Bolting Material | MNB 2332 | | A1 |
| NB-2333 | Bolting Material | MNB 2333 | | A1 |
| NB-2341 | Plates | MNB 2341 | | A1 |
| NB-2342 | Forgings and Castings | MNB 2342 | | A1(S/C) |
| NB-2343 | Bars | MNB 2343 | | A1(S/C) |
| NB-2344 | Tubular Products and Fittings | MNB 2344 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-2345 | Bolting Material | MNB 2345 | | A1(S/C) |
| NB-2346 | Test Definitions | MNB 2346 | | A1 |
| NB-2350 | RETESTS | MNB 2350 | | A1(S/C) |
| NB-2360(1) | CALIBRATION OF INSTRUMENTS AND EQUIPMENT (1) | MNB 2360(1) | ASME : the requirements of NCA-3858.2<br>KEPIC : the requirements of KEPIC-MNA 4370 | A1(R/S) |
| NB-2360(2) | CALIBRATION OF INSTRUMENTS AND EQUIPMENT (2) | MNB 2360(2) | ASME : Cv impact test machines shall be calibrated and the results recorded to meet the requirements of NCA-3858.2. The calibrations shall be performed using the frequency and methods outlined in ASTM E 23-02a and employing standard specimens obtained from the National Institute of Standards and Technology.<br>KEPIC : Cv impact test machines shall be calibrated and the results recorded to meet the requirements of KEPIC-MNA 4370. The calibrations shall be performed using the frequency and methods outlined in KASTO 93-21102-094 and employing standard specimens obtained from the Korea Research Institute of Standards and Science (KRISS). | B2<br>KASTO 93-21102-094 (Charpy Impact Tester for Metals) is equivalent to ASTM E23-93.<br>KASTO means Korea Association of Standards & Testing Organization based on the Korean Law.<br>KRISS uses standard specimens purchased from NIST.<br>For reference, the calibration procedure of KRISS is developed under ISO quality assurance system and is based on the ASTM E23 but, the requirements are defined more tightly than requirements of ASTM E23. |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-2410 | GENERAL REQUIREMENTS | MNB 2410 | ASME : Section IX, SFA specification<br>KEPIC : KEPIC-MQ, KEPIC-MDW | A1(R/S) |
| NB-2420 | REQUIRED TESTS | MNB 2420 | ASME : Section IX, QW-492, SFA or user's material specification<br>KEPIC : KEPIC-MQW 1720, KEPIC-MDW or user's material specification | A1(R/S, S/C) |
| NB-2431 | Mechanical Properties Test | MNB 2431 | | A1 |
| NB-2431.1 | General Test Requirements | MNB 2431.1 | ASME : Section IX, QW-403.1 or QW-403.4, SFA-5.1<br>KEPIC : KEPIC-MQW 2822.1 or MQW 2822.4, KEPIC-MDW 5.1 | A1(R/S) |
| NB-2431.2 | Standard Test Requirements | MNB 2431.2 | ASME : SFA-5.1 or SFA-5.5, SFA Specification<br>KEPIC : KEPIC-MDW 5.1 or MDW 5.5, KEPIC-MDW | A1(R/S) |
| NB-2432 | Chemical Analysis Test | MNB 2432 | | A1 |
| NB-2432.1 | Test Method | MNB 2432.1 | ASME : SFA Specification, Section IX, QW-214.1, QW-453 and QW-462.5(a)<br>KEPIC : KEPIC-MDW, KEPIC-MQW 2740(1), Table MQW 2740 and FIG. MQW 2740-1 | A1(R/S) |
| NB-2432.2 | Requirements for Chemical Analysis | MNB 2432.2 | ASME : Section IX, QW-442, SFA or other referenced welding material specifications<br>KEPIC : KEPIC-MQW 2330, KEPIC-MDW or other referenced welding material specifications<br>ASME : The results of the chemical analysis shall be reported in accordance with NCA-3867 | A1(R/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | | | KEPIC : The results of the chemical analysis shall be reported in accordance with KEPIC-MNA 4370 | |
| NB-2433 | Delta Ferrite Determination | MNB 2433 | ASME : Section IX, QW-442, SFA-5.9 and SFA-5.4, KEPIC : KEPIC-MQW 2330, KEPIC-MDW 5.9 and MDW-5.4 | A1(R/S) |
| NB-2433.1 | Method | MNB 2433.1 | | A1 |
| NB-2433.2 | Acceptance Standards | MNB 2433.2 | | A1 |
| NB-2440 | STORAGE AND HANDLING OF WELDING MATERIAL | MNB 2440 | | A1 |
| NB-2510 | EXAMINATION OF PRESSURERETAINING MATERIAL | MNB 2510 | | A1 |
| NB-2520 | EXAMINATION AFTER QUENCHING AND TEMPERING | MNB 2520 | | A1 |
| NB-2531 | Required Examination | MNB 2531 | | A1(S/C) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-2532.1 | Straight Beam Examination | MNB 2532.1 | ASME : Section V, SA-578, 3 in. (75 mm)<br>KEPIC : KEPIC-MEN, KEPIC-MEN 3204, 3 in. (76.2 mm)<br>KEPIC-MEN is technically equivalent to ASME Section V but, its composition of contents is different from the general requirement & the specific standards of section V. KEPIC-MEN, unlike ASME, is composited as the categorization based on the NDE method. Moreover, some articles of ASME Section V are not adopted in KEPIC. However, KEPIC-MEN 2010 ed. will be published as the same structure with ASME Section V.<br>(See the '**KEPIC-MEN vs ASME Sec V.doc**' file, for detailed comparison of KEPIC-MEN with ASME Section V. In general requirements, KEPIC-MEN demands the national license based on the Korean law in addition to the requirement of ASME Section V for NDE personnel.) | A1(S/C, R/S) |
| NB-2532.2 | Angle Beam Examination | MNB 2532.2 | ASME : Section V SA-577<br>KEPIC : KEPIC-MEN 3203 | A1(R/S) |
| NB-2537 | Time of Examination | MNB 2537 | | A1(S/C) |
| NB-2538 | Elimination of Surface Defects | MNB 2538 | | A1 |
| NB-2539 | Repair by Welding | MNB 2539 | | A1 |
| NB-2539.1 | Defect Removal | MNB 2539.1 | | A1 |
| NB-2539.2 | Qualification of Welding Procedures and Welders | MNB 2539.2 | ASME : Section IX<br>KEPIC : KEPIC-MQW | A1(R/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-2539.3 | Blending of Repaired Areas | MNB 2539.3 | | A1 |
| NB-2539.4 | Examination of Repair Welds | MNB 2539.4 | | A1 |
| NB-2539.5 | Heat Treatment After Repairs | MNB 2539.5 | | A1 |
| NB-2539.6 | Material Report Describing Defects and Repairs | MNB 2539.6 | | A1 |
| NB-2539.7 | Repair of Cladding by Welding | MNB 2539.7 | | A1(R/S) |
| NB-2541 | Required Examinations | MNB 2541 | ASME : Section V, Article 2<br>KEPIC : KEPIC-MEN 2101 | A1(R/S) |
| NB-2542.1 | Examination Procedure | MNB 2542.1 | ASME : Article 5 of Section V<br>KEPIC : KEPIC-MEN 3101 | A1(R/S) |
| NB-2542.2 | Acceptance Standards | MNB 2542.2 | | A1(S/C) |
| NB-2545.1 | Examination Procedure | MNB 2545.1 | ASME : Article 7, Section V<br>KEPIC : KEPIC-MEN 5101 | A1(R/S) |
| NB-2545.2 | Evaluation of Indications | MNB 2545.2 | | A1 |
| NB-2545.3 | Acceptance Standards | MNB 2545.3 | | A1(S/C) |
| NB-2546.1 | Examination Procedure | MNB 2546.1 | ASME : Section V, Article 6<br>KEPIC : KEPIC-MEN 4101 | A1(R/S) |
| NB-2546.2 | Evaluation of Indications | MNB 2546.2 | | A1 |
| NB-2546.3 | Acceptance Standards | MNB 2546.3 | | A1(S/C) |
| NB-2547 | Time of Examination | MNB 2547 | | A1(S/C) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-2548 | Elimination of Surface Defects | MNB 2548 | | A1 |
| NB-2549 | Repair by Welding | MNB 2549 | | A1 |
| NB-2551 | Required Examination | MNB 2551 | | A1(S/C) |
| NB-2552 | Ultrasonic Examination | MNB 2552 | ASME : SE-213, SA-388<br>KEPIC : KEPIC-MEN 3208, KEPIC-MEN 3201 | A1(R/S, S/C) |
| NB-2553 | Radiographic Examination | MNB 2553 | ASME : Article 2 of Section V<br>KEPIC : KEPIC-MEN 2101 | A1(R/S) |
| NB-2554 | Eddy Current Examination | MNB 2554 | ASME : SE-426 or SE-571<br>KEPIC : KEPIC-MEN 6202 or ASME Sec.V SE-571 | A1 (R/S, S/C)<br>KEPIC-MEN was not developed for Sec.V SE-571 |
| NB-2555 | Magnetic Particle Examination | MNB 2555 | | A1 |
| NB-2556 | Liquid Penetrant Examination | MNB 2556 | | A1 |
| NB-2557 | Time of Examination | MNB 2557 | | A1(R/S, S/C) |
| NB-2558 | Elimination of Surface Defects | MNB 2558 | | A1 |
| NB-2559 | Repair by Welding | MNB 2559 | | A1 |
| NB-2561 | Required Examinations | MNB 2561 | ASME : SA-358, SA-409, SA-671, SA-672, and SA-691, and fittings made in accordance with the WPW grades of SA-234, SA-403, and SA- 420, which are made by welding with filler metal, shall be treated as material; however, inspection by an Inspector and stamping with an NPT symbol shall | A1 for R/S<br>A2 for code symbol (KEPIC has different code symbol system with ASME symbol. See the previous documents submitted in |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | | | be in accordance with Section III requirements. In addition to the NPT symbol, a numeral 1 shall be stamped below and outside the official Code Symbol.<br>KEPIC : KEPIC-MDF A 358, A 671, A 672, and A 691, and fittings made in accordance with the WPW grades of KEPIC-MDF A 234, A 403, and A 420, which are made by welding with filler metal, shall be treated as material; however, inspection by an Inspector and stamping with an KEPIC Symbol shall be in accordance with KEPIC-MN requirements. | 2009) |
| NB-2562 | Ultrasonic Examination | MNB 2562 | | A1 |
| NB-2563 | Radiographic Examination | MNB 2563 | | A1 |
| NB-2565 | Magnetic Particle Examination | MNB 2565 | | A1 |
| NB-2566 | Liquid Penetrant Examination | MNB 2566 | | A1 |
| NB-2567 | Time of Examination | MNB 2567 | | A1(R/S) |
| NB-2568 | Elimination of Surface Defects | MNB 2568 | | A1 |
| NB-2569 | Repair by Welding | MNB 2569 | | A1 |
| NB-2570 | EXAMINATION AND REPAIR OF STATICALLY AND CENTRIFUGALLY CAST PRODUCTS | MNB 2570 | | A1 |
| NB-2571 | Required Examination | MNB 2571 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-2572.1 | Acceptance Examinations | MNB 2572.1 | | A1(S/C, R/S) |
| NB-2573 | Provisions for Repair of Base Material by Welding | MNB 2573 | | A1 |
| NB-2573.1 | Defect Removal | MNB 2573.1 | | A1 |
| NB-2573.2 | Repair by Welding | MNB 2573.2 | | A1 |
| NB-2573.3 | Qualification of Welding Procedures and Welders | MNB 2573.3 | | A1(R/S) |
| NB-2573.4 | Blending of Repaired Areas | MNB 2573.4 | | A1 |
| NB-2573.5 | Examination of Repair Welds | MNB 2573.5 | | A1 |
| NB-2573.6 | Heat Treatment After Repairs | MNB 2573.6 | | A1 |
| NB-2573.7 | Elimination of Surface Defects | MNB 2573.7 | | A1 |
| NB-2573.8 | Material Report Describing Defects and Repairs | MNB 2573.8 | | A1 |
| NB-2574 | Ultrasonic Examination of Ferritic Steel Castings | MNB 2574 | ASME : T-571.4 of Article 5 of Section V<br>KEPIC : 7.1.4 of KEPIC-MEN 3102 | A1(R/S) |
| NB-2574.1 | Acceptance Standards | MNB 2574.1 | ASME : SA-609 in Section V<br>KEPIC : KEPIC-MEN 3205 | A1(R/S, S/C) |
| NB-2575.1 | Examination | MNB 2575.1 | | A1 |
| NB-2575.2 | Extent | MNB 2575.2 | | A1 |
| NB-2575.3 | Examination Procedure | MNB 2575.3 | ASME : Article 2 of Section V, T-274 and T-285 of | A1(R/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | | | Article 2 of Section V, SE-142, SE-94<br>KEPIC : KEPIC-MEN 2101, KEPIC-MEN 2101, 7.4 and 8.5, KEPIC-MEN 2202, KEPIC-MEN 2201 | |
| NB-2575.4 | Procedure Requirements | MNB 2575.4 | | A1 |
| NB-2575.5 | Radiographic Setup Information | MNB 2575.5 | | |
| NB-2575.6 | Acceptance Criteria | MNB 2575.6 | | A1(S/C) |
| NB-2576 | Liquid Penetrant Examination | MNB 2576 | | A1(R/S, S/C) |
| NB-2577 | Magnetic Particle Examination (for Ferritic Steel Products Only) | MNB 2577 | | A1(R/S, S/C) |
| NB-2581 | Required Examination | MNB 2581 | | A1(S/C) |
| NB-2582 | Visual Examination | MNB 2582 | | A1 |
| NB-2583.1 | Examination Procedure | MNB 2583.1 | | A1 |
| NB-2583.2 | Evaluation of Indications | MNB 2583.2 | | A1(S/C) |
| NB-2583.3 | Acceptance Standard | MNB 2583.3 | | A1 |
| NB-2584.1 | Examination Procedure | MNB 2584.1 | ASME : Article 6, Section V<br>KEPIC : KEPIC-MEN 4101 | A1(R/S) |
| NB-2584.2 | Evaluation of Indications | MNB 2584.2 | | A1(S/C) |
| NB-2584.3 | Acceptance Standard | MNB 2584.3 | | A1 |
| NB-2585 | Ultrasonic Examination for Sizes Greater Than 2 in. (50 mm) | MNB 2585 | | A1(S/C) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-2585.1 | Ultrasonic Method | MNB 2585.1 | ASME : SA-388 of Article 23 of Section V<br>KEPIC : KEPIC-MEN 3201 | A1(R/S) |
| NB-2585.2 | Examination Procedure | MNB 2585.2 | | A1(S/C) |
| NB-2585.3 | Calibration of Equipment | MNB 2585.3 | | A1 |
| NB-2585.4 | Acceptance Standard | MNB 2585.4 | | A1 |
| NB-2586 | Ultrasonic Examination for Sizes Over 4 in. (100 mm) | MNB 2586 | | A1(S/C) |
| NB-2586.1 | Ultrasonic Method | MNB 2586.1 | | A1 |
| NB-2586.2 | Examination Procedure | MNB 2586.2 | | A1 |
| NB-2586.3 | Calibration of Equipment | MNB 2586.3 | | A1(S/C) |
| NB-2586.4 | Acceptance Standard | MNB 2586.4 | | A1 |
| NB-2587 | Time of Examination | MNB 2587 | | A1 |
| NB-2588 | Elimination of Surface Defects | MNB 2588 | | A1 |
| NB-2589 | Repair by Welding | MNB 2589 | | A1 |
| NB-2610 | DOCUMENTATION AND MAINTENANCE OF QUALITY SYSTEM PROGRAMS | MNB 2610 | ASME : Material Organizations shall have a Quality System Program or an Identification and Verification Program, as applicable, which meets the requirements of NCA-3800<br>KEPIC : Material Organizations shall have a Quality System Program or an Identification and Verification Program, as applicable, which meets | B1 for the Remarks<br><br>A1 for S/C |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | | | the requirements of KEPIC-MNA 3500 and MNA 4300<br>ASME : requirements of NCA-3862 and NCA-3856<br>KEPIC : requirements of KEPIC-MNA 6420 and MNA 4350 | |
| NB-2610 (cont.) | | | **Remarks :**<br>For NCA-3841, the requirements are identical except for the substitution of the Society to KEA. For NCA-3855, Instead of alternative requirement for testing and calibration laboratory in NCA-3855.3(c), KEPIC uses the organization accredited by Korea Laboratory Accreditation Scheme (KOLAS) in accordance with ISO/IEC 17025, which is not required to survey or audit. This requirement is described in MNA 3732(3). The others are identical. | |
| NB-2700 | DIMENSIONAL STANDARDS | MNB 2700 | | A1 |
| NB-3111 | Loading Conditions | MNB 3111 | | A1 |
| NB-3112 | Design Loadings | MNB 3112 | ASME : The Design Loadings shall be established in accordance with NCA-2142.1 ~<br>KEPIC : The Design Loadings shall be established in accordance with KEPIC-MNA 2321.1 ~ | A1(R/S) |
| NB-3112.1 | Design Pressure | MNB 3112.1 | ASME : NCA-2142.1 (a)<br>KEPIC : KEPIC-MNA 2321.1 (1) | A1(R/S) |
| NB-3112.2 | Design Temperature | MNB 3112.2 | ASME : NCA-2142.1 (b) | A1(R/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
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| | | | KEPIC : KEPIC-MNA 2321.1 (2) | |
| NB-3112.3 | Design Mechanical Loads | MNB 3112.3 | ASME : NCA-2142.1 (c)<br>KEPIC : KEPIC-MNA 2321.1 (3) | A1(R/S) |
| NB-3112.4 | Design Stress Intensity Values | MNB 3112.4 | | A1(R/S) |
| NB-3113 | Service Conditions | MNB 3113 | ASME : NCA-2142, NCA-2142.4(b), Figs. I-9.0<br>KEPIC : KEPIC-MNA 2320, KEPIC-MNA 2322.2, KEPIC-MNZ Figs. I-9.0 | A1(R/S) |
| NB-3121 | Corrosion | MNB 3121 | | A1(R/S) |
| NB-3122 | Cladding | MNB 3122 | | A1(R/S) |
| NB-3122.1 | Primary Stresses | MNB 3122.1 | | A1 |
| NB-3122.2 | Design Dimensions | MNB 3122.2 | | A1 |
| NB-3122.3 | Secondary and Peak Stresses | MNB 3122.3 | | A1 |
| NB-3122.4 | Bearing Stresses | MNB 3122.4 | | A1 |
| NB-3123.1 | Dissimilar Welds | MNB 3123.1 | | A1 |
| NB-3123.2 | Fillet Welded Attachments | MNB 3123.2 | | A1 |
| NB-3124 | Environmental Effects | MNB 3124 | | A1 |
| NB-3125 | Configuration | MNB 3125 | | A1(R/S) |
| NB-3131 | Scope | MNB 3131 | | A1 |
| NB-3132 | Dimensional Standards for Standard | MNB 3132 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | Products | | | |
| NB-3133.1 | General | MNB 3133.1 | | A1(R/S) |
| Table NB-3132-1 | DIMENSIONAL STANDARDS | Table MNB 3132 | ASME : ASME B16.34a-1998, SA or SB Material<br>KEPIC : KEPIC-MGG(2001), MDF or MDN Material<br>(KEPIC-MGG 2001 addendum is equivalent to ASME B16.34a-1998. KEPIC-MGG is technically identical but, its composition is modified. However KEPIC-MGG 2010 edition will be published identically to have the same composition with ASME B16.34.) | A1(R/S) |
| NB-3133.2 | Nomenclature | MNB 3133.2 | ASME : Section II, Part D, Subpart 1, Tables 2A and 2B, Table Y-1<br>KEPIC : KEPIC-MDP, Appendices ⅡA and ⅡB, Appendices Ⅵ<br>(For reference, KEPIC-MDP adopted ASME Section II, Part D except Subpart 2.) | A1(R/S) |
| NB-3133.3 | Cylindrical Shells and Tubular Products | MNB 3133.3 | | A1(R/S) |
| NB-3133.4 | Spherical Shells | MNB 3133.4 | | A1(R/S) |
| NB-3133.5 | Stiffening Rings for Cylindrical Shells | MNB 3133.5 | | A1(R/S) |
| NB-3133.6 | Cylinders Under Axial Compression | MNB 3133.6 | | A1(R/S) |
| NB-3134 | Leak Tightness | MNB 3134 | | A1 |
| NB-3135 | Attachments | MNB 3135 | | A1(R/S) |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
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| NB-3136 | Appurtenances | MNB 3136 | | A1(R/S) |
| NB-3137 | Reinforcement for Openings | MNB 3137 | | A1 |
| NB-3211 | Requirements for Acceptability | MNB 3211 | | A1(R/S) |
| NB-3212 | Basis for Determining Stresses | MNB 3212 | | A1 |
| NB-3213 | Terms Relating to Stress Analysis | MNB 3213 | | A1 |
| NB-3213.1 | Stress Intensity | MNB 3213.1 | | A1 |
| NB-3213.2 | Gross Structural Discontinuity | MNB 3213.2 | | A1 |
| NB-3213.3 | Local Structural Discontinuity | MNB 3213.3 | | A1 |
| NB-3213.4 | Normal Stress | MNB 3213.4 | | A1 |
| NB-3213.5 | Shear Stress | MNB 3213.5 | | A1 |
| NB-3213.6 | Membrane Stress | MNB 3213.6 | | A1 |
| NB-3213.7 | Bending Stress | MNB 3213.7 | | A1 |
| NB-3213.8 | Primary Stress | MNB 3213.8 | | A1 |
| NB-3213.9 | Secondary Stress | MNB 3213.9 | | A1 |
| NB-3213.10 | Local Primary Membrane Stress | MNB 3213.10 | | A1 |
| NB-3213.11 | Peak Stress | MNB 3213.11 | | A1 |
| NB-3213.12 | Load Controlled Stresses | MNB 3213.12 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3213.13 | Thermal Stress | MNB 3213.13 | | A1 |
| NB-3213.14 | Total Stress | MNB 3213.14 | | A1 |
| NB-3213.15 | Operational Cycle | MNB 3213.15 | | A1 |
| NB-3213.16 | Stress Cycle | MNB 3213.16 | | A1 |
| NB-3213.17 | Fatigue Strength Reduction Factor | MNB 3213.17 | | A1 |
| NB-3213.18 | Free End Displacement | MNB 3213.18 | | A1 |
| NB-3213.19 | Expansion Stresses | MNB 3213.19 | | A1 |
| NB-3213.20 | Deformation | MNB 3213.20 | | A1 |
| NB-3213.21 | Inelasticity | MNB 3213.21 | | A1 |
| NB-3213.22 | Creep | MNB 3213.22 | | A1 |
| NB-3213.23 | Plasticity | MNB 3213.23 | | A1 |
| NB-3213.24 | Plastic Analysis | MNB 3213.24 | | A1 |
| NB-3213.25 | Plastic Analysis — Collapse Load | MNB 3213.25 | | A1 |
| NB-3213.26 | Plastic Instability Load | MNB 3213.26 | | A1 |
| NB-3213.27 | Limit Analysis | MNB 3213.27 | | A1 |
| NB-3213.28 | Limit Analysis — Collapse Load | MNB 3213.28 | | A1 |
| NB-3213.29 | Collapse Load — Lower Bound | MNB 3213.29 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3213.30 | Plastic Hinge | MNB 3213.30 | | A1 |
| NB-3213.31 | Strain Limiting Load | MNB 3213.31 | | A1 |
| NB-3213.32 | Test Collapse Load | MNB 3213.32 | | A1 |
| NB-3213.33 | Ratcheting | MNB 3213.33 | | A1 |
| NB-3213.34 | Shakedown | MNB 3213.34 | | A1 |
| NB-3213.35 | Reversing Dynamic Loads | MNB 3213.35 | | A1 |
| NB-3213.36 | Non-reversing Dynamic Loads | MNB 3213.36 | | A1 |
| NB-3214 | Stress Analysis | MNB 3214 | | A1 |
| NB-3215 | Derivation of Stress Intensities | MNB 3215 | | A1 |
| NB-3216 | Derivation of Stress Differences | MNB 3216 | | A1 |
| NB-3216.1 | Constant Principal Stress Direction | MNB 3216.1 | | A1 |
| NB-3216.2 | Varying Principal Stress Direction | MNB 3216.2 | | A1 |
| NB-3217 | Classification of Stresses | MNB 3217 | | A1 |
| NB-3221 | Design Loadings | MNB 3221 | | A1 |
| NB-3221.1 | General Primary Membrane Stress Intensity | MNB 3221.1 | | A1 |
| NB-3221.2 | Local Membrane Stress Intensity | MNB 3221.2 | | A1 |
| NB-3221.3 | Primary Membrane (General or Local) | MNB 3221.3 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | Plus Primary Bending Stress Intensity | | | |
| NB-3221.4 | External Pressure | MNB 3221.4 | | A1 |
| NB-3222 | Level A Service Limits | MNB 3222 | ASME : NCA-2142.4(b)(1)<br>KEPIC : KEPIC-NNA 2322.2(1)<br>KEPIC-MNA 2300 is identical to ASME NCA-2140, except for addition of the requirements for Division 3 items, and separation of the requirements for Concrete Containments to KEPIC-SNA. | A1(R/S) |
| NB-3222.1 | Primary Membrane and Bending Stress Intensities | MNB 3222.1 | | A1 |
| NB-3222.2 | Primary Plus Secondary Stress Intensity | MNB 3222.2 | | A1 |
| NB-3222.3 | Expansion Stress Intensity | MNB 3222.3 | | A1 |
| NB-3222.4 | Analysis for Cyclic Operation | MNB 3222.4 | | A1(R/S) |
| NB-3222.5 | Thermal Stress Ratchet | MNB 3222.5 | | A1 |
| NB-3222.6 | Deformation Limits | MNB 3222.6 | | A1 |
| NB-3223 | Level B Service Limits | MNB 3223 | | A1 |
| NB-3224 | Level C Service Limits | MNB 3224 | | A1 |
| NB-3224.1 | Primary Stress Limits | MNB 3224.1 | | A1 |
| NB-3224.2 | External Pressure | MNB 3224.2 | | A1 |
| NB-3224.3 | Special Stress Limits | MNB 3224.3 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
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| NB-3224.4 | Secondary and Peak Stresses | MNB 3224.4 | | A1 |
| NB-3224.5 | Fatigue Requirements | MNB 3224.5 | | A1 |
| NB-3224.6 | Deformation Limits | MNB 3224.6 | | A1 |
| NB-3224.7 | Piping Requirements | MNB 3224.7 | | A1 |
| NB-3225 | Level D Service Limits | MNB 3225 | ASME: NCA-2142(b)(4)<br>KEPIC : KEPIC-MNA 2322.2(4) | A1(R/S) |
| NB-3226 | Testing Limits | MNB 3226 | | A1(R/S) |
| NB-3227 | Special Stress Limits | MNB 3227 | | A1 |
| NB-3227.1 | Bearing Loads | MNB 3227.1 | | A1 |
| NB-3227.2 | Pure Shear | MNB 3227.2 | | A1 |
| NB-3227.3 | Progressive Distortion of Non-integral Connections | MNB 3227.3 | | A1(R/S) |
| NB-3227.4 | Triaxial Stresses | MNB 3227.4 | | A1 |
| NB-3227.5 | Nozzle Piping Transition | MNB 3227.5 | | A1 |
| NB-3227.6 | Applications of Elastic Analysis for Stresses Beyond the Yield Strength | MNB 3227.6 | | A1 |
| NB-3227.7 | Requirements for Specially Designed Welded Seals | MNB 3227.7 | | A1 |
| NB-3228 | Applications of Plastic Analysis | MNB 3228 | | A1 |

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| NB-3228.1 | Limit Analysis | MNB 3228.1 | | A1(R/S) |
| NB-3228.2 | Experimental Analysis. | MNB 3228.2 | | A1 |
| NB-3228.3 | Plastic Analysis | MNB 3228.3 | | A1 |
| NB-3228.4 | Shakedown Analysis | MNB 3228.4 | | A1(R/S) |
| NB-3228.5 | Simplified Elastic–Plastic Analysis | MNB 3228.5 | | A1 |
| NB-3229 | Design Stress Values | MNB 3229 | | A1(R/S) |
| NB-3231 | Design Conditions | MNB 3231 | | A1(R/S) |
| NB-3232 | Level A Service Limits | MNB 3232 | | A1(R/S) |
| NB-3232.1 | Average Stress | MNB 3232.1 | | A1(R/S) |
| NB-3232.2 | Maximum Stress | MNB 3232.2 | | A1(R/S) |
| NB-3232.3 | Fatigue Analysis of Bolts | MNB 3232.3 | | A1(R/S, S/C) |
| NB-3233 | Level B Service Limits | MNB 3233 | | A1 |
| NB-3234 | Level C Service Limits | MNB 3234 | | A1 |
| NB-3235 | Level D Service Limits | MNB 3235 | | A1(R/S) |
| NB-3236 | Design Stress Intensity Values | MNB 3236 | | A1(R/S) |
| NB-3311 | Acceptability | MNB 3311 | | A1 |
| NB-3321 | Design and Service Loadings | MNB 3321 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
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| NB-3322 | Special Considerations | MNB 3322 | | A1 |
| NB-3323 | General Design Rules | MNB 3323 | | A1 |
| NB-3324 | Tentative Pressure Thickness | MNB 3324 | | A1(R/S) |
| NB-3324.1 | Cylindrical Shells | MNB 3324.1 | | A1 |
| NB-3324.2 | Spherical Shells | MNB 3324.2 | | A1 |
| NB-3331 | General Requirements for Openings | MNB 3331 | | A1 |
| NB-3332.1 | Openings Not Requiring Reinforcement | MNB 3332.1 | | A1 |
| NB-3332.2 | Required Area of Reinforcement | MNB 3332.2 | | A1 |
| NB-3333 | Reinforcement Required for Openings in Flat Heads | MNB 3333 | | A1 |
| NB-3334 | Limits of Reinforcement | MNB 3334 | | A1 |
| NB-3334.1 | Limit of Reinforcement Along the Vessel Wall | MNB 3334.1 | | A1 |
| NB-3334.2 | Limit of Reinforcement Normal to the Vessel Wall | MNB 3334.2 | | A1 |
| NB-3335 | Metal Available for Reinforcement | MNB 3335 | | A1 |
| NB-3336 | Strength of Reinforcing Material | MNB 3336 | | A1 |
| NB-3337.1 | General Requirements | MNB 3337.1 | | A1 |
| NB-3337.2 | Full Penetration Welded Nozzles | MNB 3337.2 | | A1 |

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| NB-3337.3 | Partial Penetration Welded Nozzles | MNB 3337.3 | | A1(S/C) |
| NB-3338.1 | General | MNB 3338.1 | | A1 |
| NB-3338.2 | Stress Index Method | MNB 3338.2 | | A1 |
| NB-3339 | Alternative Rules for Nozzle Design | MNB 3339 | | A1 |
| NB-3339.1 | Limitations | MNB 3339.1 | | A1 |
| NB-3339.2 | Nomenclature | MNB 3339.2 | | A1 |
| NB-3339.3 | Required Reinforcement Area | MNB 3339.3 | | A1 |
| NB-3339.4 | Limits of Reinforcing Zone | MNB 3339.4 | | A1 |
| NB-3339.5 | Strength of Reinforcing Material Requirements | MNB 3339.5 | | A1 |
| NB-3339.6 | Transition Details | MNB 3339.6 | | A1 |
| NB-3339.7 | Stress Indices | MNB 3339.7 | | A1 |
| NB-3340 | ANALYSIS OF VESSELS | MNB 3340 | | A1 |
| NB-3351 | Welded Joint Category | MNB 3351 | | A1 |
| NB-3351.1 | Category A | MNB 335.1 | | A1 |
| NB-3351.2 | Category B | MNB 3351.2 | | A1 |
| NB-3351.3 | Category C | MNB 3351.3 | | A1 |
| NB-3351.4 | Category D | MNB 3351.4 | | A1 |

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| NB-3352 | Permissible Types of Welded Joints | MNB 3352 | | A1 |
| NB-3352.1 | Joints of Category A | MNB 3352.1 | | A1 |
| NB-3352.2 | Joints of Category B | MNB 3352.2 | | A1 |
| NB-3352.3 | Joints of Category C | MNB 3352.3 | | A1 |
| NB-3352.4 | Joints of Category D | MNB 3352.4 | | A1 |
| NB-3354 | Structural Attachment Welds | MNB 3354 | | A1 |
| NB-3355 | Welding Grooves | MNB 3355 | | A1 |
| NB-3357 | Thermal Treatment | MNB 3357 | | A1 |
| NB-3361 | Category A or B Joints Between Sections of Unequal Thickness | MNB 3361 | | A1 |
| NB-3362 | Bolted Flange Connections | MNB 3362 | | A1 |
| NB-3363 | Access Openings | MNB 3363 | | A1 |
| NB-3364 | Attachments | MNB 3364 | | A1 |
| NB-3365 | Supports | MNB 3365 | ASME : NCA-3240<br>KEPIC : KEPIC-MNA 3230 | A1(R/S) |
| NB-3411.1 | Applicability | MNB 3411.1 | | A1 |
| NB-3411.2 | Exemptions | MNB 3411.2 | | A1(R/S) |
| NB-3412.1 | Acceptability of Large Pumps | MNB 3412.1 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3412.2 | Acceptability of Small Pumps | MNB 3412.2 | | A1 |
| NB-3414 | Design and Service Conditions | MNB 3414 | | A1 |
| NB-3415 | Loads From Connected Piping | MNB 3415 | | A1 |
| NB-3417 | Earthquake Loadings | MNB 3417 | | A1 |
| NB-3418 | Corrosion | MNB 3418 | | A1 |
| NB-3419 | Cladding | MNB 3419 | | A1 |
| NB-3421 | Radially Split Casing | MNB 3421 | | A1 |
| NB-3422 | Axially Split Casing | MNB 3422 | | A1 |
| NB-3423 | Single and Double Volute Casings | MNB 3423 | | A1 |
| NB-3424 | Seal Housing | MNB 3424 | | A1 |
| NB-3425 | Typical Examples of Pump Types | MNB 3425 | | A1 |
| NB-3431 | Design of Welding | MNB 3431 | | A1 |
| NB-3432 | Cutwater Tip Stresses | MNB 3432 | | A1 |
| NB-3433.1 | Axially Oriented Inlets and Outlets | MNB 3433.1 | | A1 |
| NB-3433.2 | Radially Oriented Inlets and Outlets | MNB 3433.2 | | A1 |
| NB-3433.3 | Tangential Inlets and Outlets | MNB 3433.3 | | A1 |
| NB-3433.4 | Minimum Inlet and Outlet Wall Thicknesses | MNB 3433.4 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3434 | Bolting | MNB 3434 | | A1 |
| NB-3435.1 | Piping Under External Pressure | MNB 3435.1 | | A1 |
| NB-3435.2 | Piping Under Internal Pressure | MNB 3435.2 | | A1 |
| NB-3436 | Attachments | MNB 3436 | | A1 |
| NB-3437 | Pump Covers | MNB 3437 | | A1 |
| NB-3438 | Supports | MNB 3438 | | A1(R/S) |
| NB-3441.1 | Design of Type A Pumps | MNB 3441.1 | | A1 |
| NB-3441.2 | Design of Type B Pumps | MNB 3441.2 | | A1 |
| NB-3441.3 | Design of Type C Pumps | MNB 3441.3 | | A1 |
| NB-3441.4 | Design of Type D Pumps | MNB 3441.4 | | A1 |
| NB-3441.5 | Design of Type E Pumps | MNB 3441.5 | | A1 |
| NB-3441.6 | Design of Type F Pumps | MNB 3441.6 | | A1 |
| NB-3442 | Special Pump Types — Type J Pumps | MNB 3442 | | A1 |
| NB-3511 | General Requirements | MNB 3511 | ASME : NCA-3254<br>KEPIC : KEPIC-MNA 6112<br>(KEPIC MNA 6112 is identical to ASME NCA-3254 except the requirements for Division 2 are separated to KEPIC-SNA.) | A1(R/S) |
| NB-3512 | Acceptability of Large Valves | MNB 3512 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3512.1 | Standard Design Rules | MNB 3512.1 | | A1 |
| NB-3512.2 | Alternative Design Rules | MNB 3512.2 | ASME : NCA-3252(a)(6)<br>KEPIC : KEPIC-MNA 6111.(6)<br>KEPIC-MNA 6111 is identical to ASME NCA-3252(a) except additional fracture mechanics data is not contained in the contents. | A1(R/S) |
| NB-3513 | Acceptability of Small Valves | MNB 3513 | | A1 |
| NB-3513.1 | Standard Design Rules | MNB 3513.1 | ASME : ANSI B16.34<br>KEPIC : KEPIC-MGG | A1(R/S) |
| NB-3513.2 | Alternative Design Rules | MNB 3513.2 | | A1 |
| NB-3515 | Acceptability of Metal Bellows and Metal Diaphragm Stem Sealed Valves | MNB 3515 | | A1 |
| NB-3521 | Design and Service Loadings | MNB 3521 | | A1 |
| NB-3524 | Earthquake | MNB 3524 | | A1 |
| NB-3525 | Levels A and B Service Limits | MNB 3525 | | A1(R/S) |
| NB-3526 | Level C Service Limits | MNB 3526 | | A1 |
| NB-3526.1 | Pressure–Temperature Ratings | MNB 3526.1 | | A1 |
| NB-3526.2 | Pipe Reaction Stress | MNB 3526.2 | | A1 |
| NB-3526.3 | Primary Stress and Secondary Stress | MNB 3526.3 | | A1 |
| NB-3526.4 | Secondary and Peak Stresses | MNB 3526.4 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3527 | Level D Service Limits | MNB 3527 | | A1 |
| NB-3531.1 | Pressure–Temperature Ratings | MNB 3531.1 | ASME ANSI B16.34, Tables 2-1.1A to 2-2.7A<br>KEPIC : KEPIC-MGG, Tables 3111-1 to 3111-21 | A1(R/S) |
| NB-3531.2 | Hydrostatic Tests | MNB 3531.2 | | A1(R/S) |
| NB-3531.3 | Allowance for Variation From Design Loadings | MNB 3531.3 | | A1(R/S) |
| NB-3532 | Design Stress Intensity Values | MNB 3532 | | A1(R/S) |
| NB-3533 | Marking | MNB 3533 | | A1(R/S) |
| NB-3534 | Nomenclature | MNB 3534 | ASME : °F/in2(°C/ mm2) for C1<br>KEPIC : °F/in2(0.556 °C/0.645×10-3 m2) for C1 | A1(S/C) |
| NB-3541 | General Requirements for Body Wall Thickness | MNB 3541 | | A1 |
| NB-3542 | Minimum Wall Thickness of Listed Pressure Rated Valves | MNB 3542 | | A1(R/S) |
| NB-3543 | Minimum Wall Thickness of Valves of Nonlisted Pressure Rating | MNB 3543 | | A1(R/S) |
| NB-3544 | Body Shape Rules | MNB 3544 | | A1 |
| NB-3544.1 | Fillets for External and Internal Intersections and Surfaces | MNB 3544.1 | | A1 |
| NB-3544.2 | Penetrations of Pressure-Retaining Boundary | MNB 3544.2 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3544.3 | Attachments | MNB 3544.3 | | A1 |
| NB-3544.4 | Body Internal Contours | MNB 3544.4 | | A1 |
| NB-3544.5 | Out-of-Roundness | MNB 3544.5 | | A1 |
| NB-3544.6 | Doubly Curved Sections | MNB 3544.6 | | A1 |
| NB-3544.7 | Flat Sections | MNB 3544.7 | | A1 |
| NB-3544.8 | Body End Dimensions | MNB 3544.8 | | A1(R/S) |
| NB-3544.9 | Openings for Auxiliary Connections | MNB 3544.9 | | A1(R/S) |
| NB-3545 | Body Primary and Secondary Stress Limits | MNB 3545 | | A1 |
| NB-3545.1 | Primary Membrane Stress Due to Internal Pressure | MNB 3545.1 | | A1(R/S) |
| NB-3545.2 | Secondary Stresses | MNB 3545.2 | | A1(S/C) |
| NB-3545.3 | Fatigue Requirements | MNB 3545.3 | | A1(R/S) |
| NB-3546.1 | Body-to-Bonnet Joints | MNB 3546.1 | | A1(R/S) |
| NB-3546.2 | Valve Disk | MNB 3546.2 | | A1 |
| NB-3546.3 | Other Valve Parts | MNB 3546.3 | | A1(R/S) |
| NB-3546.4 | Fatigue Evaluation | MNB 3546.4 | | A1 |
| NB-3551 | Verification of Adequacy for Cyclic Conditions | MNB 3551 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3552 | Excluded Cycles | MNB 3552 | | A1 |
| NB-3553 | Fatigue Usage | MNB 3553 | | A1(R/S) |
| NB-3554 | Cyclic Stress Calculations | MNB 3554 | | A1(R/S) |
| NB-3561 | General Requirements | MNB 3561 | ASME : NCA-3550<br>KEPIC : KEPIC MNA-3340 and MNA-6200 | A1(R/S) |
| NB-3562 | Design Report for Valves Larger Than NPS 4 (DN 100) | MNB 3562 | | A1 |
| NB-3563 | Design Report Requirements for NPS 4 and Smaller (≤ DN 100) Valves | MNB 3563 | | A1 |
| NB-3591.1 | General | MNB 3591.1 | | A1 |
| NB-3591.2 | Definitions | MNB 3591.2 | | A1 |
| NB-3591.3 | Acceptability of Small Liquid Relief Valves | MNB 3591.3 | | A1 |
| NB-3591.4 | Acceptability of Safety and Safety Relief Valves | MNB 3591.4 | | A1 |
| NB-3592.1 | Design Conditions | MNB 3592.1 | | A1 |
| NB-3592.2 | Stress Limits for Specified Service Loadings | MNB 3592.2 | | A1(R/S) |
| NB-3592.3 | Earthquake | MNB 3592.3 | | A1 |
| NB-3593.1 | Hydrostatic Test | MNB 3593.1 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3593.2 | Marking | MNB 3593.2 | | A1 |
| NB-3594.1 | Body | MNB 3594.1 | | A1 |
| NB-3594.2 | Bonnet (Yoke) | MNB 3594.2 | | A1 |
| NB-3594.3 | Nozzle | MNB 3594.3 | | A1 |
| NB-3594.4 | Body-to-Bonnet Joint | MNB 3594.4 | | A1 |
| NB-3594.5 | Disk | MNB 3594.5 | | A1 |
| NB-3594.6 | Spring Washer | MNB 3594.6 | | A1 |
| NB-3594.7 | Spindle (Stem) | MNB 3594.7 | | A1 |
| NB-3594.8 | Adjusting Screw | MNB 3594.8 | | A1 |
| NB-3594.9 | Spring | MNB 3594.9 | | A1 |
| NB-3595.1 | General Requirements | MNB 3595.1 | | A1 |
| NB-3611 | Acceptability | MNB 3611 | | A1 |
| NB-3611.1 | Stress Limits | MNB 3611.1 | | A1 |
| NB-3611.2 | Acceptability When Stresses Exceed Stress Limits | MNB 3611.2 | This requirement is omitted in KEPIC, not intentionally. It's an error. | A1<br>(It will be issued as Errata) |
| NB-3611.3 | Conformance to NB-3600 | MNB 3611.3 | | A1 |
| NB-3611.4 | Dimensional Standards | MNB 3611.4 | | A1 |
| NB-3611.5 | Prevention of Nonductile Fracture | MNB 3611.5 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
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| NB-3612.1 | Standard Piping Products | MNB 3612.1 | | A1 |
| NB-3612.2 | Piping Products Without Specific Ratings | MNB 3612.2 | | A1 |
| NB-3612.4 | Considerations for Local Conditions and Transients | MNB 3612.4 | | A1(S/C) |
| NB-3613.1 | Corrosion or Erosion | MNB 3613.1 | | A1 |
| NB-3613.2 | Threading and Grooving | MNB 3613.2 | | A1 |
| NB-3613.3 | Mechanical Strength | MNB 3613.3 | | A1 |
| NB-3621 | Design and Service Loadings | MNB 3621 | | A1 |
| NB-3622.1 | Impact | MNB 3622.1 | | A1 |
| NB-3622.2 | Reversing Dynamic Loads | MNB 3622.2 | | A1 |
| NB-3622.3 | Vibration | MNB 3622.3 | | A1 |
| NB-3622.4 | Nonreversing Dynamic Loads | MNB 3622.4 | | A1 |
| NB-3623 | Weight Effects | MNB 3623 | | A1 |
| NB-3623.1 | Live Weight | MNB 3623.1 | | A1 |
| NB-3623.2 | Dead Weight | MNB 3623.2 | | A1 |
| NB-3624.1 | Loadings, Displacements and Restraints | MNB 3624.1 | | A1 |
| NB-3624.2 | Analysis of Thermal Expansion and Contraction Effects | MNB 3624.2 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3624.3 | Provision for Rapid Temperature Fluctuation Effects | MNB 3624.3 | | A1 |
| NB-3625 | Stress Analysis | MNB 3625 | | A1 |
| NB-3630 | PIPING DESIGN AND ANALYSIS CRITERIA | MNB 3630 | | A1(R/S) |
| NB-3641.1 | Straight Pipe Under Internal Pressure | MNB 3641.1 | | A1(R/S) |
| NB-3641.2 | Straight Pipe Under External Pressure | MNB 3641.2 | | A1 |
| NB-3642.1 | Pipe Bends | MNB 3642.1 | | A1 |
| NB-3642.2 | Elbows | MNB 3642.2 | | A1 |
| NB-3643.1 | General Requirements | MNB 3643.1 | | A1 |
| NB-3643.2 | Branch Connections | MNB 3643.2 | | A1 |
| NB-3643.3 | Reinforcement for Openings | MNB 3643.3 | | A1(S/C) |
| NB-3644 | Miters | MNB 3644 | | A1 |
| NB-3646 | Closures | MNB 3646 | | A1(R/S) |
| NB-3647.1 | Flanged Joints | MNB 3647.1 | | A1(R/S) |
| NB-3647.2 | Permanent Blanks | MNB 3647.2 | | A1 |
| NB-3647.3 | Temporary Blanks | MNB 3647.3 | | A1(R/S) |
| NB-3648 | Reducers | MNB 3648 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3649 | Pressure Design of Other Piping Products | MNB 3649 | | A1 |
| NB-3649.1 | Expansion Joints | MNB 3649.1 | | A1 |
| NB-3651.1 | Piping Products for Which Stress Indices Are Given | MNB 3651.1 | | A1 |
| NB-3651.2 | Piping Products for Which Stress Indices Are Not Available | MNB 3651.2 | | A1 |
| NB-3651.3 | Attachments | MNB 3651.3 | | A1 |
| NB-3652 | Consideration of Design Conditions | MNB 3652 | | A1(R/S) |
| NB-3653 | Consideration of Level A Service Limits | MNB 3653 | | A1 |
| NB-3653.1 | Satisfaction of Primary Plus Secondary Stress Intensity Range | MNB 3653.1 | | A1(R/S) |
| NB-3653.2 | Satisfaction of Peak Stress Intensity Range | MNB 3653.2 | | A1 |
| NB-3653.3 | Alternating Stress Intensity | MNB 3653.3 | | A1 |
| NB-3653.4 | Use of Design Fatigue Curve | MNB 3653.4 | | A1(R/S) |
| NB-3653.5 | Cumulative Damage | MNB 3653.5 | | A1 |
| NB-3653.6 | Simplified Elastic–Plastic Discontinuity Analysis | MNB 3653.6 | | A1 |
| NB-3653.7 | Thermal Stress Ratchet | MNB 3653.7 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3654 | Consideration of Level B Service Limits | MNB 3654 | | A1 |
| NB-3654.1 | Permissible Pressure | MNB 3564.1 | | A1 |
| NB-3654.2 | Analysis of Piping Components | MNB 3654.2 | | A1 |
| NB-3655.1 | Permissible Pressure | MNB 3655.1 | | A1 |
| NB-3655.2 | Analysis of Piping Components | MNB 3655.2 | | A1 |
| NB-3655.3 | Deformation Limits | MNB 3655.3 | | A1 |
| NB-3656 | Consideration of Level D Service Limits | MNB 3656 | ASME : NCA-2142.2(b)(4)<br>KEPIC : KEPIC-MNA 2322.2(4) | A1(R/S) |
| NB-3657 | Test Loadings | MNB 3657 | | A1 |
| NB-3658 | Analysis of Flanged Joints | MNB 3658 | | A1 |
| NB-3658.1 | Design Limits, Levels A and B Service Limits | MNB 3658.1 | | A1(R/S) |
| NB-3658.2 | Level C Service Limits | MNB 3658.2 | | A1 |
| NB-3658.3 | Level D Service Limits | MNB 3658.3 | | A1 |
| NB-3658.4 | Test Loadings | MNB 3658.4 | | A1 |
| NB-3661.1 | General Requirements | MNB 3661.1 | | A1 |
| NB-3661.2 | Socket Welds | MNB 3661.2 | | A1 |
| NB-3661.3 | Fillet Welds and Partial Penetration Welds for Branch Connections | MNB 3661.3 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3671 | Selection and Limitation of Nonwelded Piping Joints | MNB 3671 | | A1 |
| NB-3671.1 | Flanged Joints | MNB 3671.1 | | A1 |
| NB-3671.2 | Expanded Joints | MNB 3671.2 | | A1 |
| NB-3671.3 | Threaded Joints | MNB 3671.3 | | A1 |
| NB-3671.4 | Flared, Flareless and Compression Joints | MNB 3671.4 | | A1 |
| NB-3671.5 | Caulked Joints | MNB 3671.5 | | A1 |
| NB-3671.6 | Brazed and Soldered Joints | MNB 3671.6 | | A1 |
| NB-3671.7 | Sleeve Coupled and Other Patented Joints | MNB 3671.7 | | A1 |
| NB-3672 | Expansion and Flexibility | MNB 3672 | | A1 |
| NB-3672.1 | Properties | MNB 3672.1 | | A1(R/S) |
| NB-3672.2 | Unit Thermal Expansion Range | MNB 3672.2 | | A1(R/S) |
| NB-3672.3 | Moduli of Elasticity | MNB 3672.3 | | A1(R/S) |
| NB-3672.4 | Poisson's Ratio | MNB 3672.4 | | A1 |
| NB-3672.5 | Stresses | MNB 3672.5 | | A1(R/S) |
| NB-3672.6 | Method of Analysis | MNB 3672.6 | | A1 |
| NB-3672.7 | Basic Assumptions and Requirements | MNB 3672.7 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-3672.8 | Cold Springing | MNB 3672.8 | | A1 |
| NB-3674 | Design of Pipe Supporting Elements | MNB 3674 | | A1(R/S) |
| NB-3677.1 | General Requirements | MNB 3677.1 | | A1 |
| NB-3677.2 | Piping to Pressure Relieving Safety Devices | MNB 3677.2 | | A1 |
| NB-3677.3 | Discharge Piping From Pressure Relieving Safety Devices | MNB 3677.3 | | A1 |
| NB-3681 | Scope | MNB 3681 | | A1 |
| NB-3682 | Definitions of Stress Indices and Flexibility Factors | MNB 3682 | | A1 |
| NB-3683 | Stress Indices for Use With NB-3650 | MNB 3683 | | A1 |
| NB-3683.1 | Nomenclature | MNB 3683.1 | | A1(R/S) |
| NB-3683.2 | Applicability of Indices—General | MNB 3683.2 | | A1 |
| NB-3683.3 | Straight Pipe Remote From Welds | MNB 3683.3 | | A1 |
| NB-3683.4 | Welds | MNB 3683.4 | | A1 |
| NB-3683.5 | Welded Transitions | MNB 3683.5 | | A1 |
| NB-3683.6 | Concentric and Eccentric Reducers | MNB 3683.6 | | A1 |
| NB-3683.7 | Curved Pipe or Butt Welding Elbows | MNB 3683.7 | | A1 |
| NB-3683.8 | Branch Connections per NB-3643 | MNB 3683.8 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
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| NB-3683.9 | Butt Welding Tees | MNB 3683.9 | | A1 |
| NB-3684 | Stress Indices for Detailed Analysis | MNB 3684 | | A1 |
| NB-3685.1 | Applicability of Indices | MNB 3685.1 | | A1 |
| NB-3685.2 | Nomenclature (Fig. NB-3685.2-1) | MNB 3685.2 | | A1(R/S) |
| NB-3685.3 | Stress From Stress Indices | MNB 3685.3 | | A1 |
| NB-3685.4 | Classification of Stresses | MNB 3685.4 | | A1 |
| NB-3686.1 | Straight Pipe | MNB 3686.1 | | A1 |
| NB-3686.2 | Curved Pipe and Welding Elbows | MNB 3686.2 | | A1 |
| NB-3686.3 | Miter Bends | MNB 3686.3 | | A1 |
| NB-3686.4 | Welding Tee or Branch Connections | MNB 3686.4 | | A1 |
| NB-3686.5 | Branch Connections in Straight Pipe | MNB 3686.5 | | A1 |
| NB-3691 | Standard Piping Products | MNB 3691 | | A1 |
| NB-3692 | Nonstandard Piping Products | MNB 3692 | | A1 |
| NB-4110 | INTRODUCTION | MNB 4110 | | A1 |
| NB-4121 | Means of Certification | MNB 4121 | ASME : The Certificate Holder for an item shall certify, by application of the appropriate Code Symbol and completion of the appropriate Data Report in accordance with NCA-8000,<br>KEPIC : The Certificate Holder for an item shall certify, by application of the appropriate KEPIC | B1<br>Code symbol stamping is not adopted in KEPIC. KEPIC symbol, which shapes different from those of ASME, application |

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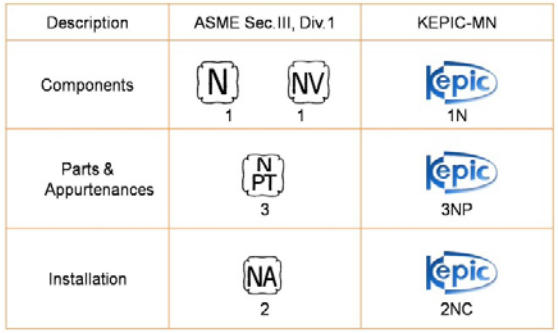
| | | | Symbol and completion of the appropriate Data Report in accordance with KEPIC-MNA 6000 and MNA-8000.<br>  <br> | takes place of stamping.<br><br>See the figures of left side column. |
| NB-4121.1 | Certification of Treatments, Tests, and Examinations | MNB 4121.1 | ASME : NCA-3862<br>KEPIC : KEPIC-MNA 6420 | A1(R/S) |
| NB-4121.2 | Repetition of Tensile or Impact Tests | MNB 4121.2 | | A1 |
| NB-4121.3 | Repetition of Surface Examination After Machining | MNB 4121.2 | | A1 |
| NB-4122 | Material Identification | MNB 4122 | | A1 |
| NB-4122.1 | Marking Material | MNB 4122.1 | | A1 |
| NB-4123 | Examinations | MNB 4123 | | A1 |
| NB-4125 | Testing of Welding and Brazing Material | MNB 4125 | | A1 |
| NB-4131 | Elimination and Repair of Defects | MNB 4131 | | A1 |

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| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
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| NB-4132 | Documentation of Repair Welds of Base Material | MNB 4132 | | A1 |
| NB-4211 | Cutting | MNB 4211 | | A1 |
| NB-4211.1 | Preheating Before Thermal Cutting | MNB 4211.1 | | A1 |
| NB-4212 | Forming and Bending Processes | MNB 4212 | | A1 |
| NB-4213 | Qualification of Forming Processes for Impact Property Requirements | MNB 4213 | | A1 |
| NB-4213.1 | Exemptions | MNB 4213.1 | | A1 |
| NB-4213.2 | Procedure Qualification Test | MNB 4213.2 | | A1 |
| NB-4213.3 | Acceptance Criteria for Formed Material | MNB 4213.3 | | A1 |
| NB-4213.4 | Requalification | MNB 4213.4 | | A1(C/S) |
| NB-4214 | Minimum Thickness of Fabricated Material | MNB 4214 | | A1 |
| NB-4221 | Tolerance for Vessel Shells | MNB 4221 | | A1 |
| NB-4221.1 | Maximum Difference in Cross-Sectional Diameters | MNB 4221.1 | | A1 |
| NB-4221.2 | Maximum Deviation From True Theoretical Form for External Pressure | MNB 4221.2 | | A1 |
| NB-4221.3 | Deviations From Tolerances | MNB 4221.3 | ASME : NCA-3551<br>KEPIC : KEPIC-MNA 6200 | A1(R/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-4221.4 | Tolerance Deviations for Vessel Parts Fabricated From Pipe | MNB 4221.4 | | A1 |
| NB-4222 | Tolerances for Formed Vessel Heads | MNB 4222 | | A1 |
| NB-4222.1 | Maximum Difference in Cross-Sectional Diameters | MNB 4222.1 | | A1 |
| NB-4222.2 | Deviation From Specified Shape | MNB 4222.2 | | A1 |
| NB-4223 | Tolerances for Formed or Bent Piping | MNB 4223 | | A1 |
| NB-4223.1 | Minimum Wall Thickness | MNB 4223.1 | | A1 |
| NB-4223.2 | Ovality Tolerance | MNB 4223.2 | | A1 |
| NB-4231 | Fitting and Aligning Methods | MNB 4231 | | A1 |
| NB-4231.1 | Tack Welds | MNB 4231.1 | | A1 |
| NB-4232 | Alignment Requirements When Components Are Welded From Two Sides | MNB 4232 | | A1 |
| NB-4232.1 | Fairing of Offsets | MNB 4232.1 | | A1 |
| NB-4233 | Alignment Requirements When Inside Surfaces Are Inaccessible | MNB 4233 | | A1(C/S) |
| NB-4241 | Category A Weld Joints in Vessels and Longitudinal Weld Joints in Other Components | MNB 4241 | | A1 |
| NB-4242 | Category B Weld Joints in Vessels and | MNB 4242 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | Circumferential Weld Joints in Other Components | | | |
| NB-4243 | Category C Weld Joints in Vessels and Similar Weld Joints in Other Components | MNB 4243 | | A1 |
| NB-4244 | Category D Weld Joints in Vessels and Similar Weld Joints in Other Components | MNB 4244 | | A1 |
| NB-4245 | Complete Joint Penetration Welds | MNB 4245 | | A1 |
| NB-4246 | Piping Branch Connections | MNB 4246 | | A1 |
| NB-4250 | WELDING END TRANSITIONS — MAXIMUM ENVELOPE | MNB 4250 | ASME : *(c)* if the weld is subject to preservice inspection, the length of the counterbore shall be 2*t*min for pipe and *t* min for components and fittings,<br>KEPIC : KEPIC-MNB has the same requirement for the above.<br>*(But, KEPIC allows 0.5 in. length of countbore for fittings such as elbows through KEPIC Code Case in the year 2009 based on the construction experience of NPPs. However, It needs permission for usage by regulation body.)* | A1<br>(Discussion is required for KEPIC Code Case. I wonder whether Code Case is one of object of code comparison work or not) |
| NB-4311 | Types of Processes Permitted | MNB 4311 | | A1(R/S) |
| NB-4311.1 | Stud Welding Restrictions | MNB 4311.1 | | A1(R/S) |
| NB-4311.2 | Capacitor Discharge Welding | MNB 4311.2 | | A1(C/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-4311.3 | Inertia and Continuous Drive Friction Welding | MNB 4311.3 | | A1 |
| NB-4321 | Required Qualifications | MNB 4321 | | A1(R/S, S/C) |
| NB-4322 | Maintenance and Certification of Records | MNB 4322 | | A1 |
| NB-4322.1 | Identification of Joints by Welder or Welding Operator | MNB 4322.1 | | A1(S/C) |
| NB-4323 | Welding Prior to Qualifications | MNB 4323 | | A1(R/S) |
| NB-4324 | Transferring Qualifications | MNB 4324 | ASME : Section IX, QW-201 and QW-300.2<br>KEPIC : KEPIC-MQW 2200 and MQW 3120 | A1(R/S) |
| NB-4331 | Conformance to Section IX Requirements | MNB 4331 | | A1(R/S) |
| NB-4333 | Heat Treatment of Qualification Welds for Ferritic Materials | MNB 4333 | | A1<br>(R/S) |
| NB-4334 | Preparation of Test Coupons and Specimens | MNB 4334 | | A1(R/S) |
| NB-4334.1 | Coupons Representing the Weld Deposit | MNB 4334.1 | | A1 |
| NB-4334.2 | Coupons Representing the Heat Affected Zone | MNB 4334.2 | | A1 |
| NB-4335 | Impact Test Requirements | MNB 4335 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-4335.1 | Impact Tests of Weld Metal | MNB 4335.1 | | A1(R/S) |
| NB-4335.2 | Impact Tests of Heat Affected Zone | MNB 4335.2 | | A1(S/C) |
| NB-4336 | Qualification Requirements for Built-Up Weld Deposits | MNB 4336 | | A1 |
| NB-4337 | Welding of Instrument Tubing | MNB 4337 | | A1(R/S, S/C) |
| NB-4350 | SPECIAL QUALIFICATION REQUIREMENTS FOR TUBE-TOTUBESHEET WELDS | MNB 4350 | ASME : Section IX, QW-202.6, QW-193, QW-303.5<br>KEPIC : KEPIC-MQW, MQW 3632, MQW 3255 | A1(R/S) |
| NB-4361 | General Requirements | MNB 4361 | | A1(R/S) |
| NB-4362 | Essential Variables for Automatic, Machine and Semiautomatic Welding | MNB 4362 | | A1(R/S) |
| NB-4363 | Essential Variables for Manual Welding | MNB 4363 | | A1 |
| NB-4366 | Test Assembly | MNB 4366 | | A1(S/C) |
| NB-4366.1 | Automatic Welding | MNB 4366.1 | | A1 |
| NB-4366.2 | Manual, Machine and Semiautomatic Welding | MNB 4366.2 | | A1 |
| NB-4367 | Examination of Test Assembly | MNB 4367 | | A1 |
| NB-4368 | Performance Qualification Test | MNB 4368 | | A1 |
| NB-4411 | Identification, Storage and Handling of Welding Material | MNB 4411 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-4412 | Cleanliness and Protection of Welding Surfaces | MNB 4412 | | A1 |
| NB-4421 | Backing Rings | MNB 4421 | | A1 |
| NB-4422 | Peening | MNB 4422 | | A1 |
| NB-4423 | Miscellaneous Welding Requirements | MNB 4423 | | A1 |
| NB-4424.1 | General | MNB 4424.1 | | A1 |
| NB-4424.2 | Preservice Examination | MNB 4424.2 | | A1(S/C) |
| NB-4425 | Welding Items of Different Diameters | MNB 4425 | | A1 |
| NB-4426.1 | Thickness of Weld Reinforcement for Vessels, Pumps and Valves | MNB 4426.1 | | A1(S/C) |
| NB-4426.2 | Thickness of Weld Reinforcement for Piping | MNB 4426.2 | | A1(S/C) |
| NB-4427 | Shape and Size of Fillet Welds | MNB 4427 | | A1(S/C) |
| NB-4428 | Seal Welds of Threaded Joints | MNB 4428 | | A1 |
| NB-4429 | Welding of Clad Parts | MNB 4429 | | A1 |
| NB-4431 | Materials for Attachments | MNB 4431 | | A1 |
| NB-4432 | Welding of Structural Attachments | MNB 4432 | | A1 |
| NB-4433 | Structural Attachments | MNB 4433 | | A1 |
| NB-4434 | Welding of Internal Structural Supports | MNB 4434 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | to Clad Components | | | |
| NB-4435 | Welding of Nonstructural Attachments and Their Removal | MNB 4435 | | A1 |
| NB-4436 | Installation of Attachments to Piping Systems After Testing | MNB 4436 | | A1(S/C) |
| NB-4440 | WELDING OF APPURTENANCES | MNB 4440 | | A1 |
| NB-4451 | General Requirements | MNB 4451 | | A1 |
| NB-4452 | Elimination of Surface Defects | MNB 4452 | | A1 |
| NB-4453 | Requirements for Making Repairs of Welds | MNB 4453 | | A1 |
| NB-4453.1 | Defect Removal | MNB 4453.1 | | A1 |
| NB-4453.2 | Requirements for Welding Material, Procedures and Welders | MNB 4453.2 | | A1 |
| NB-4453.3 | Blending of Repaired Areas | MNB 4453.3 | | A1 |
| NB-4453.4 | Examination of Repair Welds | MNB 4453.4 | | A1(R/S) |
| NB-4453.5 | Heat Treatment of Repaired Areas | MNB 4453.5 | | A1 |
| NB-4511 | Where Brazing May Be Used | MNB 4511 | | A1 |
| NB-4512 | Brazing Material | MNB 4512 | | A1(R/S) |
| NB-4521 | Brazing Procedure and Performance Qualification | MNB 4521 | | A1(R/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-4522 | Valve Seat Rings | MNB 4522 | | A1 |
| NB-4523 | Reheated Joints | MNB 4523 | | A1(R/S, S/C) |
| NB-4524 | Maximum Temperature Limits | MNB 4524 | | A1(R/S) |
| NB-4530 | FITTING AND ALIGNING OF PARTS TO BE BRAZED | MNB 4530 | | A1 |
| NB-4540 | EXAMINATION OF BRAZED JOINTS | MNB 4540 | | A1 |
| NB-4611 | When Preheat Is Necessary | MNB 4611 | | A1(R/S) |
| NB-4612 | Preheating Methods | MNB 4612 | | A1 |
| NB-4613 | Interpass Temperature | MNB 4613 | | A1 |
| NB-4621 | Heating and Cooling Methods | MNB 4621 | | A1 |
| NB-4622.1 | General Requirements | MNB 4622.1 | | A1(R/S) |
| NB-4622.2 | Time-Temperature Recordings | MNB 4622.2 | ASME : NCA-4134.17<br>KEPIC : KEPIC-MNA 4200.17<br>(This is identical with NCA-4134.17, except for addition of the records for Division 3, and separation of the records for Division 2 to KEPIC-SNA.) | A1(R/S) |
| NB-4622.3 | Definition of Nominal Thickness Governing PWHT | MNB 4622.3 | | A1(S/C) |
| NB-4622.4 | Holding Times at Temperature | MNB 4622.4 | | A1 |
| NB-4622.5 | PWHT Requirements When Different P- | MNB 4622.5 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | Number Materials Are Joined | | | |
| NB-4622.6 | PWHT Requirements for Nonpressure-Retaining Parts | MNB 4622.6 | | A1 |
| NB-4622.7 | Exemptions to Mandatory Requirements | MNB 4622.7 | | A1(R/S) |
| NB-4622.8 | Requirements for Exempting PWHT of Nozzles to Component Welds and Branch to Run Piping Welds | MNB 4622.8 | | A1(S/C) |
| NB-4622.9 | Temper Bead Weld Repair | MNB 4622.9 | | A1(R/S, S/C) |
| NB-4622.10 | Repair Welds to Cladding After Final Postweld Heat Treatment | MNB 4622.10 | | A1(R/S, S/C) |
| NB-4622.11 | Temper Bead Weld Repair to Dissimilar Metal Welds or Buttering | MNB 4622.11 | | A1(R/S, S/C) |
| NB-4623 | PWHT Heating and Cooling Rate Requirements | MNB 4623 | | A1(S/C) |
| NB-4624 | Methods of Postweld Heat Treatment | MNB 4624 | | A1 |
| NB-4624.1 | Furnace Heating - One Heat | MNB 4624.1 | | A1 |
| NB-4624.2 | Furnace Heating - More Than One Heat | MNB 4624.2 | | A1 |
| NB-4624.3 | Local Heating | MNB 4624.3 | | A1(R/S) |
| NB-4624.4 | Heating Items Internally | MNB 4624.4 | | A1 |
| NB-4630 | HEAT TREATMENT OF WELDS OTHER THAN THE FINAL | MNB 4630 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | POSTWELD HEAT TREATMENT | | | |
| NB-4651 | Conditions Requiring Heat Treatment After Bending or Forming | MNB 4651 | | A1(R/S, S/C) |
| NB-4652 | Exemptions From Heat Treatment After Bending or Forming | MNB 4652 | | A1 |
| NB-4660 | HEAT TREATMENT OF ELECTROSLAG WELDS | MNB 4660 | | A1 |
| NB-4711 | Thread Engagement | MNB 4711 | | A1 |
| NB-4712 | Thread Lubricants | MNB 4712 | | A1 |
| NB-4713 | Removal of Thread Lubricants | MNB 4713 | | A1 |
| NB-4720 | BOLTING FLANGED JOINTS | MNB 4720 | | A1 |
| NB-4730 | ELECTRICAL AND MECHANICAL PENETRATION ASSEMBLIES | MNB 4730 | | A1 |
| NB-5111 | Methods | MNB 5111 | | A1(R/S) |
| NB-5112 | Nondestructive Examination Procedures | MNB 5112 | | A1(R/S) |
| NB-5113 | Post-Examination Cleaning | MNB 5113 | | A1 |
| NB-5120 | TIME OF EXAMINATION OF WELDS AND WELD METAL CLADDING | MNB 5120 | | A1 |
| NB-5130 | EXAMINATION OF WELD EDGE PREPARATION SURFACES | MNB 5130 | | A1(S/C) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-5140 | EXAMINATION OF WELDS AND ADJACENT BASE MATERIAL | MNB 5140 | | A1 |
| NB-5210 | CATEGORY A VESSEL WELDED JOINTS AND LONGITUDINAL WELDED JOINTS IN OTHER COMPONENTS | MNB 5210 | | A1 |
| NB-5221 | Vessel Welded Joints | MNB 5221 | | A1 |
| NB-5222 | Piping, Pump, and Valve Circumferential Welded Joints | MNB 5222 | | A1 |
| NB-5231 | General Requirements | MNB 5231 | | A1 |
| NB-5241 | General Requirements | MNB 5241 | | A1 |
| NB-5242 | Full Penetration Butt Welded Nozzles, Branch, and Piping Connections | MNB 5242 | | A1 |
| NB-5243 | Corner Welded Nozzles, Branch and Piping Connections | MNB 5243 | | A1 |
| NB-5244 | Weld Metal Buildup at Openings for Nozzles, Branch and Piping Connections | MNB 5244 | | A1 |
| NB-5245 | Fillet Welded and Partial Penetration Welded Joints | MNB 5245 | | A1 |
| NB-5246 | Oblique Full Penetration Nozzles, Branch and Piping Connections | MNB 5246 | | A1 |
| NB-5261 | Fillet, Partial Penetration and Socket | MNB 5261 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | Welded Joints | | | |
| NB-5262 | Structural Attachment Welded Joints | MNB 5262 | | A1 |
| NB-5271 | Welded Joints of Specially Designed Seals | MNB 5271 | | A1 |
| NB-5272 | Weld Metal Cladding | MNB 5272 | | A1 |
| NB-5273 | Hard Surfacing | MNB 5273 | | A1 |
| NB-5274 | Tube-to-Tubesheet Welded Joints | MNB 5274 | | A1 |
| NB-5275 | Brazed Joints | MNB 5275 | | A1 |
| NB-5276 | Inertia and Continuous Drive Friction Welds | MNB 5276 | | A1(R/S) |
| NB-5277 | Electron Beam Welds | MNB 5277 | | A1 |
| NB-5278 | Electroslag Welds | MNB 5278 | | A1 |
| NB-5279 | Special Exceptions | MNB 5279 | | A1 |
| NB-5281 | General Requirements | MNB 5281 | ASME : NCA-3252(c)<br>KEPIC : KEPIC-MNA 6111<br>(For reference, MNA 6111 not adopted NCA-3252(a)(6) which is related fracture mechanics data but, the others are identical to NCA-3252)<br>ASME : NCA-4134.17<br>KEPIC : KEPIC-MNA 4200.17<br>(See the comment for NB-4622.2 of this document) | A1(R/S) |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-5282 | Examination Requirements | MNB 5282 | ASME : Section XI, table IWB-2500-1<br>KEPIC : KEPIC-MIB, table MIB 2500-1 | A1(R/S) |
| NB-5283 | Components Exempt From Preservice Examination | MNB 5283 | | A1 |
| NB-5320 | RADIOGRAPHIC ACCEPTANCE STANDARDS | MNB 5320 | | A1 |
| NB-5331 | Fabrication | MNB 5331 | | A1 |
| NB-5332 | Preservice Examination | MNB 5332 | | A1 |
| NB-5341 | Evaluation of Indications | MNB 5341 | | A1 |
| NB-5342 | Acceptance Standards | MNB 5342 | | A1(S/C) |
| NB-5343 | Preservice Examination | MNB 5343 | | A1 |
| NB-5351 | Evaluation of Indications | MNB 5351 | | A1 |
| NB-5352 | Acceptance Standards | MNB 5352 | | A1(S/C) |
| NB-5353 | Preservice Examination | MNB 5353 | | A1 |
| NB-5360 | EDDY CURRENT PRESERVICE EXAMINATION OF INSTALLED NONFERROMAGNETIC STEAM GENERATOR HEAT EXCHANGER TUBING | MNB 5360 | ASME : NCA-3252(c)<br>KEPIC : KEPIC-MNA 6111 | A1(R/S) |
| NB-5370 | VISUAL ACCEPTANCE STANDARDS FOR BRAZED JOINTS | MNB 5370 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-5380 | BUBBLE FORMATION TESTING | MNB 5380 | | A1(R/S) |
| NB-5410 | EXAMINATION AFTER HYDROSTATIC TEST | MNB 5410 | | A1 |
| NB-5510 | GENERAL REQUIREMENTS | MNB 5510 | | A1 |
| NB-5521 | Qualification Procedure | MNB 5521 | ASME : See the NB-5521 (omission)<br>KEPIC : (1) Personnel performing nondestructive examinations shall be qualified in accordance with KEPIC-MEN 1002.<br>(2) For visual examination, the Jaeger Number 1 letters shall be used in lieu of the Jaeger Number 2 letters specified in paragraph 9.1(1) of KEPIC-MEN 1002. The use of equivalent type and size letters is permitted<br>(3) For nondestructive examination methods not covered by KEPIC-MEN 1002, personnel shall be qualified to comparable levels of competency by subjection to comparable examinations on the particular method involved.<br>(4) The emphasis shall be on the individual's ability to perform the nondestructive examination in accordance with the applicable procedure for the intended application.<br>(KEPIC-MEN 1002 adopted ASNT SNT-TC-1A-96. See the 'KEPIC-MEN vs. ASME Sec. V.doc' file. In KEPIC-MEN 1002, *KEPIC-MEN demands the national license based on the Korean law in addition to the requirement of ASME Section V for NDE personnel.*) | B1 for NDE personnel qualification & certification<br>Differences are caused by national education and qualification system in Korea. |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-5522 | Certification of Personnel | - | ASME : *(a)* The Employer retains responsibility for the adequacy of the program and is responsible for certification of Levels I, II, and III nondestructive examination personnel.<br>*(b)* When ASNT is the outside agency administering the Level III basic and method examinations [NB-5521(a)(1)(a)], the Employer may use a letter from ASNT as evidence on which to base the certification.<br>*(c)* When an outside agency is the examining agent for Level III qualification of the Employer's personnel, the examination results shall be included with the Employer's record.<br>KEPIC : *Not mentioned in MNB 5521, however, personnel qualification & certification are performed as per the requirements of KEPIC-MEN which adopted ASNT SNT-TC-1A-96.* | B1 for NDE personnel qualification & certification (This is required in KEPIC-MEN.) |
| NB-5523 | Verification of Nondestructive Examination Personnel Certification | MNB 5522 | | A1 |
| NB-5530 | RECORDS | - | ASME : Personnel qualification records identified in paragraph 9.4 of SNT-TC-1A shall be retained by the Employer.<br>KEPIC : "deleted"<br>(The requirements of SNT-TC-1A are adopted in KEPIC-MEN.) | A2 (This is required in KEPIC-MEN.) |
| NB-6111 | Scope of Pressure Testing | MNB 6111 | | A1 |
| NB-6112 | Pneumatic Testing | MNB 6112 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-6112.1 | Pneumatic Test Limitations | MNB 6112.1 | | A1 |
| NB-6112.2 | Precautions to Be Employed in Pneumatic Testing | MNB 6112.2 | | A1 |
| NB-6113 | Witnessing of Pressure Tests | MNB 6113 | | A1(R/S) |
| NB-6114.1 | System Pressure Test | MNB 6114.1 | | A1 |
| NB-6114.2 | Component and Appurtenance Pressure Test | MNB 6114.2 | ASME : stamped with the NPT symbol, except as provided in NCA-8330.<br>KEPIC : stamped with the KEPIC symbol, except as provided in KEPIC-MNA 8330. | A2(R/S) |
| NB-6114.3 | Material Pressure Test | MNB 6114.3 | | A1 |
| NB-6115 | Machining After Pressure Test | MNB 6115 | | A1 |
| NB-6121 | Exposure of Joints | MNB 6121 | | A1 |
| NB-6122 | Addition of Temporary Supports | MNB 6122 | | A1 |
| NB-6123 | Restraint or Isolation of Expansion Joints | MNB 6123 | | A1 |
| NB-6124 | Isolation of Equipment Not Subjected to Pressure Test | MNB 6124 | | A1 |
| NB-6125 | Treatment of Flanged Joints Containing Blanks | MNB 6125 | | A1 |
| NB-6126 | Precautions Against Test Medium Expansion | MNB 6126 | | A1 |
| NB-6127 | Check of Test Equipment Before | MNB 6127 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | Applying Pressure | | | |
| NB-6211 | Venting During Fill Operation | MNB 6211 | | A1 |
| NB-6212 | Test Medium and Test Temperature | MNB 6212 | | A1 |
| NB-6221 | Minimum Hydrostatic Test Pressure | MNB 6221 | | A1 |
| NB-6222 | Maximum Permissible Test Pressure | MNB 6222 | | A1 |
| NB-6223 | Hydrostatic Test Pressure Holding Time | MNB 6223 | | A1 |
| NB-6224 | Examination for Leakage After Application of Pressure | MNB 6224 | | A1 |
| NB-6311 | General Requirements | MNB 6311 | | A1 |
| NB-6312 | Test Medium and Test Temperature | MNB 6312 | | A1 |
| NB-6313 | Procedure for Applying Pressure | MNB 6313 | | A1 |
| NB-6321 | Minimum Required Pneumatic Test Pressure | MNB 6321 | | A1 |
| NB-6322 | Maximum Permissible Test Pressure | MNB 6322 | | A1 |
| NB-6323 | Test Pressure Holding Time | MNB 6323 | | A1 |
| NB-6324 | Examination for Leakage After Application of Pressure | MNB 6324 | | A1 |
| NB-6411 | Types of Gages to Be Used and Their Location | MNB 6411 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-6412 | Range of Indicating Pressure Gages | MNB 6412 | | A1 |
| NB-6413 | Calibration of Pressure Test Gages | MNB 6413 | | A1 |
| NB-6610 | COMPONENTS DESIGNED FOR EXTERNAL PRESSURE | MNB 6610 | | A1 |
| NB-6621 | Pressure Chambers Designed to Operate Independently | MNB 6621 | | A1 |
| NB-6622 | Common Elements Designed for a Maximum Differential Pressure | MNB 6622 | | A1 |
| NB-7110 | SCOPE | MNB 7110 | | A1 |
| NB-7111 | Definitions | MNB 7111 | | A1 |
| NB-7120 | INTEGRATED OVERPRESSURE PROTECTION | MNB 7120 | | A1 |
| NB-7131 | Construction | MNB 7131 | | A1 |
| NB-7141 | Pressure Relief Devices | MNB 7141 | ASME : NV Certificate Holder<br>KEPIC : Pressure Relief Valve Manufacturer | A2 |
| NB-7142 | Stop Valves | MNB 7142 | | A1 |
| NB-7143 | Draining of Pressure Relief Devices | MNB 7143 | | A1 |
| NB-7151 | Pressure Relief Valves | MNB 7151 | | A1 |
| NB-7152 | Non-reclosing Pressure Relief Devices | MNB 7152 | | A1 |
| NB-7161 | Deadweight Pressure Relief Valves | MNB 7161 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-7171 | Safety Valves | MNB 7171 | | A1 |
| NB-7172 | Safety Relief Valves | MNB 7172 | | A1 |
| NB-7173 | Relief Valves | MNB 7173 | | A1 |
| NB-7174 | Pilot Operated Pressure Relief Valves | MNB 7174 | | A1 |
| NB-7175 | Power Actuated Pressure Relief Valves | MNB 7175 | | A1 |
| NB-7176 | Safety Valves With Auxiliary Actuating Devices | MNB 7176 | | A1 |
| NB-7177 | Pilot Operated Pressure Relief Valves With Auxiliary Actuating Devices | MNB 7177 | | A1 |
| NB-7178 | Non-reclosing Devices | MNB 7178 | | A1 |
| NB-7210 | RESPONSIBILITY FOR REPORT | MNB 7210 | | A1 |
| NB-7220 | CONTENT OF REPORT | MNB 7220 | | A1 |
| NB-7230 | CERTIFICATION OF REPORT | MNB 7230 | ASME : the requirements of Appendix XXIII of Section III Appendices.<br>KEPIC : the requirements of KEPIC-QAR<br>The below is explanation of KEPIC-QAR. | A1(R/S)<br>*B1 for RPE qualification requirements.*<br>*Differences, shown as the table of left side column, are caused by national education and qualification system in Korea.* |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

<table>
<tr><th>ASME Paragraphs</th><th>Contents</th><th>KEPIC Paragraphs</th><th>Differences</th><th>Categorization with Comments</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Description</th><th>ASME</th><th>KEPIC</th></tr>
<tr><td>Applicable Standard</td><td>ASME Sec. III Div. 1 App. XXIII</td><td>KEPIC-QAR</td></tr>
<tr><td>Technical Field</td><td>Mechanical, Structural</td><td>Identical to ASME</td></tr>
<tr><td>Required National Certificate</td><td>Registered Professional Engineer</td><td>- Professional Engineer (2-yr job experiences) or<br>- Engineer (7-yr job experiences)</td></tr>
<tr><td>Knowledge</td><td>Code & Working Knowledge</td><td>Identical to ASME</td></tr>
<tr><td>Accreditation Body</td><td>Certificate Holder</td><td>KEA</td></tr>
</table>
</td><td></td></tr>
<tr><td>NB-7240</td><td>REVIEW OF REPORT AFTER INSTALLATION</td><td>MNB 7240</td><td>ASME : the requirements of Appendix XXIII of Section III Appendices.<br>KEPIC : the requirements of KEPIC-QAR</td><td>A1(R/S)</td></tr>
<tr><td>NB-7250</td><td>FILING OF REPORT</td><td>MNB 7250</td><td></td><td>A1</td></tr>
<tr><td>NB-7311</td><td>Relieving Capacity of Pressure Relief Devices</td><td>MNB 7311</td><td></td><td>A1</td></tr>
<tr><td>NB-7312</td><td>Relieving Capacity of Pressure Relief Devices Used With Pressure-Reducing Devices</td><td>MNB 7312</td><td></td><td>A1</td></tr>
<tr><td>NB-7313</td><td>Required Number and Capacity of Pressure Relief Devices</td><td>MNB 7313</td><td></td><td>A1</td></tr>
<tr><td>NB-7314</td><td>Required Number and Capacity of Pressure Relief Devices for Isolatable Components</td><td>MNB 7314</td><td></td><td>A1</td></tr>
<tr><td>NB-7321</td><td>Relieving Capacity of Pressure Relief</td><td>MNB 7321</td><td></td><td>A1</td></tr>
</table>

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | Devices | | | |
| NB-7410 | SET PRESSURE LIMITATIONS FOR EXPECTED SYSTEM PRESSURE TRANSIENT CONDITIONS | MNB 7410 | | A1 |
| NB-7420 | SET PRESSURE LIMITATION FOR UNEXPECTED SYSTEM EXCESS PRESSURE TRANSIENT CONDITIONS | MNB 7420 | | A1 |
| NB-7511.1 | Spring-Loaded Valves | MNB 7511.1 | | A1 |
| NB-7511.2 | Balanced Valves | MNB 7511.2 | | A1 |
| NB-7511.3 | Antisimmer Type Valves | MNB 7511.3 | | A1 |
| NB-7512.1 | Antichattering and Lift Requirements | MNB 7512.1 | ASME : NCA-3250<br>KEPIC : KEPIC-MNA 3240 and 6110 | A1(S/C) |
| NB-7512.2 | Set Pressure Tolerance | MNB 7512.2 | | A1(S/C, R/S) |
| NB-7512.3 | Blowdown | MNB 7512.3 | | A1(R/S) |
| NB-7513 | Safety Relief and Relief Valve Operating Requirements | MNB 7513 | | A1(S/C) |
| NB-7513.1 | Set Pressure Tolerance | MNB 7513.1 | | A1(S/C, R/S) |
| NB-7513.2 | Blowdown | MNB 7513.2 | | A1(R/S) |
| NB-7514 | Credited Relieving Capacity | MNB 7514 | | A1 |
| NB-7515 | Sealing of Adjustments | MNB 7515 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-7521 | General Requirements | MNB 7521 | | A1 |
| NB-7522.1 | Actuation | MNB 7522.1 | | A1 |
| NB-7522.2 | Response Time | MNB 7522.2 | | A1(R/S) |
| NB-7522.3 | Main Valve Operation | MNB 7522.3 | | A1(S/C) |
| NB-7522.4 | Sensing Mechanism Integrity | MNB 7522.4 | | A1 |
| NB-7522.5 | Set Pressure Tolerance | MNB 7522.5 | | A1(S/C, R/S) |
| NB-7522.6 | Blowdown | MNB 7522.6 | | A1(R/S) |
| NB-7523 | Credited Relieving Capacity | MNB 7523 | | A1 |
| NB-7524 | Sealing of Adjustments | MNB 7524 | | A1 |
| NB-7531 | General Requirements | MNB 7531 | | A1 |
| NB-7532.1 | Actuation | MNB 7532.1 | | A1(R/S) |
| NB-7532.2 | Response Times | MNB 7532.2 | | A1 |
| NB-7532.3 | Main Valve Operation | MNB 7532.3 | | A1(S/C) |
| NB-7532.4 | Sensors, Controls and External Energy Sources | MNB 7532.4 | | A1(R/S) |
| NB-7533 | Certified Relieving Capacity | MNB 7533 | | A1 |
| NB-7534.1 | Expected System Pressure Transient Conditions | MNB 7534.1 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-7534.2 | Unexpected System Excess Pressure Transient Conditions | MNB 7534.2 | | A1 |
| NB-7535 | Sealing of Adjustments | MNB 7535 | | A1 |
| NB-7541 | General Requirements | MNB 7541 | | A1 |
| NB-7542 | Construction | MNB 7542 | | A1 |
| NB-7543 | Auxiliary Device Sensors and Controls | MNB 7543 | | A1 |
| NB-7544.1 | Expected System Pressure Transient Conditions | MNB 7544.1 | | A1 |
| NB-7544.2 | Unexpected System Excess Pressure Transient Conditions | MNB 7544.2 | | A1 |
| NB-7544.3 | Credited Relieving Capacity | MNB 7544.3 | | A1 |
| NB-7545 | Response Time | MNB 7545 | | A1 |
| NB-7551 | General Requirements | MNB 7551 | | A1 |
| NB-7552 | Correlation | MNB 7552 | | A1 |
| NB-7553 | Verification of Correlation Procedure | MNB 7553 | | A1 |
| NB-7554 | Procedure | MNB 7554 | | A1 |
| NB-7610 | RUPTURE DISK DEVICES | MNB 7610 | | A1 |
| NB-7611 | Burst Pressure Tolerance | MNB 7611 | | A1(S/C) |
| NB-7612 | Tests to Establish Stamped Burst | MNB 7612 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| | Pressure | | | |
| NB-7621 | Provisions for Venting or Draining | MNB 7621 | | A1 |
| NB-7622 | System Obstructions | MNB 7622 | | A1 |
| NB-7623 | Rupture Disk Devices at the Outlet Side of Pressure Relief Valves | MNB 7623 | | A1 |
| NB-7710 | RESPONSIBILITY FOR CERTIFICATION OF PRESSURE RELIEF VALVES | MNB 7710 | | A1 |
| NB-7720 | RESPONSIBILITY FOR CERTIFICATION OF NONRECLOSING PRESSURE RELIEF DEVICES | MNB 7720 | | A1 |
| NB-7731.1 | Capacity Certification | MNB 7731.1 | | A1 |
| NB-7731.2 | Test Media | MNB 7731.2 | | A1(S/C) |
| NB-7731.3 | Test Pressure | MNB 7731.3 | | A1(S/C) |
| NB-7731.4 | Blowdown | MNB 7731.4 | | A1 |
| NB-7731.5 | Drawings | MNB 7731.5 | ASME : ASME designated organization<br>KEPIC : KEA(or ASME) designated organization | A2 |
| NB-7731.6 | Design Changes | MNB 7731.6 | | A1 |
| NB-7732.1 | Flow Capacity | MNB 7732.1 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-7732.2 | Demonstration of Function | MNB 7732.2 | ASME : ASME designated organization<br>KEPIC : KEA(or ASME) designated organization<br>ASME : NV Certificate Holder<br>KEPIC : Pressure Relief Valve Manufacturer | A2 |
| NB-7733 | Slope Method | MNB 7733 | ASME : ASME designated organization<br>KEPIC : KEA(or ASME) designated organization | A2 |
| NB-7734 | Coefficient of Discharge Method | MNB 7734 | | A1 |
| NB-7734.1 | Number of Valves to Be Tested | MNB 7734.1 | | A1 |
| NB-7734.2 | Establishment of Coefficient of Discharge | MNB 7734.2 | | A1(S/C) |
| NB-7734.3 | Calculation of Certified Capacity | MNB 7734.3 | | A1 |
| NB-7734.4 | Demonstration of Function | MNB 7734.4 | | A1 |
| NB-7735.1 | Valve Capacity Within Test Facility Limits | MNB 7735.1 | | A1 |
| NB-7735.2 | Valve Capacity in Excess of Test Facility Limits | MNB 7735.2 | | A1 |
| NB-7735.3 | Valve Demonstration of Function | MNB 7735.3 | | A1 |
| NB-7736 | Proration of Capacity | MNB 7736 | | A1 |
| NB-7737 | Capacity Conversions | MNB 7737 | | A1 |
| NB-7738 | Laboratory Acceptance of Pressure Relieving Capacity Tests | MNB 7738 | ASME : ASME designated organization<br>KEPIC : KEA(or ASME) designated organization | A2 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-7739 | Laboratory Acceptance of Demonstration of Function Tests | MNB 7739 | ASME : NV Certificate Holder<br>KEPIC : Pressure Relief Valve Manufacturer | A2 |
| NB-7741.1 | Capacity Certification | MNB 7741.1 | | A1 |
| NB-7741.2 | Test Medium | MNB 7741.2 | | A1(S/C) |
| NB-7741.3 | Test Pressure | MNB 7741.3 | | A1(S/C) |
| NB-7741.4 | Blowdown | MNB 7741.4 | | A1 |
| NB-7741.5 | Drawings | MNB 7741.5 | ASME : ASME designated organization<br>KEPIC : KEA(or ASME) designated organization | A2 |
| NB-7741.6 | Design Changes | MNB 7741.6 | | A1 |
| NB-7742 | Valve Designs in Excess of Test Facility Limits | MNB 7742 | | A1 |
| NB-7743 | Slope Method | MNB 7743 | ASME : ASME designated organization<br>KEPIC : KEA(or ASME) designated organization | A2 |
| NB-7744 | Coefficient of Discharge Method | MNB 7744 | | A1 |
| NB-7744.1 | Number of Valves to Be Tested | MNB 7744.1 | | A1 |
| NB-7744.2 | Establishment of Coefficient of Discharge | MNB 7744.2 | ASME : ASME designated organization<br>KEPIC : KEA(or ASME) designated organization | A2 (A1 for S/C) |
| NB-7744.3 | Calculation of Certified Capacity | MNB 7744.3 | | A1 |
| NB-7744.4 | Demonstration of Function | MNB 7744.4 | | A1 |
| NB-7745 | Single Valve Method | MNB 7745 | | A1 |

## Appendix C1: KEPIC-MNB 2008 2nd Addendum vs. ASME BPVC Sec. III Div.1 NB 2007 Edition (cont.)

| ASME Paragraphs | Contents | KEPIC Paragraphs | Differences | Categorization with Comments |
|---|---|---|---|---|
| NB-7746 | Laboratory Acceptance of Pressure Relieving Capacity Tests | MNB 7746 | ASME : ASME Boiler and Pressure Vessel Committee<br>KEPIC : KEPIC committee(or ASME Boiler and Pressure Vessel Committee) | A2 |
| NB-7747 | Proration of Capacity | MNB 7747 | | A1 |
| NB-7748 | Capacity Conversions | MNB 7748 | | A1 |
| NB-7748 | Laboratory Acceptance of Demonstration of Function Tests | MNB 7748 | ASME : NV Certificate Holder<br>KEPIC : Pressure Relief Valve Manufacturer | A2 |
| NB-7811 | Marking and Stamping | MNB 7811 | | A1(S/C, R/S) |
| NB-7812 | Report Form for Pressure Relief Valves | MNB 7812 | ASME : Code NV symbol<br>KEPIC : KEPIC symbol | A2 |
| NB-7821 | Rupture Disks | MNB 7821 | | A1 |
| NB-7822 | Disk Holders (If Used) | MNB 7822 | | A1 |
| NB-7830 | CERTIFICATE OF AUTHORIZATION TO USE CODE SYMBOL STAMP | MNB 7830 | ASME : Code NV symbol<br>KEPIC : KEPIC symbol | B1<br>Refer to remark of NB-4121. |
| MNB 8100 | GENERAL REQUIREMENTS | NB-8100 | | A1 |

# APPENDIX C2: KEPIC MNA VERSUS ASME SECTION III NCA

# Comparison Table
# between
# ASME Section III NCA (2007)
# and KEPIC MNA (2008)

## June 30, 2009

Korea Electric Association

# Summary

- American Society of Mechanical Engineers (ASME, the Society) → Korea Electric Association (KEA)
- ASME Sec.III Division 1 and Division 3 → KEPIC-MN
- ASME Sec.III Division 2 → KEPIC-SNB (Concrete Containment)
- ASME Sec.III NCA (for Division 1) and Division 3 WA → KEPIC-MNA
- ASME Sec.III NCA (for Division 2) → KEPIC-SNA
- ASME Sec.V → KEPIC-MEN (Nondestructive Examination)
- ASME Sec.IX → KEPIC-MQ (Welding)
- ASME Sec.III Appendix XXIII → KEPIC-QAR (Qualification of Registered Professional Engineer)
- ASME NQA-1:1994 → KEPIC-QAP-1 (Quality Assurance Program Requirements): 2008
- ASME QAI-1 → KEPIC-QAI (Authorized Inspection)
- ASME Sec.XI → KEPIC-MI (In-Service Examination)
- ASME B16.34 → KEPIC-MGG (Valves)
- The article numbers of KEPIC-MNA are different from those of ASME Sec.III NCA.
- Documentation requirements are concentrated to KEPIC-MNA 6000.
- N Certificate Holder and NPT Certificate Holder → Manufacturer
- NA Certificate Holder → Installer
- Code Symbol Stamping → KEPIC Symbol Application (not adopted Stamping)
- Subcontracted Service Organizations, including nondestructive examination, design and heat treatment, are optionally required to be accredited by KEA by means of the same method for Material Organization. Those Organizations may be qualified by Certificate Holder.
- KEPIC has not adopted NS Certificate. The Welded Support Manufacturer shall certify NF-1 Data Report, and apply KEPIC Symbol.

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-1000 | Scope of Section III | MNA 1000 | | |
| NCA-1100 | General | MNA 1100 | | |
| NCA-1110 | Scope | MNA 1110 | - KEPIC-MNA is applied to the field of ASME Sec.III Division 1 and Division 3, and the chiller and air handling unit under the category of KEPIC-MH which is identical to ASME AG-1. And, KEPIC-SNA is applied to ASME Sec.III Division 2 items. | |
| NCA-1120 | Definitions | MNA 1120 | - Identical | |
| NCA-1130 | Limits of These Rules | MNA 1130 | - Identical, except for addition of the requirements for Class 1E items (KEPIC-EN, which are identical to several standards of IEEE) and Division 3 items. | |
| NCA-1140 | Use of Code Editions, Addenda, and Cases | MNA 1140 | - Identical, except for the use of Code Edition and Addenda early than 5 years prior to Construction Permit instead of 3 years in ASME Sec.III. | |
| (None) | (None) | MNA 1150 | - Describes the relationship between KEPIC-MN and ASME Sec.III. | |
| NCA-1150 | Units of Measurement | MNA 1160 | - KEPIC-MN adopted U.S. Customary units, and SI Units by soft metrication are information only. | |
| NCA-1200 | General Requirements for Items and Installation | MNA 1200 | | |
| NCA-1210 | Components | MNA 1210 | - Identical, except for addition of the requirements for Division 3 items. | |
| NCA-1220 | Materials | MNA 1220 | - Identical, except for addition of the requirements for Division 3 items, and separation of the requirements of Nonmetallic Materials to KEPIC-SNA. | |
| NCA-1230 | Parts, Piping Subassemblies, and Supports | MNA 1231, 1232, 1233 | - Identical | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-1260 | Appurtenances | MNA 1234 | - Identical | |
| NCA-1270 | Miscellaneous Items | MNA 1240 | - Identical | |
| NCA-1280 | Installation | MNA 1250 | - Identical | |
| (None) | (None) | MNA 1300 | - Describes the types and definitions of organizations, such as Owner, Manufacturer (N and NPT Certificate Holder), Installer (NA Certificate Holder), Material Organization, Authorized Inspection Agency (AIA), Korea Electric Association (KEA), and Test Laboratory. | |
| NCA-2000 | Classification of Components and Supports | MNA 2000 | | |
| NCA-2100 | General Requirements | MNA 2100 | | |
| NCA-2110 | Scope | MNA 2110 | - KEPIC adds the requirements for Division 3 items to scope, and specifies the guidance of classification to Korean Government Notice or the related KEPIC. And rules for Division 2 items are separated to KEPIC-SNA. | |
| NCA-2120 | Purpose of Classifying Items of a Nuclear Power Plant | MNA 2120 | - Identical, except for addition of the requirements for Division 3 items. | |
| NCA-2130 | Classifications and Rules of This Section | MNA 2200 | | |
| NCA-2131 | Code Classes and Rules of Division 1 | MNA 2210 | - Identical, except for addition of the requirements for Division 3 items. | |
| NCA-2132 | Rules of Division 2 | (None) | - Separated to KEPIC-SNA | |
| NCA-2133 | Multiple Code Class Components | MNA 2220 | - Identical | |
| NCA-2134 | Optional Use of Code Classes | MNA 2230 | - Identical | |
| NCA-2140 | Design Basis | MNA 2300 | - Identical, except for addition of the requirements for Division 3 items, and separation of the requirements for Concrete Containments to KEPIC-SNA. | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-2160 | Special Requirements Applied to Code Classes | MNA 2330 | - Identical | |
| NCA-3000 | Responsibilities and Duties | MNA 3000 | | |
| NCA-3100 | General | MNA 3100 | | |
| NCA-3110 | Responsibilities vs. Legal Liabilities | MNA 3110 | - Identical | |
| NCA-3120 | Accreditation | MNA 3120 | | |
| NCA-3121 | Type of Certificates | MNA 3121 | - Identical for description, but details are partially different as bellows. | |
| NCA-3125 | Subcontracted Services | MNA 3130 | - Identical | |
| NCA-3126 | Subcontracted Calibration Services | MNA 3732(3) | - Calibration or Testing Service Organization accredited by Korea Laboratory Accreditation Scheme (KOLAS) in accordance with ISO/IEC 17025 is not required to survey or audit. | |
| NCA-3130 | Welding and Subcontracting During Construction | MNA 3140 | - Identical for welding, but the requirements of Subcontracted Construction Services for Division 2 are separated to KEPIC-SNA. | |
| NCA-3200 | Owner' Responsibilities | MNA 3200 | | |
| NCA-3220 | Categories of the Owner' Responsibilities | MNA 3210 | - Identical, but the requirements for Division 2 are separated to KEPIC-SNA. | |
| (None) | (None) | MNA 3211 | - Owner's responsibilities as a Certificate Holder are added, reflecting the practice in Korea. | |
| NCA-3230 | Owner' Certificate | MNA 3220 | - Identical | |
| NCA-3240 | Provision of Adequate Supporting Structures | MNA 3230 | - Identical | |
| NCA-3250 | Provision of Design Specifications | MNA 3240 | | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-3251 | Provision and Correlation | MNA 3241 | - Identical | |
| NCA-3252 | Contents of Design Specification | MNA 6111 | - Additional fracture mechanics data is not contained in contents. The others are identical. | |
| NCA-3253 | Classification of Components, Parts, and Appurtenances | MNA 3242/6113 | - Identical | |
| NCA-3254 | Boundaries of Jurisdiction | MNA 6112 | - Identical, but the requirements for Division 2 are separated to KEPIC-SNA. | |
| NCA-3255 | Certification of the Design Specifications | MNA 3243 | - Identical, but the requirements for Division 2 are separated to<br>KEPIC-SNA, and RPE shall be qualified in accordance with KEPIC-QAR which is referred to Appendix XXIII of ASME Sec.III. | |
| NCA-3256 | Filing of Design Specifications | MNA 3244 | - Identical | |
| NCA-3260 | Review of Design Report | MNA 3250 | - Identical, but the requirements for Division 2 are separated to KEPIC-SNA. | |
| NCA-3270 | Overpressure Protection Report | MNA 6130 | - Identical | |
| NCA-3280 | Owner's Data Report and Filing | MNA 6620 | - Identical. In addition, KEPIC describes more detail requirements. | |
| NCA-3290 | Owner's Responsibility for Records | MNA 3260 | - Identical | |
| NCA-3300 | Responsibilities of a Designer —Division 2 | (None) | - Separated to KEPIC-SNA | |
| NCA-3400 | Responsibilities of an N Certificate Holder —Division 2 | (None) | - Separated to KEPIC-SNA. | |
| NCA-3500 | Responsibilities of an N Certificate Holder —Division 1 | MNA 3300 | - Combined N Certificate Holder and NPT Certificate Holder to Manufacturer | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-3520 | Categories of the N Certificate Holder' Responsibilities | MNA 3310 (1)~(12),(14) | - Identical | |
| NCA-3530 | Obtaining a Certificate | MNA 3320 | - Identical | |
| NCA-3540 | Compliance with This Section | MNA 3330 | - Identical | |
| NCA-3550 | Requirements for Design Output Documents | MNA 6200 | | |
| NCA-3551 | General (Design Report, Load Capacity Data Sheet, Certified Design Report Summary) | MNA 6210 | - Identical. In addition, KEPIC describes more detail requirements such as responsibilities of Certificate Holder for subcontract of stress analysis or design activities, and adds the requirements of Containment Fabrication Specification for Division 3. | |
| NCA-3552 | Design Output Documents for Parts | MNA 6220 | - Identical | |
| NCA-3553 | Design Output Documents for Appurtenances | MNA 6230 | - Identical | |
| NCA-3554 | Modification of Documents and Reconciliation with Design Report | MNA 6240 | - Identical | |
| NCA-3555 | Certification of Design Report | MNA 3341 | - Identical, but the requirements for Division 3 are added, and RPE shall be qualified in accordance with KEPIC-QAR which is referred to Appendix XXIII of ASME Sec.III | |
| NCA-3556 | Submittal of Design Report for Owner Review | MNA 3342 | - Identical | |
| NCA-3557 | Availability of Design Report | MNA 3343 | - Identical | |
| NCA-3560 | Responsibility for Quality Assurance | MNA 3350 | | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA 3561 | Scope of Responsibilities | MNA 3351 | - Design and heat treatment are additionally included in subcontracted service examples, and the requirements for furnace brazing operation subcontracted service are not included. The others are identical. | |
| NCA-3562 | Documentation of Quality Assurance Program | MNA 3352/6510(1) | - Identical | |
| NCA 3563 | Filing of Quality Assurance Manual | MNA 6510(2) | - Identical | |
| NCA-3570 | Data Report | MNA 6250 | - Identical, except for KEPIC Symbol application instead of stamping | |
| (None) | (None) | MNA 3360 | - The requirements of Containment Fabrication Specification preparation for Division 3 are added. | |
| NCA-3600 | Responsibilities of an NPT Certificate Holder | MNA 3300 | - Combined NPT Certificate Holder and N Certificate Holder to Manufacturer | |
| NCA-3620 | Categories of the NPT Certificate Holder's Responsibilities | MNA 3310 (1)~(10),(13) | - Identical | |
| NCA-3630 | Obtaining a Certificate | MNA 3320 | - Identical | |
| NCA-3640 | Compliance with This Section | MNA 3330 | - Identical | |
| NCA-3650 | Design Documents for Appurtenances | MNA 6230 | - Identical | |
| NCA-3660 | Responsibility for Quality Assurance | MNA 3350 | | |
| NCA 3661 | Scope of Responsibilities | MNA 3351 | - The requirements for furnace brazing operation subcontracted service are not included. The others are identical. | |
| NCA-3662 | Documentation of Quality Assurance Program | MNA 3352/6510(1) | - Identical | |
| NCA-3663 | Filing of Quality Assurance Manual | MNA 6510(2) | - Identical | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-3670 | Data Report | MNA 6250 | - Identical, except for KEPIC Symbol application instead of stamping | |
| NCA-3680 | Responsibilities of an NS Certificate Holder | (None) | - Not adopted NS Certificate | |
| NCA-3700 | Responsibilities of an NA Certificate Holder | MNA 3400 | - NA Certificate Holder → Installer | |
| NCA-3720 | Categories of the NA Certificate Holder' Responsibilities | MNA 3410 | - Identical | |
| NCA-3730 | Obtaining a Certificate | MNA 3420 | - Identical | |
| NCA-3740 | Responsibility for Compliance with This Section | MNA 3430 | - Identical | |
| NCA-3760 | Responsibility for Quality Assurance | MNA 3440 | | |
| NCA 3761 | Scope of Responsibilities | MNA 3441 | - Heat treatment is additionally included in subcontracted service examples, and the requirements for furnace brazing operation subcontracted service are not included. The others are identical. | |
| NCA 3762 | Documentation of Quality Assurance Program | MNA 3442/6510(1) | - Identical | |
| NCA 3763 | Filing of Quality Assurance Manual | MNA 6510(2) | - Identical | |
| NCA-3770 | Data Report | MNA 6310 | - Identical | |
| NCA-3800 | Metallic Material Organization's Quality System Program | MNA 3500 | | |
| NCA-3810 | Scope and Applicability | | | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-3811 | Limitations | (None) | - Because the accredited Material Organization and Certificate<br>Holder by KEA are able to qualify and approve suppliers, KEPIC doesn't allow approved suppliers to approve other suppliers that affect materials. Therefore, this limitation shall be performed by other requirements of KEPIC. | |
| NCA-3812 | Exclusions | MNA 3540 | - Identical, except for addition of the requirements for Division 3 items | |
| NCA-3820 | Accreditation or Qualification of Material Organizations | MNA 3520 | - Identical | |
| NCA-3830 | Responsibilities of Material Organizations | MNA 3510 | - Identical | |
| NCA-3840 | Evaluation of the Program | MNA 3530 | | |
| NCA-3841 | Evaluation by the Society | MNA 3531 | - Identical, except for the substitution of the Society to KEA | |
| NCA-3842 | Evaluation by Parties Other Than the Society | MNA 3532 | - Identical | |
| NCA-3850 | Quality System Program Requirements | MNA 4300 | | |
| NCA-3851 | Responsibility and Organization | MNA 4310 | - Identical | |
| NCA-3852 | Personnel | MNA 4320 | - Identical | |
| NCA 3853 | Program Documentation | MNA 4330 | - Identical | |
| NCA 3855 | Control of Purchased Materials, Source Materials, and Services | MNA 4340 | - Instead of alternative requirement for testing and calibration laboratory in NCA-3855.3(c), KEPIC uses the organization accredited by Korea Laboratory Accreditation Scheme (KOLAS) in accordance with ISO/IEC 17025, which is not required to survey or audit. This requirement is described in MNA 3732(3). The others are identical. | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA 3856 | Identification, Marking, and Material Control | MNA 4350 | - Identical | |
| NCA 3857 | Process Control | MNA 4360 | - Identical | |
| NCA-3858 | Control of Examinations, Tests, and Nonconforming Material | MNA 4370 | - Identical | |
| NCA-3859 | Audits and Corrective Action | MNA 4380 | - Identical | |
| NCA-3860 | Certification Requirements | | | |
| NCA-3861 | Certification Requirements for Material Organizations | MNA 4390 | - Identical | |
| NCA-3862 | Certification of Material | | | |
| NCA-3862.1 | Material Certification | MNA 6400 | - Separated to Certificate of Material Test Report and Certificate of Compliance. | |
| (a)~(f),(h) | - Certificate of Material Test Report | MNA 6410 | - Identical | |
| (g),(h) | - Certificate of Compliance | MNA 6420 | - Identical | |
| NCA 3862.2 | Quality System Program Statement | MNA 6430 | - Identical | |
| NCA-3900 | Nonmetallic Material Manufacturer' and Constituent Supplier's Quality System Program | (None) | - Separated to KEPIC-SNA. | |
| (None) | (None) | MNA 3600 | - Quoted the related KEPIC Identification and Article numbers for qualification of Registered Professional Engineer, Authorized Nuclear Inspector, Supervisor, Welder, Welding Operator, and Nondestructive Examination Personnel. | |
| (None) | (None) | MNA 3700 | Subcontracted Service Organization's Responsibilities and Qualification – Nondestructive Examination, Design, Heat Treatment, etc. | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-4000 | Quality Assurance | MNA 4000 | | |
| NCA-4100 | Requirements | MNA 4100 | | |
| NCA-4110 | Scope and Applicability | MNA 4110 | - Added Division 3 scope, and separated Division 2 scope to KEPIC-SNA. | |
| NCA-4120 | Definitions | MNA 4120 | - Identical | |
| NCA-4130 | Establishment and Implementation | | | |
| NCA-4131 | Material Organizations, Division 1 | (None) | - Refer to MNA 4110 : MNA 4300 applied | |
| NCA-4132 | Material Organizations, Division 2 | (None) | - Separated to KEPIC-SNA | |
| NCA-4133 | Material Organizations, Division 1 | (None) | - Refer to MNA 4110 : MNA 4300 applied | |
| NCA-4134 | N, NV, NPT, NS, and NA Certificate Holders for Class1, 2, 3, MC, CS, and CC Construction | MNA 4200 | - Added Class TC, SC, and separated CC to KEPIC-SNA | |
| NCA-4134.1 | Organization | MNA 4200.1 | - Identical | |
| NCA-4134.2 | Quality Assurance Program | MNA 4200.2 | - Identical | |
| NCA-4134.3 | Design Control | MNA 4200.3 | - Identical | |
| NCA-4134.4 | Procurement Document Control | MNA 4200.4 | - Identical | |
| NCA-4134.5 | Instructions, Procedures, and Drawings | MNA 4200.5 | - Identical | |
| NCA-4134.6 | Document Control | MNA 4200.6 | - Identical | |
| NCA-4134.7 | Control of Purchased Items and Services | MNA 4200.7 | - Identical | |
| NCA-4134.8 | Identification and Control of Items | MNA 4200.8 | - Identical | |
| NCA-4134.9 | Control of Processes | MNA 4200.9 | - Identical | |
| NCA-4134.10 | Inspection | MNA 4200.10 | - Identical | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-4134.11 | Test Control | MNA 4200.11 | - Identical | |
| NCA-4134.12 | Control of Measuring and Test Equipment | MNA 4200.12 | - Identical | |
| NCA-4134.13 | Handling, Storage, and Shipping | MNA 4200.13 | - Identical | |
| NCA-4134.14 | Inspection and Test Status | MNA 4200.14 | - Identical | |
| NCA-4134.15 | Control of Nonconforming Items | MNA 4200.15 | - Identical | |
| NCA-4134.16 | Corrective Action | MNA 4200.16 | - Identical | |
| NCA-4134.17 | Quality Assurance Records | MNA 4200.17 | - Identical, except for addition of the records for Division 3, and separation of the records for Division 2 to KEPIC-SNA. | |
| NCA-4134.18 | Audits | MNA 4200.18 | - Identical | |
| NCA-5000 | Authorized Inspection | MNA 5000 | | |
| NCA-5100 | Introduction | MNA 5100 | | |
| NCA-5110 | Applicability | MNA 5110 | - Identical | |
| NCA-5120 | Performance of Inspection | MNA 5120 | | |
| NCA-5121 | Authorized Inspection Agency | MNA 5121 | - The Authorized Inspection Agency (AIA) shall be accredited in accordance with KEPIC-QAI referred to ASME QAI-1, and when required, shall be designated or accredited from the Korean Regulatory Authority. The others are identical. | |
| NCA-5122 | Authorized Nuclear Inspector Supervisor | MNA 5122 | - Identical | |
| NCA-5123 | Authorized Nuclear Inspector | MNA 5123 | - Identical | |
| NCA-5125 | Duties of Authorized Nuclear Inspector Supervisors | MNA 5300 | - Satisfied. Requirements of KEPIC are more detail. | |
| NCA-5130 | Access for Inspection Agency Personnel | MNA 5130 | - Identical | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-5200 | Duties of Inspector | MNA 5400 | | |
| NCA-5210 | General Inspection Duties | MNA 5410 | - Identical, and satisfied by Overall of this Section | |
| NCA-5220 | Categories of Inspector's Duties | MNA 5410 | - Identical, and the requirements for Division 3 are added. | |
| NCA-5230 | Scope of Work, Design Specifications, and Design Reports | MNA 5420 | - Identical, and the requirements for Division 3 are added. | |
| NCA-5240 | Quality Assurance Programs | MNA 5430 | - Identical | |
| NCA-5250 | Qualification Records | MNA 5440 | - Identical | |
| NCA-5260 | Materials, Parts, and Heat Treatment | MNA 5450 | - Identical, and the requirements for Division 3 are added. | |
| NCA-5270 | Examinations and Tests | MNA 5460 | - Identical | |
| NCA-5280 | Final Tests | MNA 5470 | - Identical | |
| NCA-5290 | Data Reports and Construction Reports | MNA 5480 | - Identical, and the requirements for Division 2 are separated to KEPIC-SNA. | |
| NCA-5300 | Responsibilities of the Authorized Inspection Agency | MNA 5200 | - Identical, except for addition of duties required by the Regulatory Authority | |
| NCA-8000 | Certificates, Nameplates, Code Symbol Stamping, and Data Reports | MNA 8000 | | |
| NCA-8100 | Authorization to Perform Code Activities | MNA 8100 | | |
| NCA-8110 | General | MNA 8110 | - Not adopted Stamping, but KEPIC Symbol marking on the nameplate. | |
| NCA-8120 | Scope of Certificates | MNA 8120 | - Division 3 items and Subcontracted Service Organizations are included in the scopes for accreditation by KEA. And Division 2 items are separated to KEPIC-SNA. General guides for Certificates are identical or very similar to those of ASME Sec.III. (Refer to Table MNA 8100) | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-8130 | Inspection Agreement Required | MNA 8130 | - Identical | |
| NCA-8140 | Quality Assurance Program Requirements | MNA 8140 | - Identical (Refer to MNA 4000) | |
| NCA-8150 | Application for Accreditation | MNA 8150 | - Identical | |
| NCA- 8151 | Field Operation | MNA 8151 | - Identical. And requirements for Division 3 items are added. | |
| NCA-8152 | Shop Assembly | MNA 8152 | - Identical | |
| NCA-8153 | Activities Prior to Obtaining a Certificate | MNA 8153 | - Identical | |
| NCA-8160 | Evaluation | MNA 8160 | | |
| NCA-8161 | Evaluation for a Certificate | MNA 8161 | - Identical. And additional documentation requirements for an applicant related to pressure relief devices are included. | |
| NCA-8162 | Evaluation for an Owner's Certificate | MNA 8162 | - Identical | |
| NCA-8170 | Issuance | MNA 8170 | - Identical | |
| NCA-8180 | Renewal | MNA 8180 | - Identical | |
| (None) | (None) | MNA 8190 | - Certification of Material Organization | |
| NCA-8200 | Nameplates and Stamping | MNA 8200 | - Not adopted Stamping | |
| NCA-8210 | General Requirements | MNA 8210 | | |
| NCA-8211 | Nameplates | MNA 8211 | - KEPIC Symbol application instead of Stamping, if applicable, Owner's equipment number, and pressure class rating of KEPIC-MGG referred to ASME B16.34 for line valves are included in contents of nameplate. | |
| NCA-8212 | Stamping | MNA 8212 | - Requirements of KEPIC Symbol application are described. (Refer to FIG. MNA 8212) | |
| MNA 8213 | Attachment of Nameplates | MNA 8213 | - Identical | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-8220 | Nameplates for Components | MNA 8220 | - Identical | |
| NCA-8230 | Nameplates for NPT Stamped Items | MNA 8230 | - Identical | |
| NCA-8240 | Removed Nameplates | MNA 8240 | - Identical | |
| (None) | (None) | MNA 8250 | - Identification requirements for removable items of Division 3 are described. | |
| NCA-8300 | Code Symbol Stamps | MNA 8300 | | |
| NCA-8310 | General Requirements | MNA 8310 | - Identical, except for KEPIC Symbol application instead of Stamping | |
| NCA-8320 | Application of the N Symbol Stamp | MNA 8320 | | |
| NCA-8321 | Authorization and Time of Stamping | MNA 8321 | - Identical, except for KEPIC Symbol application instead of Stamping | |
| NCA-8322 | Application of the N Symbol Stamp at Field Site or Other Locations | MNA 8322 | - Identical, except for KEPIC Symbol application instead of Stamping | |
| (None) | (None) | MNA 8323 | - Alternative requirements for attachment of Division 3 containments are described. | |
| NCA-8330 | Parts and Piping Subassemblies Furnished without Stamping | MNA 8330 | - Identical, except for KEPIC Symbol application instead of Stamping | |
| NCA-8400 | Data Reports | MNA 6600 | | |
| NCA-8410 | General Requirements | MNA 6610 | - Refer to Table MNA 6600 | |
| NCA-8411 | Compiling Data Report Records | MNA 6611 | - Identical except for separation Division 2 Data Reports to KEPIC-SNA | |
| NCA-8412 | Availability of Data Reports | (None) | - Not intentional exclusion | |
| NCA-8420 | Owner's Data Report | MNA 6620 | - Identical | |

| Subject | ASME Sec.III NCA (2007) vs. KEPIC MNA (2008) | | | |
|---|---|---|---|---|
| ASME Sec. III NCA | | KEPIC MNA Article No. | Differences | Remark |
| Article No. | Title | | | |
| NCA-8430 | Data Reports, Tubular Products, and Fittings Welded with Filler Metal | MNA 6630 | - Identical | |
| NCA-8440 | Certificates of Conformance for Welded Supports | MNA 6640 | - Not adopted NS Certificate. NF-1 Data Reports are applied to welded supports. | |
| NCA-9000 | Glossary | MNA 9000 | | |
| NCA-9100 | Introduction | MNA 9100 | - Identical | |
| NCA-9200 | Definitions | MNA 9200 | - Identical, except for the case of administrative differences between KEPIC-MN and ASME Sec.III. | |

# Appendix D: CSA N285 Versus ASME Section III Detailed Comparison Table

## Appendix D1: CSA N285.0 Versus ASME Section III Div. 1 – NB Comparison

## Appendix D2: CSA N285.0 Versus ASME Section III Div. 1 – NCA Comparison

## Appendix D1: CSA N285.0 VS. ASME Section III Div. 1 – NB Comparison

### Code Editions:

1. CSA Standard N285.0 – 2008 (Update 2)
2. ASME BPV Code Section III, Div. 1, NB, 2007 Edition (No Addenda)

### Comparison Scale Used:

These are the definitions of the scale used for the code comparison throughout the report.

| | |
|---|---|
| A1 – SAME<br><br>Requirements classified as category A1 are considered to be technically identical. Requirements are classified as category A1 and considered to be the same even if there are inconsequential differences in wording, such as might result due to translation from one language to another, as long as the wording does not change the meaning or interpretation of the requirement. Likewise, differences in paragraph numbering are not considered when classifying requirements as long as the same requirement exists in both codes being compared. | B1 - DIFFERENT – NOT SPECIFIED<br><br>Requirements are considered to be different - not specified, if one code or standard includes requirements that the compared code or standard does not specify. This classification may result because of differences in the scope of equipment covered by a respective code, the scope of industrial practices applied in context of the respective code, differences in regulatory requirements applicable in conjunction with application of a particular code, or simply as a result of differences in requirements addressed in one code versus those of another. |
| A2 – EQUIVALENT<br><br>Requirements are considered to be equivalent when applying either code or standard, if compliance with the applied code or standard will also meet the requirements of the other code or standard. Equivalence is not affected by differences in level of precision of unit conversions. | B2 - TECHNICALLY DIFFERENT<br><br>Requirements are considered to be technically different if either code requires something more or less than, or otherwise technically different from, the requirements imposed by the other. These differences might be due to different technical approaches applied by a code or imposition of regulatory requirements within the country from which a code originates. |

These are the definitions of the scale used for the code comparison throughout the report.

**Summary of Comparison:**

The Table shown below shows a preliminary comparison and indicates many areas that are identical, some that are similar or equivalent and a few that are different. A detailed line-by-line comparison is performed to highlight these differences.

| Subject | ASME | CSA | Comment |
|---|---|---|---|
| Introduction (Scope) | NB-1000 | Preface & Clause 1 | A1, End Note |
| Material | NB-2000 | Clause 8.1.1 | A1, End Note |
| Design | NB-3000 | Clause 7.1.1 | A1, End Note |
| Fabrication Installation | NB-4000 | Clause 9.2.1 | A1, End Note |
| Examination | NB-5000 | Clause 11.1.1 | A1, B2, End Note |
| Testing | NB-6000 | Clause 11.4.4 | A1, End Note |
| Overpressure Protection | NB-7000 | Clause 7.7.1.1 | A1, End Note |

| **NB-1000: INTRODUCTION** | | **Compared to CSA N285.0 Preface and Clause 1: Scope** | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NB-1100** | **SCOPE** | | |
| NB-1110 | Aspects of Construction Covered by these Rules | Identical | A1 |
| NB-1120 | Temperature Limits | Identical | A1 |
| NB-1130 | Boundaries of Jurisdiction Applicable to this Subsection | | |
| NB-1131 | Boundary of Components | Identical | A1 |
| NB-1132 | Boundary Between Components and Attachments | | |
| NB-1140 | Electrical and Mechanical Penetration Assemblies | Identical (ID-E)[4]<br>• Annex I has some requirements for penetration | A1 |

| **NB-2000: MATERIALS** | | **Compared to CSA N285.0 Clause 8.1.1** | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |

4. See end notes at the end of this appendix.

| NB-2000: MATERIALS | | Compared to CSA N285.0 Clause 8.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NB-2100** | **GENERAL REQUIREMENTS FOR MATERIAL** | | |
| NB-2110 | Scope of principal terms employed | Identical (ID-E)<br>• Materials not covered by the rules of ASME, specific to CANDU nuclear power plants, the rules provided by the CSA N285.6 governs. | A1 |
| NB-2120 | Pressure-retaining material | | |
| NB-2121 | Permitted Material Specifications | Identical | A1 |
| NB-2122 | Special Requirements Conflicting With Permitted Material Specifications | | |
| NB-2124 | Size Ranges | | |
| NB-2125 | Fabricated Hubbed Flanges | | |
| NB-2126 | Finned Tubes | | |
| NB-2127 | Seal Membrane Material | | |
| NB-2128 | Bolting Material | | |
| NB-2130 | Certification of material | Identical | A1 |
| NB-2140 | Welding material | Identical | A1 |
| NB-2150 | Material identification | Identical | A1 |
| NB-2160 | Deterioration of material in-service | Identical | A1 |
| NB-2170 | Heat treatment to enhance impact properties | Identical | A1 |
| NB-2180 | Procedures for heat treatment of material | Identical | A1 |
| NB-2190 | Nonpressure-retaining Material | Identical | A1 |
| **NB-2200** | **MATERIAL TEST COUPONS AND SPECIMENS FOR FERRITIC STEEL MATERIAL** | | |
| NB-2210 | Heat treatment Requirements | | |
| NB-2211 | Test Coupon Heat Treatment for Ferritic Material | Identical | A1 |
| NB-2212 | Test Coupon Heat Treatment for Quenched and Tempered Material | | |

| NB-2000: MATERIALS | | Compared to CSA N285.0 Clause 8.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-2220 | Procedure For Obtaining Test Coupons And Specimens For Quenched And Tempered Material | | |
| NB-2221 | General Requirements | Identical | A1 |
| NB-2222 | Plates | | |
| NB-2223 | Forgings | | |
| NB-2224 | Bar and Bolting Material | | |
| NB-2225 | Tubular Products and Fittings | | |
| NB-2226 | Tensile Test Specimen Location | | |
| **NB-2300** | **FRACTURE TOUGHNESS REQUIREMENTS FOR MATERIAL** | | |
| NB-2310 | Material to be impact tested | | |
| NB-2311 | Material for Which Impact Testing Is Required | Identical | A1 |
| NB-2320 | Impact test procedures | | |
| NB-2321 | Type of Tests | Identical | A1 |
| NB-2322 | Test Specimens | | |
| NB-2330 | Test requirements and acceptance standards | | |
| NB-2331 | Material for Vessels | Identical | A1 |
| NB-2332 | Material for Piping, Pumps and Valves, Excluding Bolting Material | | |
| NB-2333 | Bolting Material | | |
| NB-2340 | Number of impact tests required | | |
| NB-2341 | Plates | Identical | A1 |
| NB-2342 | Forgings and Castings | | |
| NB-2343 | Bars | | |
| NB-2344 | Tubular Products and Fittings | | |
| NB-2345 | Bolting Material | | |
| NB-2346 | Test Definitions | | |

| NB-2000: MATERIALS | | Compared to CSA N285.0 Clause 8.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-2350 | Retests | Identical | A1 |
| NB-2360 | Calibration of instruments and equipment | Identical | A1 |
| **NB-2400** | **WELDING MATERIAL** | | |
| NB-2410 | General requirements | Identical | A1 |
| NB-2420 | Required tests | Identical | A1 |
| NB-2430 | Weld metal tests | | |
| NB-2431 | Mechanical Properties Test | Identical | A1 |
| NB-2432 | Chemical Analysis Test | | |
| NB-2343 | Delta Ferrite Determination | | |
| NB-2440 | Storage and handling of welding material | Identical | A1 |
| **NB-2500** | **EXAMINATION AND REPAIR OF PRESSURE-RETAINING MATERIAL** | | |
| NB-2510 | Examination of pressure-retaining Material | Identical | A1 |
| NB-2520 | Examination after quenching and tempering | Identical | A1 |
| NB-2530 | Examination and repair of Plate | | |
| NB-2531 | Required Examinations | Identical | A1 |
| NB-2532 | Examination Procedures | | |
| NB-2537 | Time of Examination | | |
| NB-2538 | Elimination of Surface Defects | | |
| NB-2539 | Repair by Welding | | |
| NB-2540 | Examination and repair of forgings and bars | | |
| NB-2541 | Required Examinations | Identical | A1 |
| NB-2542 | Ultrasonic Examination | | |
| NB-2545 | Magnetic Particle Examination | | |
| NB-2546 | Liquid Penetrant Examination | | |

| NB-2000: MATERIALS | | Compared to CSA N285.0 Clause 8.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-2547 | Time of Examination | | |
| NB-2548 | Examination of Surface Defects | | |
| NB-2549 | Repair by Welding | | |
| NB-2550 | Examination and repair of Seamless and welded (without filler metal) Tubular products and Fittings | | |
| NB-2551 | Required Examination | Identical | A1 |
| NB-2552 | Ultrasonic Examination | | |
| NB-2553 | Radiographic Examination | | |
| NB-2554 | Eddy Current Examination | | |
| NB-2555 | Magnetic Particle Examination | | |
| NB-2556 | Liquid Penetrant Examination | | |
| NB-2557 | Time of Examination | | |
| NB-2558 | Elimination of Surface Defects | | |
| NB-2559 | Repair by Welding | | |
| NB-2560 | Examination and repair of Tubular products and Fittings welded with filler Metal | | |
| NB-2561 | Required Examination | Identical | A1 |
| NB-2562 | Ultrasonic Examination | | |
| NB-2563 | Radiographic Examination | | |
| NB-2564 | Eddy Current Examination | | |
| NB-2565 | Magnetic Particle Examination | | |
| NB-2566 | Liquid Penetrant Examination | | |
| NB-2567 | Time of Examination | | |
| NB-2568 | Elimination of Surface Defects | | |
| NB-2569 | Repair by Welding | | |
| NB-2570 | Examination and repair of Statically and Centrifugally cast products | Identical | A1 |

| NB-2000: MATERIALS | | Compared to CSA N285.0 Clause 8.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-2580 | Examination of bolts, studs and nuts | | |
| NB-2581 | Required Examination | Identical | A1 |
| NB-2582 | Visual Examination | | |
| NB-2583 | Magnetic Particle Examination | | |
| NB-2584 | Liquid Penetrant Examination | | |
| NB-2585 | Ultrasonic Examination for Sizes Greater Than 2 in | | |
| NB-2586 | Ultrasonic Examination for Sizes Over 4 in | | |
| NB-2587 | Time of Examination | | |
| NB-2588 | Elimination of Surface Defects | | |
| NB-2589 | Repair by Welding | | |
| NB-2600 | MATERIAL ORGANIZATIONS' QUALITY SYSTEM PROGRAMS | | |
| NB-2610 | Documentation and maintenance of quality system programs | Identical | A1 |
| NB-2700 | DIMENSIONAL STANDARDS | Identical | A1 |

| NB-3000: DESIGN | | Compared to CSA N285.0 Clause 7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NB-3100** | **GENERAL DESIGN** | | |
| NB-3110 | Loading Criteria | | |
| NB-3111 | Loading Conditions | Identical | A1 |
| NB-3112 | Design Loadings | | |
| NB-3113 | Service Conditions | | |
| NB-3120 | Special Considerations | | |
| NB-3121 | Corrosion | Identical | A1 |
| NB-3122 | Cladding | | |
| NB-3123 | Welding | | |
| NB-3124 | Environmental Effects | | |
| NB-3125 | Configuration | | |
| NB-3130 | General Design Rules | | |
| NB-3131 | Scope | Identical | A1 |
| NB-3132 | Dimensional Standards for Standard Products | | |
| NB-3133 | Components Under External Pressure | | |
| NB-3134 | Leak Tightness | | |
| NB-3135 | Attachments | | |
| NB-3136 | Appurtenances | | |
| NB-3137 | Reinforcement for Openings | | |
| NB-3200 | DESIGN BY ANALYSIS | | |
| NB-3210 | Design Criteria | | |
| NB-3211 | Requirements for Acceptability | Identical | A1 |
| NB-3212 | Basis for Determining Stresses | | |
| NB-3213 | Terms Relating to Stress Analysis | | |
| NB-3214 | Stress Analysis | | |

| NB-3000: DESIGN | | Compared to CSA N285.0 Clause 7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-3215 | Derivation of Stress Intensities | | |
| NB-3217 | Classification of Stresses | | |
| NB-3220 | Stress Limits for Other than Bolts | | |
| NB-3221 | Design Loadings | Identical | A1 |
| NB-3222 | Level A Service Limits | | |
| NB-3223 | Level B Service Limits | | |
| NB-3224 | Level C Service Limits | | |
| NB-3225 | Level D Service Limits | | |
| NB-3226 | Testing Limits | | |
| NB-3227 | Special Stress Limits | | |
| NB-3228 | Application of Plastic Analysis | | |
| NB-3229 | Design Stress Values | | |
| NB-3230 | Stress Limits for Bolts | | |
| NB-3231 | Design Conditions | Identical | A1 |
| NB-3232 | Level A Service Limits | | |
| NB-3233 | Level B Service Limits | | |
| NB-3234 | Level C Service Limits | | |
| NB-3235 | Level D Service Limits | | |
| NB-3236 | Design Stress Intensity Values | | |
| NB-3300 | VESSEL DESIGN | | |
| NB-3310 | General Requirements | | |
| NB-3311 | Acceptability | Identical | A1 |
| NB-3320 | Design Considerations | | |
| NB-3321 | Design and Service Loadings | Identical | A1 |
| NB-3322 | Special Considerations | | |
| NB-3323 | General Design Rules | | |

| NB-3000: DESIGN | | Compared to CSA N285.0 Clause 7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-3324 | Tentative Pressure Thickness | | |
| NB-3330 | Openings and Reinforcement | | |
| NB-3331 | General Requirements for Openings | Identical | A1 |
| NB-3332 | Reinforcement Requirements for Openings in Shells and Formed Heads | | |
| NB-3333 | Reinforcement Requirements for Openings in Flat Heads | | |
| NB-3334 | Limits of Reinforcement | | |
| NB-3335 | Metal Available for Reinforcement | | |
| NB-3336 | Strength of Reinforcing Material | | |
| NB-3337 | Attachment of Nozzles and Other Connections | | |
| NB-3338 | Fatigue Evaluations of Stressed in Openings | | |
| NB-3339 | Alternative Rules for Nozzle Design | | |
| NB-3340 | Analysis of Vessels | Identical | A1 |
| NB-3350 | Design of Welded Construction | | |
| NB-3351 | Welded Joint Category | Identical | A1 |
| NB-3352 | Permissible Types of Welded Joints | | |
| NB-3354 | Structural Attachment Welds | | |
| NB-3355 | Welding Grooves | | |
| NB-3357 | Thermal Treatment | | |
| NB-3360 | Special Vessel Requirements | | |
| NB-3361 | Category A or B Joint Between Sections of Unequal Thickness | Identical | A1 |
| NB-3362 | Bolted Flange Connections | | |
| NB-3363 | Access Openings | | |
| NB-3364 | Attachments | | |

| NB-3000: DESIGN | | Compared to CSA N285.0 Clause 7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-3365 | Supports | | |
| NB-3400 | PUMP DESIGN | | |
| NB-3410 | General Requirements for Centrifugal Pumps | | |
| NB-3411 | Scope | Identical | A1 |
| NB-3412 | Acceptability | | |
| NB-3414 | Design and Service Conditions | | |
| NB-3415 | Loads from Connected Piping | | |
| NB-3417 | Earthquake Loadings | | |
| NB-3418 | Corrosion | | |
| NB-3419 | Cladding | | |
| NB-3420 | Definitions | | |
| NB-3421 | Radially Split Casing | Identical | A1 |
| NB-3422 | Axially Split Casing | | |
| NB-3423 | Single and Double Volute Casings | | |
| NB-3424 | Seal Housing | | |
| NB-3425 | Typical Examples of Pump Types | | |
| NB-3430 | Design Requirements for Centrifugal Pumps | | |
| NB-3431 | Design of Welding | Identical | A1 |
| NB-3432 | Cutwater Tip Stresses | | |
| NB-3433 | Reinforcement of Pump Casing Inlets and Outlets | | |
| NB-3434 | Bolting | | |
| NB-3435 | Piping | | |
| NB-3436 | Attachments | | |
| NB-3437 | Pump Covers | | |
| NB-3438 | Supports | | |

| NB-3000: DESIGN | | Compared to CSA N285.0 Clause 7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-3440 | Design of Specific Pump Types | | |
| NB-3441 | Standard Pump Types | Identical | A1 |
| NB-3442 | Special Pump Types – Type J Pumps | | |
| **NB-3500** | **VALVE DESIGN** | | |
| NB-3510 | Acceptability | | |
| NB-3511 | General Requirements | Identical | A1 |
| NB-3512 | Acceptability of Large Valves | | |
| NB-3513 | Acceptability of Small Valves | | |
| NB-3515 | Acceptability of Metal Bellows and Metal Diaphragm Stem Sealed Valves | | |
| NB-3520 | Design Considerations | | |
| NB-3521 | Design and Service Loadings | Identical | A1 |
| NB-3524 | Earthquake | | |
| NB-3525 | Level A and B Service Limits | | |
| NB-3526 | Level C Service Limits | | |
| NB-3527 | Level D Service Limits | | |
| NB-3530 | General Rules | | |
| NB-3531 | Pressure-Temperature Ratings and Hydrostatic Tests | Identical | A1 |
| NB-3532 | Design Stress | | |
| NB-3533 | Marking | | |
| NB-3534 | Nomenclature | | |
| NB-3540 | Design of Pressure-Retaining Parts | | |
| NB-3541 | General Requirements for Body Wall Thickness | Identical | A1 |
| NB-3542 | Minimum Wall Thickness of Listed Pressure Rated Valves | | |
| NB-3543 | Minimum Wall Thickness of Valves of Nonlisted | | |

| NB-3000: DESIGN | | Compared to CSA N285.0 Clause 7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| | Pressure Rating | | |
| NB-3544 | Body Shape Rules | | |
| NB-3545 | Body Primary and Secondary Stress Limits | | |
| NB-3546 | Design Requirements for Valve Parts Other than Bodies | | |
| NB-3550 | Cyclic Loading Requirements | | |
| NB-3551 | Verification of Adequacy for Cyclic Conditions | Identical | A1 |
| NB-3552 | Excluded Cycles | | |
| NB-3553 | Fatigue Usage | | |
| NB-3554 | Cyclic Stress Calculations | | |
| NB-3560 | Design Reports | | |
| NB-3561 | General Requirements | Identical | A1 |
| NB-3562 | Design Report for Valves Larger than NPS 4 (DN 100) | | |
| NB-3563 | Design Report Requirements for NPS 4 and Smaller (≤ DN100) | | |
| NB-3590 | Pressure Relief Valve Design | | |
| NB-3591 | Acceptability | Identical | A1 |
| NB-3592 | Design Considerations | | |
| NB-3593 | Special Design Rules | | |
| NB-3594 | Design of Pressure Relief Valve Parts | | |
| NB-3595 | Design Report | | |
| **NB-3600** | **PIPING DESIGN** | | |
| NB-3610 | General Requirements | | |
| NB-3611 | Acceptability | Identical | A1 |
| NB-3612 | Pressure-Temperature Ratings | | |

| NB-3000: DESIGN | | Compared to CSA N285.0 Clause 7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-3613 | Allowances | | |
| NB-3620 | Design Considerations | | |
| NB-3621 | Design and Service Loadings | Identical | A1 |
| NB-3622 | Dynamic Effects | | |
| NB-3623 | Weight Effects | | |
| NB-3624 | Thermal Expansion and Contraction Loads | | |
| NB-3625 | Stress Analysis | | |
| NB-3630 | Piping Design and Analysis Criteria | Identical | A1 |
| NB-3640 | Pressure Design | | |
| NB-3641 | Straight Pipe | Identical | A1 |
| NB-3642 | Curved Segments of Pipe | | |
| NB-3643 | Intersections | | |
| NB-3644 | Miters | | |
| NB-3646 | Closures | | |
| NB-3647 | Pressure Design of Flanged Joints and Blanks | | |
| NB-3648 | Reducers | | |
| NB-3649 | Pressure Design of Other Piping Products | | |
| NB-3650 | Analysis of Piping Products | | |
| NB-3651 | General Requirements | Identical | A1 |
| NB-3652 | Consideration of Design Conditions | | |
| NB-3653 | Considerations of Level A Service Limits | | |
| NB-3654 | Considerations of Level B Service Limits | | |
| NB-3655 | Considerations of Level C Service Limits | | |
| NB-3656 | Considerations of Level D Service Limits | | |
| NB-3657 | Test Loadings | | |

| NB-3000: DESIGN | | Compared to CSA N285.0 Clause 7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-3658 | Analysis of Flanged Joints | | |
| NB-3660 | Design of Welds | | |
| NB-3661 | Welded joints | Identical | A1 |
| NB-3670 | Special Piping Requirements | | |
| NB-3671 | Selection and Limitation of Non-welded Piping Joints | Identical | A1 |
| NB-3672 | Expansion and Flexibility | | |
| NB-3674 | Design of Pipe Supporting Elements | | |
| NB-3677 | Pressure Relief Piping | | |
| NB-3680 | Stress Indices and Flexibility Factors | | |
| NB-3681 | Scope | Identical | A1 |
| NB-3682 | Definitions of Stress Indices and Flexibility Factors | | |
| NB-3683 | Stress Indices for Use With NB-3650 | | |
| NB-3684 | Stress Indices for Detailed Analysis | | |
| NB-3685 | Curved Pipe or Welding Elbows | | |
| NB-3686 | Flexibility Factors | | |
| NB-3690 | Dimensional Requirements for Piping Products | | |
| NB-3691 | Standard Piping Products | Identical | A1 |
| NB-3692 | Nonstandard Piping Products | | |

| NB-4000: FABRICATION AND INSTALLATION | | Compared to CSA N285.0 Clause 9.2.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-4100 | GENERAL REQUIREMENTS | | |
| NB-4110 | Introduction | Identical | A1 |
| NB-4120 | Certification of materials and fabrication by Certificate holder | | |
| NB-4121 | Means of Certification | Identical | A1 |

| NB-4000: FABRICATION AND INSTALLATION | | Compared to CSA N285.0 Clause 9.2.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-4122 | Material Identification | | |
| NB-4123 | Examinations | | |
| NB-4125 | Testing of Welding and Brazing Material | | |
| NB-4130 | Repair of material | Identical | A1 |
| **NB-4200** | **FORMING, FITTING, AND ALIGNING** | | |
| NB-4210 | Cutting, forming and bending | | |
| NB-4211 | Cutting | Identical | A1 |
| NB-4212 | Forming and Bending Processes | | |
| NB-4213 | Qualification of Forming Processes for Impact Property Requirements | | |
| NB-4214 | Minimum Thickness of Fabricated Material | | |
| NB-4220 | Forming tolerances | | |
| NB-4221 | Tolerances for Vessel Shells | Identical | A1 |
| NB-4222 | Tolerances for Formed Vessel Heads | | |
| NB-4223 | Tolerances for Formed or Bent Piping | | |
| NB-4230 | Fitting and aligning | | |
| NB-4231 | Fitting and Aligning Methods | Identical | A1 |
| NB-4232 | Alignment Requirements When Components are Welded From Two Sides | | |
| NB-4233 | Alignment Requirements When Inside Surfaces Are Inaccessible | | |
| NB-4240 | Requirements for weld joints in components | | |
| NB-4241 | Category A Weld Joints in Vessels and Longitudinal Weld Joints in Other Components | Identical | A1 |
| NB-4242 | Category B Weld Joints in Vessels and Circumferential Weld Joints in Other Components | | |

| NB-4000: FABRICATION AND INSTALLATION | | Compared to CSA N285.0 Clause 9.2.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-4243 | Category C Weld Joints in Vessels and Similar Weld Joints in Other Components | | |
| NB-4244 | Category D Weld Joints in Vessels and Similar Weld Joints in Other Components | | |
| NB-4245 | Complete Joint Penetration Welds | | |
| NB-4246 | Piping Branch Connections | | |
| NB-4250 | Welding end transitions — maximum envelope | Identical | A1 |
| **NB-4300** | **WELDING QUALIFICATIONS** | | |
| NB-4310 | General Requirements | | |
| NB-4311 | Types of Processes Permitted | Identical | A1 |
| NB-4320 | Welding Qualifications, Records and Identifying Stamps | | |
| NB-4321 | Required Qualifications | Identical | A1 |
| NB-4322 | Maintenance and Certification of Records | | |
| NB-4323 | Welding Prior to Qualifications | | |
| NB-4324 | Transferring Qualifications | | |
| NB-4330 | General Requirements for Welding Procedure Qualification Tests | | |
| NB-4331 | Conformance to Section IX Requirements | Identical | A1 |
| NB-4333 | Heat Treatment of Qualification Welds for Ferritic Materials | | |
| NB-4334 | Preparation of Test Coupons and Specimens | | |
| NB-4335 | Impact Test Requirements | | |
| NB-4336 | Qualification Requirements for Built-up Weld Deposits | | |
| NB-4337 | Welding of Instrument Tubing | | |
| NB-4350 | Special Qualification Requirements for Tube-to-Tubesheet Welds | Identical | A1 |
| NB-4360 | Qualification Requirements for Welding Specially Designed Welded | | |

| NB-4000: FABRICATION AND INSTALLATION | | Compared to CSA N285.0 Clause 9.2.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-4361 | General Requirements | Identical | A1 |
| NB-4362 | Essential Variables for Automatic Machine and Semiautomatic Welding | | |
| NB-4363 | Essential Variables for Manual Welding | | |
| NB-4366 | Test Assembly | | |
| NB-4367 | Examination of Test Assembly | | |
| NB-4368 | Performance Qualification Test | | |
| **NB-4400** | **RULES GOVERNING MAKING, EXAMINING, AND REPAIRING WELDS** | | |
| NB-4410 | Precautions to Be Taken Before Welding | | |
| NB-4411 | Identification, Storage, and Handling of Welding Material | Identical | A1 |
| NB-4412 | Cleanliness and Protection of Welding Surfaces | Identical | A1 |
| NB-4420 | Rules for Making Welded Joints | | |
| NB-4421 | Backing Rings | Identical | A1 |
| NB-4422 | Peening | | |
| NB-4423 | Miscellaneous Welding Requirements | | |
| NB-4424 | Surface of Welds | | |
| NB-4425 | Welding Items of Different Diameters | | |
| NB-4426 | Reinforcement of Welds | | |
| NB-4427 | Shape and Size of Fillet Welds | | |
| NB-4428 | Seal Welds of Threaded Joints | | |
| NB-4429 | Welding of Clad Parts | | |
| NB-4430 | Welding of Attachments | | |
| NB-4431 | Materials for Attachments | Identical | A1 |
| NB-4432 | Welding of Structural Attachments | | |
| NB-4433 | Structural Attachments | | |

| NB-4000: FABRICATION AND INSTALLATION | | Compared to CSA N285.0 Clause 9.2.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-4434 | Welding of Internal Structural Supports to Clad Components | | |
| NB-4435 | Welding of Nonstructural Attachments and Their Removal | | |
| NB-4436 | Installation of Attachments to Piping Systems After Testing | | |
| NB-4440 | Welding of Appurtenances | Identical | A1 |
| NB-4450 | Repair of Weld Metal Defects | | |
| NB-4451 | General Requirements | Identical | A1 |
| NB-4452 | Elimination of Surface Defects | | |
| NB-4453 | Requirements for Making Repairs of Welds | | |
| NB-4500 | BRAZING | | |
| NB-4510 | Rules for Brazing | | |
| NB-4511 | Where Brazing May be Used | Identical | A1 |
| NB-4512 | Brazing Material | | |
| NB-4520 | Brazing Qualification Requirements | | |
| NB-4521 | Brazing Procedure and Performance Qualification | Identical (ID-E)<br>The welding and brazing procedures are required to be registered by the authorized inspection agency as required by CSA N285 Clause 6.1.11.1 | A1 |
| NB-4522 | Valve Seat Rings | | |
| NB-4523 | Reheated Joints | | |
| NB-4524 | Maximum Temperature Limits | | |
| NB-4530 | Fitting and Aligning of Parts to be Brazed | Identical | A1 |
| NB-4540 | Examination of Brazed Joints | Identical | A1 |
| **NB-4600** | **HEAT TREATMENT** | | |
| NB-4610 | Welding Preheat Requirements | | |
| NB-4611 | When Preheat is Necessary | Identical | A1 |
| NB-4612 | Preheating Methods | | |

| NB-4000: FABRICATION AND INSTALLATION | | Compared to CSA N285.0 Clause 9.2.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-4613 | Interpass Temperature | | |
| NB-4620 | Postweld Heat Treatment | | |
| NB-4621 | Heating and Cooling Methods | Identical | A1 |
| NB-4622 | PWHT Time and Temperature Requirements | | |
| NB-4623 | PWHT Heating and Cooling Rate Requirements | | |
| NB-4624 | Methods of Postweld Heat Treatment | | |
| NB-4630 | Heat Treatment of Welds Other Than the Final Postweld Heat Treatment | Identical | A1 |
| NB-4650 | Heat Treatment After Bending or Forming for Pipes, Pumps and Valves | | |
| NB-4651 | Conditions Requiring Heat Treatment After Bending or Forming | Identical | A1 |
| NB-4652 | Exemptions From Heat Treatment After Bending Forming | | |
| NB-4660 | Heat Treatment of Electroslag Welds | Identical | A1 |
| **NB-4700** | **MECHANICAL JOINTS** | | |
| NB-4710 | Bolting and Threading | | |
| NB-4711 | Thread Engagement | Identical | A1 |
| NB-4712 | Thread Lubricants | | |
| NB-4713 | Removal of Thread Lubricants | | |
| NB-4720 | Bolting Flanged Joints | Identical | A1 |
| NB-4730 | Electrical and Mechanical Penetration Assemblies | Identical | A1 |

| NB-5000: EXAMINATION | | Compared to CSA N285.0 Clause 11.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NB-5100** | **GENERAL REQUIREMENTS FOR EXAMINATION** | | |
| NB-5110 | Methods, Nondestructive Examination Procedures and Cleaning | | |
| NB-5111 | Methods | Identical | A1 |
| NB-5112 | Nondestructive Examination Procedures | | |
| NB-5113 | Post-Examination Cleaning | | |
| NB-5120 | Time of Examination of Welds and Weld Metal Cladding | Identical | A1 |
| NB-5130 | Examination of Weld Edge Preparation Surfaces | Identical | A1 |
| NB-5140 | Examination of Welds and Adjacent Base Material | Identical | A1 |
| **NB-5200** | **REQUIRED EXAMINATION OF WELDS FOR FABRICATION AND PRE-SERVICE BASELINE** | | |
| NB-5210 | Category A Vessel Welded Joints and Longitudinal Welded Joints in Other Components | Identical | A1 |
| NB-5220 | Category B Vessel Welded Joints and Circumferential Welded Joints in Piping, Pumps and Valves | | |
| NB-5221 | Vessel Welded Joints | Identical | A1 |
| NB-5222 | Piping, Pump and Valve Circumferential Welded Joints | | |
| NB-5230 | Category C Vessel Welded Joints and Similar Welded Joints in Other Components | | |
| NB-5231 | General Requirements | Identical | A1 |
| NB-5240 | Category D Vessel Welded Joints and Branch and Piping Connections in Other Components | | |
| NB-5241 | General Requirements | Identical | A1 |
| NB-5242 | Full Penetration Butt Welded Nozzles, Branch and Piping Connections | | |
| NB-5243 | Corner Welded Nozzles, Branch and Piping Connections | | |
| NB-5244 | Weld Metal Building at Openings for Nozzles, Branch and Piping Connections | | |
| NB-5245 | Fillet Welded and Partial Penetration Welded Joints | | |

| NB-5000: EXAMINATION | | Compared to CSA N285.0 Clause 11.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-5246 | Oblique Full Penetration Nozzles, Branch and Piping Connections | | |
| NB-5260 | Fillet, Partial Penetration, Socket and Attachment Welded Joints | | |
| NB-5261 | Fillet, Partial Penetration and Socket Welded Joints | Identical | A1 |
| NB-5262 | Structural Attachment Welded Joints | | |
| NB-5270 | Special Welded Joints | | |
| NB-5271 | Welded Joints of Specially Designed Seals | Identical | A1 |
| NB-5272 | Weld Metal Cladding | | |
| NB-5273 | Hard Surfacing | | |
| NB-5274 | Tube-to-Tubesheet Welded Joints | | |
| NB-5275 | Brazed Joints | | |
| NB-5276 | Inertia and Continuous Drive Friction Welds | | |
| NB-5277 | Electron Beam Welds | | |
| NB-5278 | Electroslag Welds | | |
| NB-5279 | Special Exceptions | | |
| NB-5280 | Pre-service Examination | | |
| NB-5281 | General Requirements | Identical | A1 |
| NB-5282 | Examination Requirements | | |
| NB-5283 | Components Exempt From Preservice Examination | | |
| **NB-5300** | **ACCEPTANCE STANDARDS** | | |
| NB-5320 | Radiographic Acceptance Standards | Identical | A1 |
| NB-5330 | Ultrasonic Acceptance Standards | | |
| NB-5331 | Fabrication | Identical | A1 |
| NB-5332 | Preservice Examination | | |
| NB-5340 | Magnetic Particle Acceptance Standards | | |

| NB-5000: EXAMINATION | | Compared to CSA N285.0 Clause 11.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-5341 | Evaluation of Indications | Identical | A1 |
| NB-5342 | Acceptance Standards | | |
| NB-5343 | Preservice Examination | | |
| NB-5350 | Liquid Penetrant Acceptance Standards | | |
| NB-5351 | Evaluation of Indications | Identical | A1 |
| NB-5352 | Acceptance Standards | | |
| NB-5353 | Preservice Examination | | |
| NB-5360 | Eddy Current Preservice Examination of Installed Non-ferromagnetic Steam Generator Heat Exchanger Tubing | Identical | A1 |
| NB-5370 | Visual Acceptance Standards for Brazed Joints | Identical | A1 |
| NB-5380 | Bubble Formation Testing | Identical | A1 |
| **NB-5400** | **FINAL EXAMINATION OF VESSELS** | | |
| NB-5410 | Examination After HydroStatic Test | Identical | A1 |
| **NB-5500** | **QUALIFICATIONS AND CERTIFICATION OF NONDESTRUCTIVE EXAMINATION PERSONNEL** | | |
| NB-5510 | General Requirements | Identical | A1 |
| NB-5520 | Personnel Qualification, Certification and Verification | | |
| NB-5521 | Qualification Procedure | Different<br>CSA Clause 11.3: The licensee shall have documentation to demonstrate | B2 |
| NB-5522 | Certification of Personnel | | |

| NB-5000: EXAMINATION | | Compared to CSA N285.0 Clause 11.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-5523 | Verification of Nondestructive Examination Personnel Certification | that persons performing nondestructive examinations on pressure-retaining components were, at the time of the examinations, qualified in accordance with the following standards:<br>In Canada: (i) radiography, ultrasonic, magnetic particle, liquid penetrant, and eddy current methods – CAN/CGSB-48.9712/ISO 9712; and (ii) other methods — standards acceptable to the licensee and the authorized inspection agency.<br>Outside Canada: all methods — standards acceptable to the licensee and the authorized inspection agency.<br>Note: Stamped items are acceptable in Canada and in this case the use of SNT-TC-1A for qualification of NDE personnel is acceptable provided the AIA and the Licensee accepted its use. | |
| NB-5530 | Records | Identical | A1 |

| NB-6000: TESTING | | Compared to CSA N285.0 Clause 11.4.4 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NB-6100** | **GENERAL REQUIREMENTS** | | |
| NB-6110 | Pressure Testing of Components, Appurtenances and Systems | | |
| NB-6111 | Scope of Pressure Testing | Identical | A1 |
| NB-6112 | Pneumatic Testing | | |
| NB-6113 | Witnessing of Pressure Tests | | |
| NB-6114 | Time of Pressure Testing | | |
| NB-6115 | Machining After Pressure Test | | |
| NB-6120 | Preparation for Testing | | |
| NB-6211 | Exposure of Joints | Identical | A1 |
| NB-6212 | Addition of Temporary Supports | | |
| NB-6213 | Restraint or Isolation of Expansion Joints | | |
| NB-6214 | Isolation of Equipment Not Subjected to Pressure Test | | |
| NB-6215 | Treatment of Flanged Joints Containing Blanks | | |
| NB-6216 | Precautions Against Test Medium Expansion | | |
| NB-6217 | Check of Test Equipment Before Applying Pressure | | |
| **NB-6200** | **HYDROSTATIC TESTS** | | |
| NB-6210 | Hydrostatic Test Procedure | | |
| | | Identical | A1 |
| NB-6220 | Hydrostatic Test Pressure Requirements | | |
| NB-6221 | Maximum Required Pneumatic Test Pressure | Identical | A1 |
| NB-6222 | Maximum Permissible Test Pressure | | |
| NB-6223 | Hydrostatic Test Pressure Holding Time | | |
| NB-6224 | Examination for Leakage After Application of Pressure | | |

| NB-6000: TESTING | | Compared to CSA N285.0 Clause 11.4.4 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NB-6300** | **PNEUMATIC TESTS** | | |
| NB-6310 | Pneumatic Testing Procedures | | |
| NB-6311 | | Identical | A1 |
| NB-6312 | Test Medium and Test Temperature | | |
| NB-6313 | Procedure for Applying Pressure | | |
| NB-6320 | Pneumatic Test Pressure Requirements | | |
| NB-6321 | Maximum Required Pneumatic Test Pressure | Identical | A1 |
| NB-6322 | Maximum Permissible Test Pressure | | |
| NB-6223 | Test Pressure Holding Time | | |
| NB-6324 | Examination for Leakage After Application of Pressure | | |
| **NB-6400** | **PRESSURE TEST GAGES** | | |
| NB-6411 | Types of Gages to be Used and Their Location | | |
| NB-6412 | Range of Indicating Pressure Gages | Identical | A1 |
| NB-6413 | Calibration of Pressure Test Gages | | |
| **NB-6600** | **SPECIAL TEST PRESSURE SITUATIONS** | | |
| NB-6610 | Components Designed for External Pressure | | |
| NB-6620 | Pressure Testing of Combination Units | | |
| NB-6621 | Pressure Chambers Designed to Operate Independently | Identical | A1 |
| NB-6622 | Common Elements Designed for a Maximum Differential Pressure | | |

| NB-7000: OVERPRESSURE PROTECTION | | Compared to CSA N285.0 Clause 7.7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NB-7100** | **GENERAL REQUIREMENTS** | | |
| NB-7110 | Scope | Identical | A1 |
| NB-7120 | Integrated Overpressure Protection | Identical | A1 |
| NB-7130 | Verification of the Operation of Reclosing Pressure Relief Devices | | |
| NB-7131 | Construction | Identical | A1 |
| NB-7140 | Installation | | |
| NB-7141 | Pressure Relief Devices | Identical | A1 |
| NB-7142 | Stop Valves | | |
| NB-7143 | Draining of Pressure Relief Devices | | |
| NB-7150 | Acceptable Pressure Relief Devices | | |
| NB-7151 | Pressure Relief Valves | Identical | A1 |
| NB-7152 | Nonreclosing Pressure Relief Devices | | |
| NB-7160 | Unacceptable Pressure Relief Devices | | |
| NB-7161 | Deadweight Pressure Relief Valves | Identical | A1 |
| NB-7170 | Permitted Use of Pressure Relief Devices | | |
| NB-7171 | Safety Valves | Identical | A1 |
| NB-7172 | Safety Relief Valves | | |
| NB-7173 | Relief Valves | | |
| NB-7174 | Pilot Operated Pressure Relief Valves | | |
| NB-7175 | Power Actuated Pressure Relief Valves | | |
| NB-7176 | Safety Valves with Auxiliary Actuating Devices | | |
| NB-7177 | Pilot Operated Pressure Relief Valves with Auxiliary Actuating Devices | | |
| **NB-7200** | **OVERPRESSURE PROTECTION REPORT** | | |
| NB-7210 | Responsibility for Report | Identical | A1 |

| NB-7000: OVERPRESSURE PROTECTION | | Compared to CSA N285.0 Clause 7.7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-7220 | Content of Report | Identical<br>CSA N285 has a Table of Contents which contains similar content as ASME Sec. III | A1 |
| NB-7230 | Certification of Report | Identical | A1 |
| NB-7240 | Review of Report After Installation | Identical | A1 |
| NB-7250 | Filing of Report | Identical | A1 |
| **NB-7300** | **RELIEVING CAPACITY** | | |
| NB-7310 | Expected System Pressure Transient Conditions | Identical | A1 |
| NB-7320 | Unexpected System Excess Pressure Transient Conditions | Identical | A1 |
| **NB-7400** | **SET PRESSURES OF PRESSURE RELIEF DEVICES** | | |
| NB-7410 | Set Pressure Limitations for Expected System Pressure Transient Conditions | Identical | A1 |
| NB-7420 | Set Pressure Limitation for Unexpected System Excess Pressure Transient Conditions | Identical | A1 |
| **NB-7500** | **OPERATING AND DESIGN REQUIREMENTS FOR PRESSURE RELIEF VALVES** | | |
| NB-7510 | Safety, Safety Relief and Relief Valves | | |
| NB-7511 | General Requirements | Identical | A1 |
| NB-7512 | Safety Valve Operating Requirements | | |
| NB-7513 | Safety Relief and Relief Valve Operating Requirements | | |
| NB-7514 | Credited Relieving Capacity | | |
| NB-7511 | Sealing of Adjustments | | |

| NB-7000: OVERPRESSURE PROTECTION | | Compared to CSA N285.0 Clause 7.7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-7520 | Pilot Operated Pressure Relief Valves | | |
| NB-7521 | General Requirements | Identical | A1 |
| NB-7522 | Operating Requirements | | |
| NB-7523 | Credited Relieving Capacity | | |
| NB-7524 | Sealing of Adjustments | | |
| NB-7530 | Power Actuated Pressure Relief Valves | | |
| NB-7531 | General Requirements | Identical | A1 |
| NB-7532 | Operating Requirements | | |
| NB-7533 | Certified Relieving Capacity | | |
| NB-7534 | Credited Relieving Capacity | | |
| NB-7535 | Sealing of Adjustments | | |
| NB-7540 | Safety Valves and Pilot Operated Pressure Relief Valves With Auxiliary Actuating Devices | Identical | A1 |
| NB-7550 | Alternative Test Media | | |
| NB-7551 | General Requirements | Identical | A1 |
| NB-7552 | Correlation | | |
| NB-7553 | Verification of Correlation Procedure | | |
| NB-7554 | Procedure | | |
| NB-7600 | NON-RECLOSING PRESSURE RELIEF DEVICES | | |
| NB-7610 | Rupture Disk Devices | Identical | A1 |
| NB-7620 | Installation | | |
| NB-7621 | Provisions for Venting or Draining | Identical | A1 |
| NB-7622 | System Obstructions | | |
| NB-7623 | Rupture Disk Devices at the Outlet Side of Pressure Relief Valves | | |

| NB-7000: OVERPRESSURE PROTECTION | | Compared to CSA N285.0 Clause 7.7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NB-7700** | **CERTIFICATION** | | |
| NB-7710 | Responsibility for Certification of Pressure Relief Valves | Identical | A1 |
| NB-7720 | Responsibility for Certification of Non-reclosing Pressure Relief Devices | Identical | A1 |
| NB-7730 | Capacity Certification Pressure Relief Valves — Compressible Fluids | | |
| NB-7731 | General Requirements | Identical | A1 |
| NB-7732 | Flow Model Test Method | | |
| NB-7733 | Slope Method | | |
| NB-7734 | Coefficient of Discharge Method | | |
| NB-7735 | Single Valve Method | | |
| NB-7736 | Proration of Capacity | | |
| NB-7737 | Capacity Conversions | | |
| NB-7738 | Laboratory Acceptance of Pressure Relieving Capacity Tests | | |
| NB-7739 | Laboratory Acceptance of Demonstration of Function Tests | | |
| NB-7740 | Capacity Certification of Pressure Relief Valves — Incompressible Fluids | | |
| NB-7741 | General Requirements | Identical | A1 |
| NB-7742 | Valve Designs in Excess of Test Facility Limits | | |
| NB-7743 | Slope Method | | |
| NB-7744 | Coefficient of Discharge Method | | |
| NB-7745 | Single Valve Method | | |
| NB-7746 | Laboratory Acceptance of Pressure Relieving Capacity Tests | | |

| NB-7000: OVERPRESSURE PROTECTION | | Compared to CSA N285.0 Clause 7.7.1.1 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NB-7747 | Proration of Capacity | | |
| NB-7748 | Capacity Conversions | | |
| NB-7749 | Laboratory Acceptance of Demonstration of Function Tests | | |
| **NB-7800** | **MARKING, STAMPING AND DATA REPORTS** | | |
| NB-7810 | Pressure Relief Valves | | |
| NB-7811 | Marking and Stamping | Identical | A1 |
| NB-7812 | Report Form for Pressure Relief Valves | | |
| NB-7820 | Rupture Disk Devices | | |
| NB-7821 | Rupture Disks | Identical | A1 |
| NB-7822 | Disk Holders | | |
| NB-7830 | Certificate of Authorization to Use Code Symbol Stamp | Identical | A1 |

| NB-8000: NAMEPLATE, STAMPING AND REPORTS | | Compared to CSA N285.0 Clause 12.4 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NB-8100** | **GENERAL REQUIREMENTS** | Identical (ID-E)<br>• Except Code symbol stamping is not required. | A1 |

## END NOTE(S):

**Identical (ID-E)**

1. The Division 2 deviations and other minor deviations, such as: no stamping, will be identified by "Identical (ID-E)" which is meant to indicate the requirement is identical with an exception as below.

## EXPLANATION OF DIFFERENCES:

ASME BPV Code Section III, Subsection NB, Division 1 was compared against CSA Standard N285.0-08 (Update # 2). The summary of these differences are noted below:

1. CSA Standard N285.0, Annex I has requirements for penetration
2. CANDU Nuclear Power Plants specific Materials which are not covered by the rules of ASME, rules are provided by the CSA N285.6.
3. The welding and brazing procedures are required to be registered with the authorized inspection agency as required by CSA N285 Clause 6.1.11.1
4. CSA Clause 11.3: The licensee shall have documentation to demonstrate that persons performing nondestructive examinations on pressure-retaining components were, at the time of the examinations, qualified in accordance with the following standards:

   In Canada: (i) radiography, ultrasonic, magnetic particle, liquid penetrant, and eddy current methods – CAN/CGSB-48.9712/ISO 9712; and (ii) other methods — standards acceptable to the licensee and the authorized inspection agency.

   Outside Canada: all methods — standards acceptable to the licensee and the authorized inspection agency.

   **Note**: Stamped items are acceptable in Canada and in this case the use of SNT-TC-1A for qualification of NDE personnel is acceptable provided the AIA and the Licensee accepted its use.
5. CSA N285 has a Table of Contents which contains similar content as ASME BPV Code Section III
6. CSA N285 does not require Code symbol stamping

# APPENDIX D2: CSA N285.0 VERSUS ASME SECTION III DIV. 1 – NCA COMPARISON

**CODE EDITIONS:**

1. CSA Standard N285.0 – 2008 (Update 2)
2. ASME BPV Code Section III, Div. 1, NCA, 2007 Edition (No Addenda)

**COMPARISON SCALE USED:**

These are the definitions of the scale used for the code comparison throughout the report.

| | |
|---|---|
| **A1 – SAME**<br>Requirements classified as category A1 are considered to be technically identical. Requirements are classified as category A1 and considered to be the same even if there are inconsequential differences in wording, such as might result due to translation from one language to another, as long as the wording does not change the meaning or interpretation of the requirement. Likewise, differences in paragraph numbering are not considered when classifying requirements as long as the same requirement exists in both codes being compared. | **B1 - DIFFERENT – NOT SPECIFIED**<br>Requirements are considered to be different - not specified, if one code or standard includes requirements that the compared code or standard does not specify. This classification may result because of differences in the scope of equipment covered by a respective code, the scope of industrial practices applied in context of the respective code, differences in regulatory requirements applicable in conjunction with application of a particular code, or simply as a result of differences in requirements addressed in one code versus those of another. |
| **A2 – EQUIVALENT**<br>Requirements are considered to be equivalent when applying either code or standard, if compliance with the applied code or standard will also meet the requirements of the other code or standard. Equivalence is not affected by differences in level of precision of unit conversions. | **B2 - TECHNICALLY DIFFERENT**<br>Requirements are considered to be technically different if either code requires something more or less than, or otherwise technically different from, the requirements imposed by the other. These differences might be due to different technical approaches applied by a code or imposition of regulatory requirements within the country from which a code originates. |

These are the definitions of the scale used for the code comparison throughout the report.

**SUMMARY OF COMPARISON:**

The Table shown below shows a preliminary comparison and indicates many areas that are identical, some that are similar or equivalent and a few that are different. A detailed line-by-line comparison is performed to highlight these differences.

| Subject | ASME | CSA | Comment |
|---|---|---|---|
| Scope of Section III | NCA-1000 | Preface & Clause 1 | A1, A2, End Note |
| Classification | NCA-2000 | Clause 5, Fig. 1, Annex A | A1, A2, End Note |
| Responsibilities & Duties | NCA-3000 | Clause 3 & 10, Annex E | A1, A2, B2, End Note |
| Quality Assurance | NCA-4000 | Clause 10, Annex E | A1, End Note |
| Authorized Inspection | NCA-5000 | Clause 3 | A2 |
| Certificates, Nameplates, Data Reports | NCA-8000 | Clause 12.3 | A1, A2, B2, End Note |
| Glossary & Definitions | NCA-9000 | Clause 3 | A1, End Note |

| NCA-1000: SCOPE OF SECTION III | | Compared to CSA N285.0 Preface and Clause 1: Scope | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NCA-1100** | **GENERAL** | | |
| NCA-1110 | Scope | Identical (ID-E)[5]<br>• CSA N285 has identical requirements, except stamping is not required and the concrete requirements of Division 2 are covered by CSA N287 Series. | A1 |
| NCA-1120 | Definitions | Identical (ID-E)<br>• CSA N285 has identical requirements, but different CANDU requirements results in some new or modified definitions. | A1 |

[5] See end notes at the end of this appendix

| NCA-1000: SCOPE OF SECTION III | | Compared to CSA N285.0 Preface and Clause 1: Scope | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NCA-1130 | Limits of These Rules | Identical (ID-E)<br>• Except the requirements of NCA-1130 (d) are covered by CSA N287 Series. | A1 |
| NCA-1140 | Use of Code Editions, Addenda and Cases | Equivalent<br>• Except the requirements of NCA-1140 (a) are addressed by CSA N285, Clause 4. | A2 |
| NCA-1150 | Units of Measurement | Identical | A1 |
| **NCA-1200** | **GENERAL REQUIREMENTS FOR ITEMS AND INSTALLATION** | | |
| NCA-1210 | Components | Identical (ID-E)<br>• Except Code symbol stamping is not required. | A1 |
| NCA-1220 | Materials | Identical (ID-E)<br>• Except Code symbol stamping is not required and concrete requirements of Division 2 are covered by CSA N287 Series. | A1 |
| NCA-1230 | Parts, Piping Subassemblies and Supports | Identical (ID-E)<br>• Except Code symbol stamping is not required. | A1 |
| NCA-1260 | Appurtenances | Identical (ID-E)<br>• Except Code symbol stamping is not required. | A1 |
| NCA-1270 | Miscellaneous Items | Identical (ID-E)<br>• Except Code symbol stamping is not required. | A1 |
| NCA-1280 | Installation | Identical (ID-E)<br>• Except Code symbol stamping is not required. | A1 |

| NCA-2000: CLASSIFICATION OF COMPONENTS AND SUPPORTS | | Compared to CSA N285.0 Clause 5, Figure 1 and Annex A | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NCA-2100** | **GENERAL REQUIREMENTS** | | |
| NCA-2110 | Scope | Equivalent<br>• CSA N285 provides requirements for the classification of process and safety systems and their supports. This is beyond the scope of ASME BPVC Section III because CSA N285 provides rules for components once they have been classified to their appropriate system criteria. Annex A of CSA N285 provides requirements for CANDU nuclear power plant.<br>• The requirements of Division 2 are covered by CSA N287 Series. | A2 |
| NCA-2120 | Purpose of Classifying Items of a Nuclear Power Plant | Identical (ID-E)<br>• Except there are no requirements provided for Class MC, CS and CC. | A1 |
| NCA-2130 | Classifications and Rules of This Section | Identical (ID-E)<br>• Except there are no requirements provided for Class MC, CS (NCA-2131) and CC (NCA-2132) | A1 |
| NCA-2140 | Design Basis | | |
| NCA-2141 | Consideration of Plant and System Operating and Test Conditions | Identical (ID-E)<br>• Except the requirements of NCA-2144 (d) are covered by CSA N287 Series. | A1 |
| NCA-2142 | Establishment of Design, Service and Test Loadings and Limits | | |
| NCA-2143 | Acceptance Criteria | | |
| NCA-2144 | Concrete Containments | | |
| NCA-2160 | Special Requirements Applied to Code Classes | Identical | A1 |

| NCA-3000: RESPONSIBILITIES AND DUTIES | | Compared to CSA N285.0 Clause 3: Licensee Definition and Clause 10: QA | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NCA-3100** | **GENERAL** | | |
| NCA-3110 | Responsibilities vs. Legal Liabilities | Identical | A1 |
| NCA-3120 | Accreditation | | |
| NCA-3121 | Types of Certificates | Equivalent<br>• CSA N285 Certificate of Authorization is different than ASME Certificates but meet the same intent, except Code symbol stamping is not required. | A2 |
| NCA-3125 | Subcontracted Services | | |
| NCA-3126 | Subcontracted Calibration Services | | |
| NCA-3130 | Welding and Subcontracting During Construction | Identical (ID-E)<br>• Except the concrete requirements of NCA-3132 are covered by CSA N287 Series. | A1 |
| **NCA-3200** | **OWNER'S RESPONSIBILITIES** | | |
| NCA-3220 | Categories of the Owner's Responsibilities | Technically Different<br>• Regulatory process for licensing requirements is specified by the Canadian Nuclear Safety Commission (CNSC), and is not covered by CSA N285. Compliance with CNSC requirements is mandatory. | B2 |
| NCA-3230 | Owner's Certificate | Technically Different<br>• Regulatory process for licensing requirements is specified by the Canadian Nuclear Safety Commission (CNSC), and is not covered by CSA N285. Compliance with CNSC requirements is mandatory. | B2 |
| NCA-3240 | Provision of Adequate Supporting Structures | Identical | A1 |
| NCA-3250 | Provision of Design Specifications | | |
| NCA-3251 | Provision and Correlation | Identical | A1 |
| NCA-3252 | Contents of Design Specifications | | |
| NCA-3253 | Classification of Components, Parts and Appurtenances | | |

| NCA-3000: RESPONSIBILITIES AND DUTIES | | Compared to CSA N285.0 Clause 3: Licensee Definition and Clause 10: QA | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NCA-3254 | Boundaries of Jurisdictions | | |
| NCA-3255 | Certification of the Design Specifications | | |
| NCA-3256 | Filing of Design Specifications | | |
| NCA-3260 | Review of Design Report | Identical | A1 |
| NCA-3270 | Overpressure Protection Report | | |
| NCA-3271 | Responsibility and Content | Identical | A1 |
| NCA-3272 | Certification of Report | | |
| NCA-3273 | Filing of Report | | |
| NCA-3280 | Owner's Data Report and Filing | Identical (ID-E)<br>• Similar process is observed in CSA N285.0 with minor variations in the form templates | A1 |
| NCA-3290 | Owner's Responsibility for Records | Identical | A1 |
| **NCA-3300** | **RESPONSIBILITIES OF A DESIGNER – DIVISION 2** | Not Applicable for this comparison<br>• The scope of CSA N285 does not cover the requirements of Division 2; CSA N287 provides rules for concrete buildings and containment. | - |
| **NCA-3400** | **RESPONSIBILITIES OF AN N CERTIFICATE HOLDER – DIVISION 2** | Not Applicable for this comparison<br>• The scope of CSA N285 does not cover the requirements of Division 2; CSA N287 provides rules for concrete buildings and containment. | - |
| **NCA-3500** | **RESPONSIBILITIES OF AN N CERTIFICATE HOLDER** | | |
| NCA-3520 | Categories of the N Certificate Holder's Responsibilities | Equivalent<br>• All of the requirements of this Para are adopted by CSA N285, except the requirement of NCA-3520 (a) for Code symbol stamping is not required.<br>• NCA-3520 (o): Certificate issued by ASME is different from the certificate issued by CSA N285 but meets the same intent. | A2 |

| NCA-3000: RESPONSIBILITIES AND DUTIES | | Compared to CSA N285.0 Clause 3: Licensee Definition and Clause 10: QA | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NCA-3530 | Obtaining a Certificate | Identical (ID-E)<br>• All of the requirements of this Para are adopted by CSA N285, except Code symbol stamping is not required. | A1 |
| NCA-3540 | Compliance With This Section | Identical | A1 |
| NCA-3550 | Requirements for Design Output Documents | | |
| NCA-3551 | General | Identical | A1 |
| NCA-3552 | Design Output Documents for Parts | | |
| NCA-3553 | Design Output Documents for Appurtenances | | |
| NCA-3554 | Modification of Documents and Reconciliation With Design Report | | |
| NCA-3555 | Certification of Design Report | | |
| NCA-3556 | Submittal of Design Report for Owner Review | | |
| NCA-3557 | Availability of Design Report | | |
| NCA-3560 | Responsibility for Quality Assurance | | |
| NCA-3561 | Scope of Responsibilities | Identical | A1 |
| NCA-3562 | Documentation of Quality Assurance | | |
| NCA-3563 | Filing of Quality Assurance Manual | | |
| NCA-3570 | Data Report | Equivalent<br>• CSA N285 Clause 12.3 and 12.4 require certificate holders to submit data reports and provides samples in Figures 8 – 15. | A2 |

| NCA-3000: RESPONSIBILITIES AND DUTIES | | Compared to CSA N285.0 Clause 3: Licensee Definition and Clause 10: QA | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NCA-3600** | **RESPONSIBILITIES OF AN NPT CERTIFICATE HOLDER** | | |
| NCA-3620 | Categories of the NPT Certificate Holder's Responsibilities | Equivalent<br>• CSA N285 Certificate of Authorization is different. Exceptions are requirement of NCA-3620 (a) for Code symbol stamping is not required and the requirements of NCA-3260 (l) for the rules of Division 2 are not covered. | A2 |
| NCA-3630 | Obtaining a Certificate | Identical (ID-E)<br>• All of the requirements of this Para are adopted by CSA N285, except Code symbol stamping is not required. | A1 |
| NCA-3640 | Compliance With This Section | Identical | A1 |
| NCA-3650 | Design Documents for Appurtenances | Identical | A1 |
| NCA-3660 | Responsibility for Quality Assurance | | |
| NCA-3661 | Scope of Responsibilities | Identical | A1 |
| NCA-3662 | Documentation of Quality Assurance | | |
| NCA-3663 | Filing of Quality Assurance Manual | | |
| NCA-3670 | Data Report | Equivalent<br>• CSA N285 Clause 12.3 and 12.4 require certificate holders to submit data reports and provides samples in Figures 8 – 15. | A2 |
| NCA-3680 | Responsibilities of an NS Certificate Holder | | |
| NCA-3681 | Categories of the NS Certificate Holder's Responsibilities | Equivalent<br>• CSA N285 Certificate of Authorization is different. | A2 |
| NCA-3682 | Obtaining a Certificate | | |
| NCA-3683 | Compliance with this Section | | |

| NCA-3000: RESPONSIBILITIES AND DUTIES | | Compared to CSA N285.0 Clause 3: Licensee Definition and Clause 10: QA | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NCA-3684 | Scope of Responsibilities | | |
| NCA-3685 | Documentation of Quality Assurance | | |
| NCA-3686 | Filing of the Quality Assurance Program | | |
| NCA-3687 | NS-1 Certificate of Conformance | | |
| NCA-3689 | Certificate of Compliance | | |
| **NCA-3700** | **RESPONSIBILITIES OF AN NA CERTIFICATE HOLDER** | | |
| NCA-3720 | Categories of the NA Certificate Holder's Responsibilities | Equivalent<br>• CSA N285 Certificate of Authorization is different than ASME Certificates but meet the same intent | A2 |
| NCA-3730 | Obtaining a Certificate | Identical (ID-E)<br>• Except Code symbol stamping is not required. | A1 |
| NCA-3740 | Responsibility for Compliance With This Section | Identical | A1 |
| NCA-3760 | Responsibility for Quality Assurance | Identical | A1 |
| NCA-3770 | Data Report | Equivalent<br>• CSA N285 Clause 12.3 and 12.4 require certificate holders to submit data reports and provides samples in Figures 8 – 15. | A2 |
| **NCA-3800** | **METALLIC MATERIAL ORGANIZATION'S QUALITY SYSTEM PROGRAM** | | |
| NCA-3810 | Scope and Applicability | Identical | A1 |
| NCA-3820 | Accreditation or Qualification of Material Organizations | Identical | A1 |

| NCA-3000: RESPONSIBILITIES AND DUTIES | | Compared to CSA N285.0 Clause 3: Licensee Definition and Clause 10: QA | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NCA-3830 | Responsibilities of Material Organizations | Identical | A1 |
| NCA-3840 | Evaluation of the Program | Identical | A1 |
| NCA-3850 | Quality System Program Requirements | | |
| NCA-3851 | Responsibility and Organization | Identical | A1 |
| NCA-3852 | Personnel | | |
| NCA-3853 | Program Documentation | | |
| NCA-3855 | Control of Purchased Materials, Source Materials and Services | | |
| NCA-3856 | Identification, Marking and Material Control | | |
| NCA-3857 | Process Control | | |
| NCA-3858 | Control of Examinations, Tests and Nonconforming Material | | |
| NCA-3859 | Audits and Correction Action | | |
| NCA-3860 | Certification Requirements | | |
| NCA-3861 | Certification Requirements for Material Organization | Identical | A1 |
| NCA-3862 | Certification of Material | | |
| **NCA-3900** | **NONMETALLIC MATERIAL MANUFACTURER'S AND CONSTITUENT SUPPLIER'S QUALITY SYSTEM PROGRAM** | | |
| NCA-3920 | Quality System Certificate (Nonmetallic Materials) | Identical | A1 |

| NCA-3000: RESPONSIBILITIES AND DUTIES | | Compared to CSA N285.0 Clause 3: Licensee Definition and Clause 10: QA | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NCA-3950 | Quality Program Requirements | Identical (ID-E)<br>• Except the requirements of NCA-3950 (b) and (c) are coved by CSA N87 Series. | A1 |
| NCA-3960 | Responsibility | Equivalent<br>• Concrete requirements of Division 2 are covered by CSA N287 Series. | A2 |

| **NCA-4000: QUALITY ASSURANCE** | | Compared to CSA N285.0 Clause 3: Licensee Definition and Clause 10: QA | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NCA-4100** | **REQUIREMENTS** | | |
| NCA-4110 | Scope and Applicability | Identical | A1 |
| NCA-4120 | Definitions | Identical (ID-E)<br>• CSA N285 has identical requirements, but different CANDU requirements results in some new or modified definitions. | A1 |
| NCA-4130 | Establishment and Implementation | | |
| NCA-4131 | Material Organizations, Division 1 | Identical (ID-E) | A1 |
| NCA-4132 | Material Organizations, Division 2 (not applicable) | • Not applicable | - |
| NCA-4133 | Material Organizations, Division 1 | Identical (ID-E) | A1 |
| NCA-4134 | N, NV, NPT, NS, and NA Certificate Holders for Class 1, 2, 3, MC, CS and CC Construction | Identical (ID-E)<br>• CSA N285 Certificates of Authorization is different but serves the same intent | A1 |

| NCA-5000: AUTHORIZED INSPECTION | | Compared to CSA N285.0 Clause 3: Authorized Inspection Agency Definition & Duties discussed in Clause 2.4: Data report for fabrication activities and report for repair, replacement, or modification | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NCA-5100** | **INTRODUCTION** | | |
| NCA-5110 | Applicability | Equivalent<br>• CSA N285 does not address authorized inspection requirements in significant detail. However, the Canadian Nuclear Safety Commission (CNSC) prescribes mandatory requirements based on NCA-5000 and the Qualification requirements for the Authorized Inspectors are in accordance with QAI-1. | A2 |
| NCA-5120 | Performance of Inspection | | |
| NCA-5121 | Authorized Inspection Agency (AIA) | Equivalent (Same as NCA-5110) | A2 |
| NCA-5122 | Authorized Nuclear Inspection Supervisor | | |
| NCA-5123 | Authorized Nuclear Inspection | | |
| NCA-5125 | Duties of Authorized Nuclear Inspection Supervisor | | |
| NCA-5130 | Access for Inspection Agency Personnel | | |
| NCA-5131 | Access to the CH Facilities | Equivalent (Same as NCA-5110) | A2 |
| NCA-5132 | Access to the Owner's Facilities | | |
| **NCA-5200** | **DUTIES OF INSPECTOR** | | |
| NCA-5210 | General Inspection Duties | Equivalent (Same as NCA-5110) | A2 |
| NCA-5220 | Categories of Inspector's Duties | Equivalent (Same as NCA-5110) | A2 |
| NCA-5230 | Scope of Work, Design Specifications | Equivalent (Same as NCA-5110) | A2 |

| NCA-5000: AUTHORIZED INSPECTION | | Compared to CSA N285.0 Clause 3: Authorized Inspection Agency Definition & Duties discussed in Clause 2.4: Data report for fabrication activities and report for repair, replacement, or modification | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| | and Design Reports | | |
| NCA-5240 | Quality Assurance Programs | Equivalent (Same as NCA-5110) | A2 |
| NCA-5250 | Qualification Records | Equivalent (Same as NCA-5110) | A2 |
| NCA-5260 | Materials, Parts and Heat Treatment | Equivalent (Same as NCA-5110) | A2 |
| NCA-5270 | Examinations and Tests | Equivalent (Same as NCA-5110) | A2 |
| NCA-5280 | Final Tests | Equivalent (Same as NCA-5110) | A2 |
| NCA-5290 | Data Reports and Construction Reports | Equivalent (Same as NCA-5110) | A2 |
| **NCA-5300** | **RESPONSIBILITIES OF THE AIA** | Equivalent (SAME AS NCA-5110) | A2 |

| NCA-8000: CERTIFICATES, NAMEPLATES, CODE SYMBOL STAMPING AND DATA REPORTS | | Compared to CSA N285.0 Clause 12.3 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NCA-8100** | **AUTHORIZATION TO PERFORM CODE ACTIVITIES** | | |
| NCA-8110 | General | Identical (ID-E)<br>• Except Code symbol stamping is not required. | A1 |
| NCA-8120 | Scope of Certificates | Identical (ID-E)<br>• CSA N285 Certificate of Authorization is different than ASME Certificates but meet the same intent and Code symbol stamping is not required. | A1 |
| NCA-8130 | Inspection Agreement Required | Identical | A1 |

| **NCA-8000: CERTIFICATES, NAMEPLATES, CODE SYMBOL STAMPING AND DATA REPORTS** | Compared to CSA N285.0 Clause 12.3 | | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NCA-8140 | Quality Assurance Program Requirements | Identical | A1 |
| NCA-8150 | Application for Accreditation | Identical (ID-E)<br>• CSA N285 Certificate of Authorization is different than ASME Certificates but meet the same intent. | A1 |
| NCA-8160 | Evaluation | | |
| NCA-8161 | Evaluation of a Certificate | Identical (ID-E)<br>• CSA N285 Certificate of Authorization is different than ASME Certificates but meet the same intent and Code symbol stamping is not required. | A1 |
| NCA-8162 | Evaluation of Owner's Certificate | Technically Different<br>• CSA N285 has no owner's certificate; CNSC imposes mandatory requirements on the Licensee (owner) | B2 |
| NCA-8170 | Issuance | Technically Different<br>• CSA N285 has no owner's certificate; CNSC imposes mandatory requirements on the Licensee (owner) | B2 |
| NCA-8180 | Renewal | Technically Different<br>• CSA N285 has no owner's certificate; CNSC imposes mandatory requirements on the Licensee (owner) | B2 |
| **NCA-8200** | **NAMEPLATES AND STAMPING** | | |
| NCA-8210 | General Requirements | Identical (ID-E)<br>• Additional rules are provided in CSA N285. Code symbol stamping is not required and concrete requirements are not covered. | A1 |
| NCA-8220 | Nameplates for Components | Identical | A1 |

| **NCA-8000: CERTIFICATES, NAMEPLATES, CODE SYMBOL STAMPING AND DATA REPORTS** | | Compared to CSA N285.0 Clause 12.3 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NCA-8230 | Nameplates for NPT Stamped Items | Identical (ID-E)<br>• Additional rules are provided in CSA N285 | A1 |
| NCA-8240 | Removed Nameplates | Identical | A1 |
| **NCA-8300** | **CODE SYMBOL STAMPS** | | |
| NCA-8310 | General Requirements | Technically Different<br>• Code symbol stamping is not required by CSA N285. | B2 |
| NCA-8320 | Application of the N Symbol Stamp | Technically Different<br>• Code symbol stamping is not required by CSA N285. | B2 |
| NCA-8330 | Parts and Piping Subassemblies Furnished Without Stamping | Equivalent<br>• Identification, nameplates and data reports are required but Code symbol stamping is not required by CSA N285. | A2 |
| **NCA-8400** | **DATA REPORTS** | | |
| NCA-8410 | General Requirements | Equivalent<br>• CSA N285 Clause 12.3 and 12.4 require certificate holders to submit data reports and provides samples in Figures 8 – 15. | A2 |
| NCA-8420 | Owner's Data Report | Equivalent<br>• CSA N285 Clause 12.3 and 12.4 require certificate holders to submit data reports and provides samples in Figures 8 – 15. | A2 |

| **NCA-8000: CERTIFICATES, NAMEPLATES, CODE SYMBOL STAMPING AND DATA REPORTS** | | Compared to CSA N285.0 Clause 12.3 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| NCA-8430 | Data Reports, Tubular Products and Fittings Welded With Filler Metal | Equivalent<br>• CSA N285 Clause 12.3 and 12.4 require certificate holders to submit data reports and provides samples in Figures 8 – 15. | A2 |
| NCA-8440 | Certificates of Conformance for Welded Supports | Equivalent<br>• CSA N285 Clause 12.3 and 12.4 require certificate holders to submit data reports and provides samples in Figures 8 – 15. | A2 |

| NCA-9000: DEFINITIONS | | Compared to CSA N285.0 Clause 3 | |
|---|---|---|---|
| **Clause #** | **Clause Title** | **Comment** | **Scale** |
| **NCA-9100** | **INTRODUCTION** | | |
| **NCA-9200** | **DEFINITIONS** | Identical (ID-E)<br>• CSA N285 has identical requirements, but different CANDU requirements results in some new or modified definitions. | A1 |

**END NOTE(S):**

Identical (ID-E):

1. The Division 2 deviations and other minor deviations, such as: no stamping, will be identified by "*Identical (ID-E)*" which is meant to indicate the requirement is identical with an exception as below.

**EXPLANATION OF DIFFERENCES:**

ASME BPV Code Section III, Subsection NCA, Division 1 was compared against CSA Standard N285.0-08 (Update # 2), the observed differences are summarized below:

1. CSA N285 does not require Code symbol stamping
2. Concrete requirements of Division 2 are covered by CSA N287 Series
3. CSA N285 provides requirements for the classification of process and safety systems and their supports. This is beyond the scope of ASME BPVC Section III because CSA N285 provides rules for components once they have been classified to their appropriate system criteria. Annex A of CSA N285 provides requirements for CANDU nuclear power plant
4. CSA N285 does not provide requirements for Class MC, CS and CC
5. CSA N285 Certificate of Authorization is different than ASME Certificates but meet the same intent
6. Regulatory process for licensing requirements is specified by the Canadian Nuclear Safety Commission (CNSC), and is not covered by CSA N285. Compliance with CNSC requirements is mandatory
7. Similar process is observed for the Owner's review of the Data Report in CSA N285.0 with minor variations in the form templates
8. CSA N285 Clause 12.3 and 12.4 require certificate holders to submit data reports and provides samples in Figures 8 – 15
9. CSA N285 does not address authorized inspection requirements in significant detail. However, the Canadian Nuclear Safety Commission (CNSC) prescribes mandatory requirements based on NCA-5000 and the Qualification requirements for the Authorized Inspectors are in accordance with QAI-1
10. CSA N285 has no owner's certificate; CNSC imposes mandatory requirements on the Licensee (owner)

# APPENDIX E: PNAE G7 VERSUS ASME SECTION III DETAILED COMPARISON TABLE

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A<br>B |
|---|---|---|---|---|---|
| **Article NB-1000 Introduction** | | | | | |
| **NB-1100 Scope** | | | | | |
| NB-1110 Aspects of Construction Covered by These Rules | Rules for the material design, fabrication, examination, testing, overpressure relief, marking, stamping and preparation of reports by the Certificate Holder. | PNAE G-7-008-89 (Scope, 1.2. Documentation), PNAE G-7-009-89 (Scope), PNAE G-7-010-89 (Scope) | No stamping, no Certificate Holder in PNAE G-7 | | **A2** |
| | Rules for strength and pressure integrity, failure of them would violate the pressure retaining boundary. | PNAE G-7-002-86 (1.1), PNAE G-7-008-89 (1.1.1) | Rules are applied to vessels functioning under pressure, pumps and pipelines. No words about failure consequence in PNAE G-7. | | **A2** |
| | Rules cover initial construction, but do not cover deterioration which may occur in service as result of corrosion, radiation, instability of material. | PNAE G-7-002-86 (1.2) | Deterioration shall be covered. Corrosion allowances, ageing effect (including radiation, thermal and fatigue ageing) on fracture toughness are included in in PNAE G-7-002-86. | Through analysis | **B1** |
| NB-1120 Temperature Limits | Temperature limits of Section II, part D, Subpart 1, Tables 2A, 2B and 4. | PNAE G-7-008-89 (Mandatory annex 9) | Up to 600°C for some materials in in PNAE G-7-008-89. | PNAE G-7 also covers high-temperature components | **B1** |
| NB-1130 Boundaries of Jurisdiction Applicable to This Subsection | Boundary between component and attachments. | PNAE G-7-008-89 (1.1.11, 1.1.12) | General boundaries definitions are the same. ASME NB includes more detailed definitions than PNAE G-7-008-89. | | **A2** |
| | Jurisdictional boundary | | No strictly jurisdiction aspect in PNAE G-7. | | **B1** |
| NB-1140 Electrical and Mechanical Penetration Assemblies | Assemblies shall constructed in accordance with rules for vessels. | PNAE G-7-008-89 (1.1.2) | Electrical and mechanical assemblies are out of PNAE G-7 scope. | | **B2** |
| **Article NB-2000 Material** | | | | | |
| **NB-2100 General Requirements for Material** | | | | | |
| NB-2110 Scope of Principal Terms Employed | Definitions: *material*, *pressure-retaining material*, *thickness* (*plate*, *forging* (*hollow forging*, *disk forging*, *flat ring forging*, *rectangular solid forging*), *casting* (*thickness for fracture toughness* measurement, *thickness for heat treatment purposes*). | | No equivalent provision in PNAE G-7. | | **B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-2000 Material (cont.)** | | | | | |
| **NB-2100 General Requirements for Material (cont.)** | | | | | |
| NB-2120 Pressure-Retaining Material | | | | | |
| *NB 2121: Permitted material specification* | Permitted to use pressure-retaining materials from Section II Part D Subpart 1 Tables 2A and 2B. | PNAE G-7-008-89 (3.1.2) | Applicable material specifications are listed in PNAE G-7-008-89 (mandatory annex 9). | The list of permitted by PNAE G-7 specifications based on RF and USSR standards. Materials included in PNAE G-7 list often have not direct analogies in ASME or ASTM materials. | **B2** |
| | Permitted to use welding and brazing materials with SFA specification from Section II Part C, except as otherwise permitted in Section IX. | PNAE G-7-008-89 (3.1.2, 3.1.7) | Applicable welding materials are listed in PNAE G-7-009-89.<br><br>Brazing is out of PNAE G-7 scope. | Similar to above. | **B2**<br><br>**B1** |
| *NB 2122: Special requirements conflicting with permitted material specification* | Special requirements for the case of conflict with NCA-3856.<br>SA-453 and SA-638 stress rupture test is not required under 427°C operating temperatures. | | No equivalent provision in PNAE G-7.<br><br>No equivalent provision in PNAE G-7. | | **B1**<br><br>**B1** |
| *NB 2124: Size ranges* | No size limitation in the rules for construction, nearest specified range (NCA 3856) shall be used. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 2125: Fabricated hubbed flanges* | Hubbed flanges shall be machined from hot rolled or forged billet/from ring with NB 2540 examination. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 2126: Finned tubes* | Requirements for integrally finned tubes/welded finned tubes materials. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 2127: Seal membrane material* | Material shall conform to the requirements of Section II Part D Subpart 1 Tables 2A and 2B. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 2128: Bolting material* | Material shall conform to the requirements of Section II Part D Subpart 1 Table 4 or SA 194. | PNAE G-7-008-89 (3.3.1) | Material shall conform to the requirements listed in PNAE G-7-008-89 (mandatory annex 9). | The list of permitted by PNAE G-7 specifications based on RF and USSR standards. Materials included in PNAE G-7 list often have not direct analogies in ASME or ASTM materials. | **B2** |
| NB-2130 Certification of Material | Material shall be certified as required in NCA 3861 and NCA 3862. Material Test Report are required except from NCA-3861. | PNAE G-7-008-89 (3.1.3, 3.1.4) | The certification of material shall confirm the full compliance of materials with requirements of standards and technical specifications. | Connected to RF standards and technical specifications requirements. | **B2** |
| NB-2140 Welding Material | See NB-2400 | | | | |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-2000 Material (cont.)** | | | | | |
| **NB-2100 General Requirements for Material (cont.)** | | | | | |
| NB-2150 Material Identification | Material identification shall met NCA-3856, excluding small components. For welding and brazing materials - NB-4122. | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-2160 Deterioration of Material in Service | Deterioration of material is outside the ASME scope. The keeping of deterioration is the Owner responsibility. | PNAE G-7-008-89 (3.1.1) | Materials shall be selected with accounting of the required ... and operability under operational conditions within the service lifetime. | | **B2** |
| NB-2170 Heat Treatment to Enhance Impact Properties | Specified materials may be heat treated by quenching or tempering. Postweld heat treatment at a temperature ≥ 595°C. | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-2180 Procedures for Heat Treatment of Material | Heat treating shall be performed if required. Temperature survey and furnace calibration or measurement of material temperature shall be controlled using thermocouples. | PNAE G-7-008-89 (4.4.1, 4.4.8) | No requirement about using thermocouples. | | **A2** |
| NB-2190 Nonpressure-Retaining Material | Requirements for materials of support load path are in NF-2000.<br>Materials of nonstructural attachments need not comply with NB-2000 and NF-2000. | | No equivalent provision in PNAE G-7. | Rules for NPP components supports do not included into PNAE G-7. | **B1** |
| **NB-2200 Material Test Coupons and Specimens for Ferritic Steel Material** | | | | | |
| NB-2210 Heat Treatment Requirements<br>*NB 2211: Test coupon heat treatment for ferritic materials* | Tensile and impact test specimens shall be same heat treating as the component (exemption < 50mm). For the case of postweld heat treating the specimen total time at temperature shall be ≥ 80% of components total time at temperature; test material, coupon and specimen performed in a single cycle. | PNAE G-7-008-89 (4.4.12 - 4.4.15) | No exception for < 50 mm nominal thickness. 20% total time reduction allowed for tempering of main metal as well as for weld. | PNAE G-7-008-89 (4.4) requirements are more detailed | **A2** |
| *NB 2212: Test coupon heat treatment for quenched and tempered material* | Cooling rate of specimens shall be same as the component except certain forgings and castings. General procedure NB-2112.2 or one of described in NB-2220 shall be used. | PNAE G-7-008-89 (4.4.12 with note) | No special requirements for cooling procedure in PNAE G-7. PNAE G-7 considers quenching and tempering as one of the type of heat treatment. | | **B1** |
| NB-2220 Procedure for Obtaining Test Coupons and Specimens for Quenched and Tempered Material | | | | | |
| *NB 2221: General requirements* | Specimen location and number of test coupons shall met the material specification or NB-2222 - NB-2226. | PNAE G-7-008-89 (4.4.12 - 4.4.17) | According PNAE G-7 specimens cut off from overdimension pieces or individual check samples taken from billets. Number of coupons can be one or two according PNAE G-7-008-89 (4.4.16, 4.4.17). | | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A<br>B |
|---|---|---|---|---|---|
| **Article NB-2000 Material (cont.)** | | | | | |
| **NB-2200 Material Test Coupons and Specimens for Ferritic Steel Material (cont.)** | | | | | |
| *NB 2222: Plates* | Number, orientation, location and requirements for separate test coupons from plates. | | No special requirements for plates in PNAE G-7. | | **B1** |
| *NB 2224: Bar and bolting material* | Size and location of specimens from bars and bolting materials. | | No special requirements for bars and bolting materials in PNAE G-7. | | **B1** |
| *NB 2225: Tubular products and fittings* | Location of coupons from tubular products and fittings. | | No special requirements for tubular products and fittings in PNAE G-7. | | **B1** |
| *NB 2226: Tensile test specimen location (for quenched and tempered ferritic steel castings)* | Size and location of tensile specimens for quenched and tempered ferritic steel castings. | | No special requirements for tensile specimens for quenched and tempered ferritic steel castings in PNAE G-7. | | **B1** |
| **NB-2300 Fracture Toughness Requirements for Material** | | | | | |
| NB-2310 Material to Be Impact Tested<br>*NB 2311: Material for which impact testing is required* | Pressure-retaining material and material welded shall be impact tested except: material with s ≤ 16 mm, bolting with d ≤ 25 mm, bars with A ≤ 650 $mm^2$, pipes with DN ≤ 150mm, austenitic steels and nonferrous materials. | | No special requirements in PNAE G-7. | Material shall be impact tested if it required by material specification. | **B1** |
| NB-2320 Impact Test Procedures<br>*NB 2321: Type of tests* | Drop weight test if required shall be in accordance with ASTM E 208-91.<br>Charpy V-notch tests if required shall be in accordance with SA 371. | PNAE G-7-002-86 (App. 2.5.4.1.3) | PNAE G-7 does not required to use drop weight test.<br>According PNAE G-7 GOST 9454 shall be used. | GOST 9454 covers any type of Drop weight test including Charpy V-notch tests | **B1**<br>**B2** |
| *NB 2322: Test specimen* | Location of test specimen.<br>Orientation of Impact test specimen | PNAE G-7-002-86 (App. 2.5.2)<br>PNAE G-7-002-86 (App. 2.5.3) | PNAE G-7 includes additional requirements for specimen location. Requirements for bolting are different. | | **B2**<br>**A2** |
| NB-2330 Test Requirements and Acceptance Standards<br>*NB 2331: Material for vessels* | Material over than bolting shall be tested as follows:<br>– establish $RT_{NDT}$;<br>– establishing procedure applies to base material/HAZ/weld;<br>– bar having width or diameter ≤ 50mm shall be tested in accordance with NB-2332; | PNAE G-7-002-86 (App. 2.5.5)<br>PNAE G-7-002-86 (App. 2.5.4.1.1, App. 2.5.5.5.1) | PNAE G-7 used $T_k$ - critical brittle temperature.<br>No special requirements in PNAE G-7. | PNAE G-7 uses the same provisions for vessels, piping, pumps and valves<br>Method for establishing of $T_k$ is similar to $RT_{NDT}$, but with technical differences. | **B2**<br>**A2**<br>**B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-2000 Material (cont.)** | | | | | |
| NB-2300 Fracture Toughness Requirements for Material (cont.) | | | | | |
| *NB 2331: Material for vessels (cont.)* | – exclusion for drop weight test for some nozzles or appurtenances in vessels;<br>– effect of irradiation shall be considered;<br>– test temperature requirements of hydrotest. | <br>PNAE G-7-002-86 (App. 2.8.1)<br>PNAE G-7-008-89 (5.3) | PNAE G-7 does not require to use drop weight test.<br>Effect of irradiation considered using critical brittle temperature shift due to irradiation ($\Delta T_F$).<br>PNAE G-7 includes detailed rules for hydrotest temperature determination using $T_K$. | | **B1**<br>**B2**<br>**B2** |
| *NB 2332: Material for piping, pumps and valves* | Material over than bolting with s≤64 mm shall be tested - 3 Cv tests at lowest service temperature for base material/HAZ/weld with corresponding lateral expansion criteria from 0.5 to 1mm (nothing for 16mm or less).<br>Material with s>64 mm shall be tested according NB-2331. | | No special requirements for piping, pumps and valves in PNAE G-7. Common rules are using for any pressure retaining equipment material and bolting. | | **B1** |
| *NB 2333: Bolting material* | For bolts, studs and nuts test 3 Cv at temperature not higher than preload temperature or lowest service temperature. Specimens shall met the table NB-2333-1. | | No special requirements for bolting material. Common rules are using for any pressure retaining equipment material and bolting. | | **B1** |
| NB-2340 Number of Impact Tests Required<br>*NB 2341: Plates* | One test from each plate as heat treated. | PNAE G-7-002-86 (App. 2.5.4.2.3) | At least three specimen for each heat is required. | | **B2** |
| *N B 2342: Forgings and castings* | One test for each heat in each heat treatment lot for forging or casting up to 450kg.<br>One test for each forging or casting of 450kg to 4500kg.<br>Forging or casting > 4500kg shall have 2 Cv and one drop weight; location selected equal number of specimens 180° apart. | PNAE G-7-002-86 (App. 2.5.4.2.3) | At least three specimen for each heat is required. | | **B2** |
| *NB 2343: Bars* | One test for each lot of bars with area > 650mm$^2$; lot definition < 2700kg. | PNAE G-7-002-86 (App. 2.5.4.2.3) | At least three specimen for each heat is required. | | **B2** |
| *NB 2344: Tubular products and fittings* | One test for each lot; if welded with filler metal one test from the weld area. | PNAE G-7-002-86 (App. 2.5.4.2.3) | At least three specimen for each heat is required. | | **B2** |
| *NB 2345: Boiling Material* | One test from each lot of material; lot = one heat of material heat treated in one charge with limited mass. Mass limitation given. | PNAE G-7-002-86 (App. 2.5.4.2.3) | At least three specimen for each heat is required. | | **B2** |
| *NB 2346: Test definition* | One test means drop weight test and Cv test if $RT_{NDT}$ is required.<br>One test means $C_V$ test if $RT_{NDT}$ is not required. | PNAE G-7-002-86 (App. 2.5.1.2) | To determine critical temperature of brittleness (analog of $RT_{NDT}$) only Cv test is required. | | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-2000 Material (cont.)** | | | | | |
| **NB-2300 Fracture Toughness Requirements for Material (cont.)** | | | | | |
| NB-2350 Retests | One $C_V$ retest at same temperature is acceptable with 3 requirements:<br>– average value meets minimum required,<br>– not more than 1 below the minimum,<br>- not meeting the minimum but not lower than 14J or 0.13mm below specified requirements.<br>Retest consists of 2 additional specimens taken as near as possible to the failed specimens conditions. For acceptance both specimens shall met the minimum requirements. | PNAE G-7-002-86 (App. 2.5.5.2) | Retest consists of 3 additional specimens. Failed specimen does not taken into account. No limits for below specified requirements. | | **B2** |
| NB-2360 Calibration of Instruments and Equipment | Temperature instruments calibrate according NCA-3858.2 (every 3 months).<br>$C_V$ impact test machine calibrates according NCA-3858.2 using ASTM E23-02a. | PNAE G-7-002-86 (App. 2.5.4.1.3) | The test equipment shall meet the requirements of GOST 9454. | | **B2** |
| **NB-2400 Welding Material** | | | | | |
| NB-2410 General Requirements | All welding material except cladding and hard surfacing shall conform to the requirements of material specification or ASME Section IX and also NB-2150.<br>Certificate holder shall provide the organization performing the testing with specific information: welding process, specification, minimum tensile strength, drop weight test, Cv test, preheat temperature, postweld heat treatment temperature, minimum delta ferrite. | PNAE G-7-009-89 (2.8) | Welding materials shall meet the requirements of standards and specifications given in PNAE G-7-009-89 Appendix 1 and have a certificate.<br><br>No equivalent provision in PNAE G-7. | | **B2**<br><br>**B1** |
| NB-2420 Required Tests | Test shall be conducted for each lot of covered, flux cored or fabricated electrode; each heat of bare electrodes, rods or wires for use with OFW, GMAW, GTAW, PAW EGW; each heat of consumable insert…. | PNAE G-7-010-89 (6.1.1) | Requirements of PNAE G are more generic, without list and definitions of welding methods and materials. | | **A2** |
| NB-2430 Weld Metal Tests<br>*NB 2431: Mechanical properties test* | Tensile and impact tests shall be made except austenitic and nonferrous steels, consumable inserts, welding materials for GTAW.<br>General test requirements.<br>Standard tests requirements. | PNAE G-7-010-89 (10.1) | PNAE G-7 does not include exceptions.<br>Tensile test according GOST 6996.<br>Impact test according GOST 6996 and PNAE G-7-002-86 (App. 2). | | **B2** |
| *NB 2432: Chemical Analysis Test* | Test method/Requirements for chemical analysis | PNAE G-7-010-89 (11.14, App. 6) | The list of chemical elements to be determined is different. | PNAE G-7-010-89 (App. 6) contains tables with percentage composition limits. | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-2000 Material (cont.)** | | | | | |
| **NB-2400 Welding Material (cont.)** | | | | | |
| *NB 2433: Delta ferrite determination* | Method/Acceptance standard | PNAE G-7-010-89 (11.13) | PNAE G-7 does not specify the determination method.<br>PNAE G-7 specifies allowable percentage of delta ferrit content. | PNAE G limits are less strict. | **B2** |
| NB-2440 Storage and Handling of Welding Material | Suitable storage and handling shall be maintained. Minimize moisture absorption by fluxes and cored, fabricated and coated electrodes | PNAE G-7-008-89 (4.1.7), PNAE G-7-008-89 (2.9) | | | **A2** |
| **NB-2500 Examination and Repair of Pressure-retaining Material** | | | | | |
| NB-2510 Examination of Pressure-Retaining Material | Material shall be examined except pumps and valves DN50 or less/seamless pipe, tubes and fitting DN25 or less.<br>For forged and cast pumps and valves connections over DN50 to DN100 surface instead of volumetric may be performed. | PNAE G-7-008-89 (3.2,4.5.1,App. 10) | PNAE G-7 governs that the requirements for examination shall be included into specification of material, semiproduct or equipment. | | **B2** |
| NB-2520 Examination After Quenching and Tempering | Ferritic products after quenching and tempering shall be examined. | PNAE G-7-008-89 (4.4.12,4.5.4) | | | **A2** |
| NB-2530 Examination and Repair of Plate | | | | | |
| *NB 2531: Required examination* | All plates shall be examined by the beam ultrasonic method. | PNAE G-7-014-89 (8.1,8.2) | PNAE G-7 does not require to examine plates < 5 mm. PNAE G has not restrictions for using type of ultrasonic methods. | PNAE G-7-014-89 "Unified examination procedures of base materials (semi-finished elements), welding and facing of equipment and pipelines of nuclear power installations. Ultrasonic examination".<br>Requirements may also be in technical specifications. | **B2** |
| *NB 2532: Examination procedure* | Straight or angle beam examinations/acceptance standards. | PNAE G-7-014-89 (9.1,9.5) | According PNAE G-7 acceptance standards shall be include in technical specifications. | | **B1** |
| *NB 2537: Time of examination* | Ultrasonic examination. | PNAE G-7-014-89 (1.13) | | | **A2** |
| | Radiographic examination of repair welds. | PNAE G-7-010-89 (9.10.3), PNAE G-7-010-89 (12.5), | According PNAE G-7 examination performs after heat treatment. | | **B2** |
| | Magnetic particle or liquid penetrant examination. | PNAE G-7-010-89 (12.5) | | | **A2** |
| *NB 2538: Elimination of surface defects* | Surface defects shall be removed. | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2539: Repair by welding* | Repair by welding is available. Defect removal/Qualifications of welding procedure and welders/Blending of surface/Heat treatment/Material report/Repair of cladding. | | No special provisions for repair of plates in PNAE G-7. | | **B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-2000 Material (cont.)** | | | | | |
| **NB-2500 Examination and Repair of Pressure-retaining Material (cont.)** | | | | | |
| NB-2540 Examination and Repair of Forgings and Bars | | | | | |
| *NB 2541: Required examination* | Forgings and bars shall be examined by the ultrasonic method.<br>Flanges, fittings, products for tubes shall be examined like tubes. | PNAE G-7-014-89 (6.1) | According PNAE G forgings and bars with dimensions exceeded specified shall be examined. | | **B2** |
| *NB 2542: Ultrasonic examination* | Examination Procedure/Acceptance standards | PNAE G-7-014-89 (6.2-6.7,9.1) | Examination procedure is different. According PNAE G acceptance standards shall be include in technical specifications. | | **B2** |
| *NB 2545: Magnetic Particle Examination* | Examination Procedure/Acceptance standards | PNAE G-7-015-89 | | PNAE G-7-015-89 "Unified examination procedures of base materials (semi-finished elements), welding and facing of equipment and pipelines of nuclear power installations. Magnetic particle examination". Requirements may also be in technical specifications. | **B2** |
| *NB 2546: Liquid penetration examination* | Examination procedure/Evaluation of Indications/Acceptance standards. | PNAE G-7-018-89 | | PNAE G-7-018-89 "Unified examination procedures of base materials (semi-finished elements), welding and facing of equipment and pipelines of nuclear power installations. Liquid penetration examination". Requirements may also be in technical specifications. | **B2** |
| *NB 2547: Time of examination* | Ultrasonic examination.<br><br>Radiographic examination of repair welds.<br><br>Magnetic particle or liquid penetrant examination.<br>Forgings and bars which will be bored shall be examined after boring except for threading<br>Bars for tubeplags may be surface examined after final machining. | PNAE G-7-014-89 (1.13), PNAE G-7-010-89 (9.10.3)<br>PNAE G-7-014-89 (12.5)<br><br>PNAE G-7-010-89 (12.5) | According PNAE G examination performs after postweld heat treatment.<br>According PNAE G examination performs after heat treatment.<br><br>No equivalent provision in PNAE G-7.<br><br>No equivalent provision in PNAE G-7. | <br><br><br><br><br>Requirements may be in technical specifications.<br><br>Requirements may be in technical specifications. | **B2**<br><br>**B2**<br><br>**A2**<br>**B1**<br><br>**B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-2000 Material (cont.)** | | | | | |
| **NB-2500 Examination and Repair of Pressure-retaining Material (cont.)** | | | | | |
| *NB 2548: Elimination of surface defects* | Surface defects shall be removed. | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2549: Repair by welding* | Repair by welding is available according NB-2539 with exceptions. | | No special provisions for repair of forgings in PNAE G-7. | | **B1** |
| NB-2550 Examination and Repair of Seamless and Welded (Without Filler Metal)-Tubular Products and Fittings<br>*NB 2551: Required examination* | Tubes shall be examined by the ultrasonic method and additionally by the magnetic particle or liquid penetrant method . | PNAE G-7-008-89 (3.2.3), PNAE G-7-014-89 (7) | | | **B2** |
| *NB 2552: Ultrasonic Examination* | Examination Procedure/Acceptance standards. | PNAE G-7-014-89 (7) | | Requirements may also be in technical specifications. | **B2** |
| *NB 2553: Radiographic examination* | Examination Procedure/Acceptance standards. | | | Requirements may be in technical specifications. | **B2** |
| *NB 2554: Eddy Current Examination* | Examination Procedure/Acceptance standards. | PNAE G-7-008-89 (3.2.3), | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 2555: Magnetic Particle Examination* | Examination according NB-2545. | PNAE G-7-015-89 | | Requirements may also be in technical specifications. | **B2** |
| *NB 2556: Liquid Penetrant Examination* | Examination according NB-2546. | PNAE G-7-018-89 | | Requirements may also be in technical specifications. | **B2** |
| *NB 2557: Time of examination* | Ultrasonic examination.<br><br>Eddy current examination.<br>Radiographic examination.<br><br>Magnetic particle or liquid penetrant examination. | PNAE G-7-014-89 (1.13)<br><br><br>PNAE G-7-014-89 (12.5)<br><br>PNAE G-7-010-89 (12.5) | According PNAE G examination performs after postweld heat treatment.<br>No equivalent provision in PNAE G-7.<br>According PNAE G examination performs after heat treatment. | | **B2**<br><br>**B1**<br>**B2**<br><br>**A2** |
| *NB 2558: Elimination of surface defects* | Surface defects shall be removed. | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2559: Repair by welding* | Repair by welding is available according NB-2539 with exceptions. | | No special provisions for repair of tubes in PNAE G-7. | | **B1** |
| NB-2560 Examination and Repair of Tubular Products and Fittings Welded With Filler Metal | | | | | |
| *NB 2561: Required examination* | Plates shall be examined by the ultrasonic method, welds shall be 100% examined by radiographic methods. | PNAE G-7-008-89 (3.2.3-3.2.4) | | | **A2** |
| *NB 2562: Ultrasonic Examination* | Examination according NB-2552. | PNAE G-7-014-89 (7) | | Requirements may also be in technical specifications. | **B2** |
| *NB 2563: Radiographic examination* | Examination according NB-2553. | | | Requirements may be in technical specifications. | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-2000 Material (cont.)** | | | | | |
| **NB-2500 Examination and Repair of Pressure-retaining Material (cont.)** | | | | | |
| *NB 2565: Magnetic Particle Examination* | Examination according NB-2545. | PNAE G-7-015-89 | | Requirements may also be in technical specifications. | **B2** |
| *NB 2566: Liquid Penetrant Examination* | Examination according NB-2546. | PNAE G-7-018-89 | | Requirements may also be in technical specifications. | **B2** |
| *NB 2567: Time of examination* | Examination according NB-2557. | | | | |
| *NB 2568: Elimination of surface defects* | Examination according NB-2558. | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2569: Repair by welding* | Examination according NB-2559. | | No special provisions for repair of tubes in PNAE G-7. | | **B1** |
| NB-2570 Examination and Repair of Statically and Centrifugally Cast Products<br>*NB 2571: Required examination* | Cast products shall be examined by the either of ultrasonic or radiographic methods (or both) and surface shall be examined by the either of magnetic particle or liquid penetrant methods. | PNAE G-7-008-89 (3.2.5), PNAE G-7-025-90(1.4, table 2) | | PNAE G-7-025-90 "Steel cast products intended for nuclear power units. Examinations rules". | **B2** |
| *NB 2572: Time of non-destructive examination* | Ultrasonic examination.<br><br>Radiographic examination.<br>Magnetic particle or liquid penetrant examination. | PNAE G-7-025-90(3.7)<br><br>PNAE G-7-025-90(3.7)<br>PNAE G-7-025-90(3.6.3) | | | **B2**<br><br>**B2**<br>**A2** |
| *NB 2573: Provision for Repair of Base Material by Welding* | Defects removal/repair by welding/welding procedure/examination/heat treatment. | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2574: Ultrasonic examination of Ferritic Steel Castings* | Examination Procedure/Acceptance standards. | PNAE G-7-025-90(3.7,4.6) | Acceptance standards are different. | | **B2** |
| *NB 2575: Radiographic Examination* | Examination Procedure/Acceptance standards. | PNAE G-7-025-90(3.7,4.7) | Acceptance standards are different. | | **B2** |
| *NB 2576: Liquid Penetrant Examination* | Examination Procedure/Acceptance standards. | PNAE G-7-025-90(3.6,4.5) | Acceptance standards are different. | | **B2** |
| *NB 2577: Magnetic Particle Examination (for ferritic steel product only)* | Examination Procedure/Acceptance standards. | PNAE G-7-025-90(3.6,4.5) | Acceptance standards are different. | | **B2** |
| NB-2580 Examination of Bolts, Studs, and Nuts<br>*NB 2581: Required examination* | Bolting shall be visually examined and ultrasonic examined if bolt > 50 mm. | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2582: Visual Examination* | Harmful discontinuities are unacceptable. | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2583: Magnetic Particle Examination* | Examination Procedure/Evaluation of Indications/Acceptance Standard | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2584: Liquid Penetrant Examination* | Examination Procedure/Evaluation of Indications/Acceptance Standard | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2585: Ultrasonic examination (for size greater than 2")* | Ultrasonic Method/Examination Procedure/Calibration of Equipment/Acceptance Standard | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-2000 Material (cont.)** | | | | | |
| **NB-2500 Examination and Repair of Pressure-retaining Material (cont.)** | | | | | |
| *NB 2586: Ultrasonic examination (for size over 4")* | Ultrasonic Method/ Examination Procedure/Calibration of Equipment/Acceptance Standard | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2687: Time of examination* | | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2588: Elimination of surface defects* | | | No equivalent provision in PNAE G-7. | Requirements may be in technical specifications. | **B1** |
| *NB 2589: Repair by welding* | | | No equivalent provision in PNAE G-7. | | **B1** |
| **NB-2600 Material Organizations' Quality System Programs** | | | | | |
| NB-2610 Documentation and Maintenance of Quality System Programs | Requirements of NCA 3800 and NCA 4000 (small product = pipe, tube, pipe fittings and flanges DN50 or less, bolting material nominal diameter 1" or less, bar nominal cross section 1 inch$^2$ or less, pump and valve with inlet pipe DN50 or less, material exempted in NB 2121 (c). | | Responsibilities defined in ASME NCA 3000 not addressed in PNAE G. | | **B1** |
| **NB-2700 Dimensional Standards** | Reference to NCA 7100-1. | | No equivalent provision in PNAE G-7. | | **B1** |
| **Article NB-3000 Design** | | **PNAE G-7-002-86** | | | |
| **NB-3100 General Design** | | | | | |
| NB-3110 Loading Criteria<br>*NB 3111: Loading conditions* | Internal/external pressure, impact loads, weight including static and dynamic head of liquids, superimposed loads, wind, snow, vibration, earthquake, reaction of supports, temperature effects. | PNAE G-7-002-86 (5.1.3) | PNAE G-7 does not consider snow and wind loads as basic loads. | | **A2** |
| *NB 3112: Design loadings* | Design pressure.<br>Design temperature.<br>Design mechanical load.<br>Design stress intensity values. | PNAE G-7-002-86 (2.1)<br>PNAE G-7-002-86 (2.2)<br><br>PNAE G-7-002-86 (3.1-3.7) | <br><br>No equivalent provision in PNAE G-7.<br>PNAE G-7 prescribes to use 2.6 as ultimate strength margin. PNAE G-7 does not include the special consideration of austenitic stainless steels (0.8 instead of 2/3). | | **A2**<br>**A1**<br>**B1**<br>**B2** |
| *NB 3113: Service conditions* | Level A, B, C conditions | PNAE G-7-002-86 (2.10-2.12) referenced to PNAE G-7-008-89 (App.1) | PNAE G-7 defines Operational Conditions (NOC, VNOC, ES) instead of Levels A-D. There is not direct analogy between Operational Conditions and Levels. | | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-3000 Design (cont.)** | | | | | |
| NB-3100 General Design (cont.) | | | | | |
| NB-3120 Special Considerations<br>*NB 3121: Corrosion* | | PNAE G-7-002-86 (1.2.18,4.1.4) | | | **A2** |
| *NB 3122: Cladding* | | PNAE G-7-002-86 (4.1.2) | According PNAE G-7 cladding is not taking into account during determination of basic dimensions by formulae, and taking into account during design by analysis. | | **B2** |
| *NB 3123: Welding* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 3124: Environmental effects* | | PNAE G-7-002-86 (1.2.17,1.2.18) | | | **A2** |
| *NB 3125: Configuration* | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-3130 General Design Rules<br>*NB 3131: Scope* | | | | | |
| *NB 3132: Dimensional Standards for Standard products* | | | | | |
| *NB 3133: Component under external pressure* | General, nomenclature, cylindrical shells and tubular products, spherical shells, stiffening rings for cylindrical shells, cylinders under axial compression | PNAE G-7-002-86 (5.5), PNAE G-7-002-86 (4.2) | Formulas and methodology to determine minimum required thickness in PNAE G-7 and ASME differs significantly. | | **B2** |
| *NB 3134: Leak Tightness* | | | There is no corresponding paragraph in PNAE G-7. | | **B1** |
| *NB 3135: Attachments* | Describes stress limits for attachments | | No separate paragraph for attachments in PNAE G-7. | According to both PNAE G-7 and ASME Codes, attachments should meet the general stress limits for component, but in some cases rules from specific sections of ASME Code (NF and NG) can be used. Corresponding sections are absent in PNAE G-7. | **B1** |
| *NB 3136: Appurtenance* | Describes stress limits for attachments | | No separate paragraph for appurtenances in PNAE G-7. | | **B1** |
| *NB 3137: Reinforcement of openings* | Rules of reinforcement of openings | PNAE G-7-002-86 (4.3) | Different approach to account openings. | | **B2** |
| **NB-3200 Design by Analysis** | | | | | |
| NB-3210 Design Criteria<br>*NB 3211: Requirements for acceptability* | The design intensities in Section 2; design shall conform NB-3100; buckling according NB-3133; protection against non-ductile failure according Appendix G with exceptions. | PNAE G-7-002-86 (1.2.2,1.2.6) | No equivalent exemption rules for non-ductile failure in PNAE G-7. | | **B2** |
| *NB 3212: Basis for Determining Stresses* | Maximum shear stress theory shall be used. | PNAE G-7-002-86 (1.2.15) | | | **A1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-3000 Design (cont.)** | | | | | |
| NB-3200 Design by Analysis (cont.) | | | | | |
| *NB 3213: Term related to Stress Analysis* | Stress intensity. | PNAE G-7-002-86 (1.2.15) | | | **A1** |
| | Gross structural discontinuity. | | No equivalent definition in PNAE G-7. | The same philosophy used in PNAE G-7 but without of clear definition. | **B1** |
| | Local structural discontinuity. | | No equivalent definition in PNAE G-7. | The same philosophy used in PNAE G-7 but without of clear definition. | **B1** |
| | Normal stress. | | No equivalent definition in PNAE G-7. | The same philosophy used in PNAE G-7 but without of clear definition. | **B1** |
| | Shear stress. | | No equivalent definition in PNAE G-7. | The same philosophy used in PNAE G-7 but without of clear definition. | **B1** |
| | Membrane stress. | PNAE G-7-002-86 (2.18) | PNAE G includes the definition of primary membrane stress. | | **B2** |
| | Bending stress. | PNAE G-7-002-86 (2.20) | PNAE G includes the definition of primary bending stress. | | **B2** |
| | Primary stress. | | No equivalent definition in PNAE G-7. | The same philosophy used in PNAE G-7 but without of clear definition. | **B1** |
| | Secondary stress. | | No equivalent definition in PNAE G-7. | The same philosophy used in PNAE G-7 but without of clear definition. | **B1** |
| | Local primary membrane stress. | PNAE G-7-002-86 (2.19) | | | **A2** |
| | Peak stress. | | No equivalent definition in PNAE G-7. | The same philosophy used in PNAE G-7 but without of clear definition. | **B1** |
| | Load controlled stress. | | No equivalent definition in PNAE G-7. | The same philosophy used in PNAE G-7 but without of clear definition. | **B1** |
| | Thermal stress. | PNAE G-7-002-86 (2.22,2.23) | | | **A2** |
| | Total stress. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Operational cycle. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Stress cycle. | PNAE G-7-002-86 (2.13) | | | **A2** |
| | Fatigue strength reduction factor. | PNAE G-7-002-86 (5.3.10) | | | **A2** |
| | Free end displacement. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Expansion stresses. | PNAE G-7-002-86 (2.24) | | | **A2** |
| | Deformation. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Creep. | | No equivalent definition in PNAE G-7. | The same philosophy used in PNAE G-7 but without of clear definition. | **B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-3000 Design (cont.)** | | | | | |
| **NB-3200 Design by Analysis (cont.)** | | | | | |
| *NB 3213: Term related to Stress Analysis (cont.)* | Plasticity. | | No equivalent definition in PNAE G-7. | The same philosophy used in PNAE G-7 but without of clear definition. | **B1** |
| | Plastic analysis. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Plastic analysis-collapse load. | | No equivalent definition in PNAE G-7. | Plastic analysis does not use for evaluating of mechanical loads according PNAE G-7. | **B1** |
| | Plasticity instabilities load. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Limit analysis. | | No equivalent definition in PNAE G-7. | PNAE G-7 does not contain the rules of limit analysis. | **B1** |
| | Limit analysis-collapse load. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Collapse load-lower bound. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Plastic hinge. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Strain limiting load. | | No equivalent definition in PNAE G-7. | The same philosophy used in PNAE G-7 but without of clear definition. | **B1** |
| | Test collapse load. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Ratcheting. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Shakedown. | | No equivalent definition in PNAE G-7. | | **B1** |
| | Reversing dynamic , nonreversing dynamic l loads | | No equivalent definitions in PNAE G-7. | | **B1** |
| *NB 3214: Stress analysis* | Stress analysis shall be prepared. | PNAE G-7-002-86 (1.2.2) | | | **A2** |
| *NB 3215: Derivation of stress intensities* | | PNAE G-7-002-86 (5.1) | | The same philosophy used in PNAE G-7 but with technical features. | **B2** |
| *NB 3216: Derivation of stress differences* | Constant principal stress direction, varying principal stress directions. | PNAE G-7-002-86 (5.2) | According PNAE G-7 directions of principal stresses are "freezing" during all load history. | The similar philosophy used in PNAE G-7 but with technical features. | **B2** |
| *NB 3217: Classification of stresses* | Classification of stresses: tables NB 3217-1 and 2 | PNAE G-7-002-86 (Tables 5.1-5.2) | | The same philosophy used in PNAE G-7 but with technical features. | **B2** |
| NB-3220 Stress Limits for Other Than Bolts<br>*NB 3221: Design loadings* | General primary membrane stress intensity, local membrane stress intensity, primary membrane + primary bending stress intensity, external pressure. | | No equivalent provision in PNAE G-7. | PNAE G-7 does not include the limits for design loadings. | **B1** |
| *NB 3222: Level A service limits* | Primary stresses as for design loadings. Primary + secondary ≤ $3S_m$. Analysis of cyclic operation. intensity, local membrane stress intensity, primary membrane + primary bending stress intensity, external pressure. | PNAE G-7-002-86 (5.4, table 5.6, 5.6) | Different limitations for primary bending and primary+secondary stresses.<br>Technical differences in fatigue analysis - Ke formula and design fatigue curves. | The similar philosophy used in PNAE G-7 but with significant technical differences. Here PNAE G-7 NOC considers as equivalent of ASME level A. | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A<br>B |
|---|---|---|---|---|---|
| **Article NB-3000 Design (cont.)** | | | | | |
| **NB-3200 Design by Analysis (cont.)** | | | | | |
| *NB 3223: Level B service limits* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 3224: Level C service limits* | | PNAE G-7-002-86 (5.4, table 5.6, 5.6) | Different limitations for primary stresses. According PNAE G-7 fatigue damage shall be evaluated. | Here PNAE G-7 VNOC considers as equivalent of ASME level C. | **B2** |
| *NB 3225: Level D service limits* | | PNAE G-7-002-86 (5.4, table 5.6, 5.6) | Different limitations for primary stresses. According PNAE G-7 fatigue damage shall be evaluated. | Here PNAE G-7 ES considers as equivalent of ASME level D. | **B2** |
| *NB 3226: Testing limits* | | PNAE G-7-002-86 (5.4.6,5.6) | Different limitations for primary stresses. According PNAE G-7 fatigue damage shall be evaluated for any number of tests. | | **B2** |
| *NB 3227: Special stress limits* | Bearing loads.<br>Pure shear.<br>Progressive distortion of nonintegral connections.<br>Triaxial stresses.<br>Nozzle piping transition.<br><br>Applications of elastic analysis for stresses beyond the yield strength.<br>Requirements for specially designed welded seals | PNAE G-7-002-86 (5.4.3)<br>PNAE G-7-002-86 (5.4.4,5.4.5) | Different limitations.<br>Different limitations.<br>No equivalent provision in PNAE G-7.<br>No equivalent provision in PNAE G-7.<br>No special consideration of nozzle piping transition in PNAE G-7.<br>No additional rules in PNAE G-7.<br><br>No equivalent provision in PNAE G-7. | | **B2**<br>**B2**<br>**B1**<br>**B1**<br>**B1**<br><br>**B1**<br><br>**B1** |
| *NB 3228: Application of plastic analysis* | Limit, experimental, plastic analyses.<br><br>Shakedown analysis.<br>Simplified elastic-plastic analysis. | <br><br><br>PNAE G-7-002-86 (5.3.8) | No equivalent provision in PNAE G-7.<br><br>No equivalent provision in PNAE G-7.<br>Different methodology. | There are not abilities of these analyses in PNAE G-7. | **B1**<br><br>**B1**<br>**B2** |
| *NB 3229: Design stress values* | | | There are not tables with allowable stress values in PNAE G. The procedure for allowable stress determination given in PNAE G-7-002-86 (3). The procedure is slightly different. | | **B1** |
| NB-3230 Stress Limits for Bolts | | | | | |
| *NB 3231: Design conditions* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 3232: Level A service limits* | Average stress.<br>Maximum stress.<br>Fatigue analysis of bolts. | PNAE G-7-002-86 (5.4, table 5.6)<br>PNAE G-7-002-86 (5.4, table 5.6)<br>PNAE G-7-002-86 (5.3.12, 5.6) | Different limitation.<br>Different limitation.<br>Different procedure, different fatigue design curves. | Here PNAE G-7 NOC considers as equivalent of ASME level A. | **B2**<br>**B2**<br>**B2** |
| *NB 3233: Level B service limits* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 3234: Level C service limits* | | PNAE G-7-002-86 (5.3.12,5.4,5.6) | Different limitations. Allowable stress values are dependent on Operation Condition. Fatigue analysis shall be done. | Here PNAE G-7 VNOC considers as equivalent of ASME level C. | **B2** |
| *NB 3235: Level D service limits* | | PNAE G-7-002-86 (5.3.12,5.4,5.6) | Different limitations. Fatigue analysis shall be done. | Here PNAE G-7 ES considers as equivalent of ASME level D. | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-3000 Design (cont.)** | | | | | |
| **NB-3200 Design by Analysis (cont.)** | | | | | |
| *NB 3236: Design stress intensity values* | | | There are not tables with allowable stress values in PNAE G. The procedure for allowable stress determination given in PNAE G-7-002-86 (3). The procedure is different. | | **B1** |
| **Article NB-4000 Fabrication and Installation** | | | | | |
| **NB-4100 General Requirements** | | | | | |
| NB-4110 Introduction | | | Materials shall be according PNAE G-7-008-86 (3) | | **B2** |
| NB-4120 Certification of Materials and Fabrication by Certificate Holder | | | | | |
| *NB 4121: Means of certification* | Certification of treatments, tests and examinations, repetition of tensile or impact tests, repetition of surface examination after machining. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4122: Material identification* | Material shall be marked. | | No equivalent provision in PNAE G-7. | Marking may be required by material specification. | **B1** |
| *NB 4123: Examinations* | Reference to NB 5000. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4124: blank* | | | | | |
| *NB 4125: Testing of welding and brazing material* | Materials shall met NB 2400. | PNAE G-7-008-89 (3.1.7) | Materials shall be in accordance with PNAE G-7-009-89. | | **B2** |
| NB-4130 Repair of Material | | | | | |
| *NB 4131: Elimination and repairs of defects* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4132: Documentation of repair welds of base material* | | PNAE G-7-008-89 (4.1.2) | Repairing shall be according instruction approved by Material Organization. | | **B2** |
| **NB-4200 Forming, Fitting, and Aligning** | | | | | |
| NB-4210 Cutting, Forming, and Bending<br>*NB 4211: Cutting* | Preheating shall be when thermal cutting. | PNAE G-7-008-89 (4.1.2,4.2.1) | Thermal cutting shall be according documentation approved by Material Organization. After thermal cutting machining may be used if it required. | | **B2** |
| *NB 4212: Forming and bending process* | Forming and bending are allowed with requirements. | PNAE G-7-008-89 (4.1.2,4.2) | Additional requirements in PNAE G-7. | | **B2** |
| *NB 4213: Qualification of forming process for impact property requirement* | Exemption procedure qualification test, acceptance criteria for formed material, requalification. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4214: Minimum thickness for fabricated material* | If the thinkness is less then required by NB-3000 it may be repaired. | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-4220 Forming Tolerances<br>*NB 4221: Tolerances for vessel shells* | Minimum difference in cross-sectional diameters, maximum deviation in cross-sectional diameters, deviation from tolerances, tolerance deviations for pressure vessel parts fabricated from pipe. | PNAE G-7-008-89 (4.3.1-4.3.4) | Different allowables. | | **B2** |
| *NB 4222: Tolerances for formed vessel heads* | Maximum difference in cross-sectional diameters, deviation from specified shape. | PNAE G-7-008-89 (4.3.5) | Different allowables. | | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-4000 Fabrication and Installation (cont.)** | | | | | |
| **NB-4200 Forming, Fitting, and Aligning (cont.)** | | | | | |
| *NB 4223: Tolerances for formed or bent piping* | Minimum wall thickness, ovality tolerance. | PNAE G-7-008-89 (4.3.7,4.3.8,4.3.9) | Different allowables. | | **B2** |
| NB-4230 Fitting and Aligning | | | | | |
| *NB 4231: Fitting and aligning methods* | Tack welds. | PNAE G-7-009-89 (4.1,5.3.3-5.3.8) | | | **B2** |
| *NB 4232: Alignment requirements when components are welded from 2 sides* | Offsets. | PNAE G-7-009-89 (12.11) | | Requirements may also be in technical documentation on specified weld. | **B2** |
| *NB 4233: Alignment requirements when inside surfaces are inaccessible* | Offsets. | PNAE G-7-009-89 (12.11) | | Requirements may also be in technical documentation on specified weld. | **B2** |
| NB-4240 Requirements for Weld Joints in Components | | PNAE G-7-010-89 (2) - definitions of categories of welded joints.<br>PNAE G-7-009-89 (12) - requirements to types of welded joints.<br>PNAE G-7-008-89 (2.4.1) - permissible types of welded joints. | PNAE G-7 uses different categorization procedure based on safety class of component.<br>Partial penetration welds are prohibit for pressure boundary except tubes-to-tubesheets. | | |
| *NB 4241: Cat A weld joints in vessels and longit weld joints in other components* | | | | | **B2** |
| *NB 4242: Cat B weld joints in vessels and circumf weld joints in other components* | | | | | **B2** |
| *NB 4243: Cat C weld joints in vessels and similar weld joints in other components* | | | | | **B2** |
| *NB 4244: Cat D weld joints in vessels and similar weld joints in other components* | | | | | **B2** |
| *NB 4245: Complete joint penetration welds* | | | | | **B2** |
| *NB 4246: Piping branch connection* | | | | | **B2** |
| NB-4250 Welding End Transitions — Maximum Envelope | | PNAE G-7-008-89 (2.4.1.6),PNAE G-7-009-89 (5.2.6) | | PNAE G-7 does not include any specific requirements. | **B1** |
| **NB-4300 Welding Qualifications** | | | | | |
| NB-4310 General Requirements<br>*NB 4311: Type of processes permitted* | Types permitted are in Section IX with stud welding restriction, capacitor discharge welding, inertia and continuous drive friction welding. | PNAE G-7-009-89 (6.1.2) | | | **A2** |
| NB-4320 Welding Qualifications, Records, and Identifying Stamps<br>*NB 4321: Required qualifications* | | PNAE G-7-009-89 (4),PNAE G-7-010-89 (3.1) | | | **B2** |
| *NB 4322: Maintenance and certification of records* | | PNAE G-7-009-89 (10) | PNAE G-7 contains only requirements on marking. | | **B2** |
| *NB 4323: Welding prior to qualification* | | | No equivalent provision in PNAE G-7. | Welding is allowed only after qualification. | **B1** |
| *NB 4324: Transferring qualification* | | | No equivalent provision in PNAE G-7. | | **B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-4000 Fabrication and Installation (cont.)** | | | | | |
| **NB-4300 Welding Qualifications (cont.)** | | | | | |
| NB-4330 General Requirements for Welding Procedure Qualification Tests<br>*NB 4331: Conformance to section IX requirements* | | | Welding procedure qualification tests shall be in accordance with the requirements of PNAE G-7-010-89 (3.2) | | **B2** |
| *NB 4332: not used* | | | | | |
| *NB 4333: Heat treatment of qualification welds for ferritic materials* | | PNAE G-7-009-89 (6.4.3.12-6.4.3.13) | | | **B2** |
| *NB 4334: Preparation of test coupons and specimens: representing weld deposit, heat affected zone* | | PNAE G-7-009-89 (6.4.3,6.4.4) | | | **B2** |
| *NB 4335: Impact test requirements: of weld metal, of HAZ* | | PNAE G-7-009-89 (App.2.5.2.1) | Impact test shall be done according GOST 6996. | | **B2** |
| *NB 4336: Qualification requirements for built-up weld deposits* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4337: Welding of instrument tubing* | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-4340 (not used) | | | | | |
| NB-4350 Special Qualification Requirements for Tube-to-Tubesheet Welds | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-4360 Qualification Requirements for Welding Specially Designed Welded Seals<br>*NB 4361: General requirements* | | | No special provision of welded seals in PNAE G-7. | | **B1** |
| *NB 4362: Essential variables for automatic machine, and semi-automatic welding* | | | | | **B1** |
| *NB 4363: Essential variables for manual welding* | | | | | **B1** |
| *NB 4364: not used* | | | | | **B1** |
| *NB 4365: not used* | | | | | **B1** |
| *NB 4366: Test assembly: automatic, manual, machine and semi-automatic welding* | | | | | **B1** |
| *NB 4367: Examination of test assembly* | | | | | **B1** |
| *NB 4368: Performance qualification tests* | | | | | **B1** |
| **NB-4400 Rules Governing Making, Examining, and Repairing Welds** | | | | | |
| NB-4410 Precautions to Be Taken Before Welding<br>*NB 4411: Identification, storage and handling of welding material* | | PNAE G-7-009-89 (2.8-2.16) | Additional requirements for tempering in PNA G-7. | | **B2** |
| *NB 4412: Cleanliness and protection of welding surfaces* | | PNAE G-7-009-89 (5.3.16) | | | **A2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-4000 Fabrication and Installation (cont.)** | | | | | |
| **NB-4400 Rules Governing Making, Examining, and Repairing Welds (cont.)** | | | | | |
| NB-4420 Rules for Making Welded Joints<br>*NB 4421: Backing rings* | | PNAE G-7-009-89 (5.3.21-5.3.22) | Unremovable backing rings are allowed. | | **B2** |
| *NB 4422: Peening* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4423: Miscellaneous welding requirements* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4424: Surface of welds: general and preservice examination* | General requirements and pre-service examination. | PNAE G-7-009-89 (6.1.14,) | | Additional requirements in PNAE G-7-010-89 (11.2) | **B2** |
| *NB 4425: Welding items of different diameters* | Reference to design provisions. | PNAE G-7-008-89 (2.4.1.6),PNAE G-7-009-89 (5.2.6) | | | **A2** |
| *NB 4426: Reinforcement of welds* | Thickness of weld reinforcement for vessels, pumps and valves; thickness of weld reinforcement for piping. | | The size of reinforcement define by PNAE G-7-009-89 (table App.3) | | **B2** |
| *NB 4427: Shape and size of fillet welds* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4428: Seal welds of threated joints* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4429: Welding of clad parts* | | | No equivalent provision in PNAE G-7. | PNAE G-7 includes specified requirements for welding of clad surfaces. | **B1** |
| NB-4430 Welding of Attachments<br>*NB 4431: Materials for attachments* | | | Some requirements for attachment welding given in PNAE G-7-008-89 (2.4.1.3-2.4.1.5, 2.4.3.9, 2.4.3.15) | | **B1** |
| *NB 4432: Welding of structural attachments* | | | | | **B1** |
| *NB 4433: Structural attachments* | | | | | **B1** |
| *NB 4434: Welding of internal structural supports to clad components* | | | | | **B1** |
| *NB 4435: Welding of nonstructural attachments and their removal* | | | | | **B1** |
| *NB 4436: Installation of attachments to piping systems after testing* | | | | | **B1** |
| NB-4440 Welding of Appurtenances | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-4450 Repair of Weld Metal Defects<br>*NB 4451: General requirements* | | PNAE G-7-009-89 (9.1) | | | **A2** |
| *NB 4452: Elimination of surface defects* | | PNAE G-7-009-89 (9.3,9.4) | | | **B2** |
| *NB 4453: Requirements for making repairs of welds* | defect removal, welding material, procedures, welders, examination of repair welds, heat treatment of repair welds | PNAE G-7-009-89 (9) | | | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-4000 Fabrication and Installation (cont.)** | | | | | |
| **NB-4500 Brazing** | | | | | |
| NB-4510 Rules for Brazing | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-4520 Brazing Qualification Requirements<br>*NB 4521: Brazing procedure and performance qualification* | | | | | **B1** |
| *NB 4522: Valve seat rings* | | | | | **B1** |
| *NB 4523: Reheated joints* | | | | | **B1** |
| *NB 4524: Maximum temperature limits* | | | | | **B1** |
| NB-4530 Fitting and Aligning of Parts to Be Brazed | | | | | **B1** |
| NB-4540 Examination of Brazed Joints | | | | | **B1** |
| **NB-4600 Heat Treatment** | | | | | |
| NB-4610 Welding Preheat Requirements<br>*NB 4611: When preheat is necessary* | | PNAE G-7-009-89 (6.2.1) | | | **B2** |
| *NB 4612: Preheating methods* | | PNAE G-7-009-89 (6.2.14) | | | **B2** |
| *NB 4613: Interpass temperature* | | PNAE G-7-009-89 (6.2.2-6.2.5) | | | **B2** |
| NB-4620 Postweld Heat Treatment<br>*NB 4621: Heating and cooling methods* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4622: PWHT time and temperature requirements* | General requirements, time-temperature recording, definition of nominal thickness governing PWHT, holding time at temperature, PWHT requirements when different P-number materials are joined, PWHT for nonpressure retaining parts, exemptions to mandatory requirements, requirements for exempting PWHT of nozzles to component welds and branch to run piping welds, temper bead weld repair, repair welds to cladding after final postweld heat treatment, temper bead weld repair to disequivalent metal welds or buttering. | PNAE G-7-009-89 (8) | Globally equivalent but with many technical differences. | | **B2** |
| *NB 4623: PWHT heating and cooling rate requirements,* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4624: Methods of PWHT* | Furnace heating-one heat, furnace heating – more than one heat, local heating, heating items internally. | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-4630 Heat Treatment of Welds Other Than the Final Postweld Heat Treatment | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-4640 not used | | | | | |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-4000 Fabrication and Installation (cont.)** | | | | | |
| **NB-4600 Heat Treatment (cont.)** | | | | | |
| NB-4650 Heat Treatment After Bending or Forming for Pipes, Pumps, and Valves<br>*NB 4651: Conditions requiring heat treatment after bending or forming* | | PNAE G-7-009-89 (4.4.3-4.4.4) | | | **B2** |
| *NB 4652: Exemptions from heat treatment after bending or forming* | | PNAE G-7-009-89 (4.4.5-4.4.6) | | | **B2** |
| NB-4660 Heat Treatment of Electroslag Welds | | | No equivalent provision in PNAE G-7. | | **B1** |
| **NB-4700 Mechanical Joints** | | | | | |
| NB-4710 Bolting and Threading | | | | | |
| *NB 4711: Thread engagement* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4712: Thread lubricants* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 4713: Removal of thread lubricants* | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-4720 Bolting Flanged Joints | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-4730 Electrical and Mechanical Penetration Assemblies | | | No equivalent provision in PNAE G-7. | | **B1** |
| **Article NB-5000 Examination** | | **PNAE G-7-008-89 (Article 7), PNAE G-7-010-89** | | | |
| | | | | | |
| NB-5110 Methods, Nondestructive Examination Procedures, and Cleaning<br>*NB 5111: Methods* | Nondestructive examinations shall be conducted in accordance with the examination methods of Section V, except as they may be modified by the requirements of this Article. | PNAE G-7-008-89 (4.1.3, 7.3)<br>PNAE G-7-010-89 (1.15, 9.1.1) | There are no limitations on examination methods during fabrication and preservice inspection in PNAE G-7. | Examination methods should met the requirements of PNAE G-7-010-89, project or fabrication documentation. | **B2** |
| *NB 5112: NDE procedures* | All nondestructive examinations required by this Article shall be performed in accordance with detailed written procedures which have been proven by actual demonstration to the satisfaction of the Inspector. | PNAE G-7-008-89 (4.1.3, 7.1, 7.3) | There are no words in PNAE G-7 about actual demonstration of NDE procedures to the satisfaction of the Inspector. There are no requirements for digital image acquisition in PNAE G-7. | | **B2** |
| *NB 5113: Post-examination cleaning* | Following any nondestructive examination in which examination materials are applied to the piece, the piece shall be thoroughly cleaned in accordance with applicable material or procedure specifications. | | No equivalent provision in PNAE G-7. | | **B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-5000 Examination (cont.)** | | **PNAE G-7-008-89 (Article 7), PNAE G-7-010-89** | | | |
| NB-5120 Time of Examination of Welds and Weld Metal Cladding | Description of examination and heat and other treatment priority. | PNAE G-7-010-89 (9.10)<br>PNAE G-7-008-89 (4.5.1) | There are coincidences but not all of statements have equivalent in PNAE G-7. | Additional requirements may included in standards on materials, or fabrication standards. | **B2** |
| NB-5130 Examination of Weld Edge Preparation Surfaces | All full penetration weld edge preparation surfaces for joint Categories A, B, C, D, and similar joints in material 2 in. (50 mm) or more in thickness shall be examined by the magnetic particle or liquid penetrant method. | PNAE G-7-010-89 (8.2) | Preparation surfaces of components only from austenitic and high-chromium steel shall be examined by the magnetic particle or liquid penetrant method according to PNAE G-7. | | **B2** |
| NB-5140 Examination of Welds and Adjacent Base Material | Examination of Welds and Adjacent Base Material | PNAE G-7-010-89 (9.1.12) | There are more detailed requirements in PNAE G-7. | | **B2** |
| **NB-5200 Required Examination of Welds for Fabrication and Preservice Baseline** | | | | | |
| NB-5210 Category A Vessel Welded Joints and Longitudinal Welded Joints in Other Components | Category A welded joints in vessels and longitudinal<br>welded joints in other components shall be examined by a volumetric and either the liquid penetrant or magnetic particle method. | PNAE G-7-010-89 (1.1, 9.1.12, 9.1.1) | Definitions of welded joint categories and examination requirements are different in ASME Code and PNAE G-7. According to PNAE G-7 methods and amount of non-destructive testing of different weld joint categories are determined by design organization. | | **B2** |
| NB-5220 Category B Vessel Welded Joints and Circumferential Welded Joints in Piping, Pumps, and Valves<br>*NB 5221: Vessel welded joints* | Category B welded joints in vessels shall be examined by a volumetric and either the liquid penetrant or magnetic particle method. | PNAE G-7-010-89 (1.1, 9.1.12, 9.1.1) | The same as above. | | **B2** |
| *NB 5222: Piping , pump and valve circonf welded joints* | | PNAE G-7-010-89 (1.1, 9.1.12, 9.1.1) | The same as above. | | **B2** |
| NB-5230 Category C Vessel Welded Joints and Similar Welded Joints in Other Components<br>*NB 5231: General requirements* | | PNAE G-7-010-89 (1.1, 9.1.12, 9.1.1) | The same as above. | | **B2** |
| NB-5240 Category D Vessel Welded Joints and Branch and Piping Connections in Other Components<br>*NB 5241: General requirements* | | PNAE G-7-010-89 (1.1, 9.1.12, 9.1.1) | The same as above. | | **B2** |
| *NB 5242: Full penetration butt welded nozzles branch and piping connections* | | PNAE G-7-010-89 (1.1, 9.1.12, 9.1.1) | The same as above. | | **B2** |
| *NB 5243: Corner welded nozzles, branch and piping connections* | | PNAE G-7-010-89 (1.1, 9.1.12, 9.1.1) | The same as above. | | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-5000 Examination (cont.)** | | **PNAE G-7-008-89 (Article 7), PNAE G-7-010-89** | | | |
| **NB-5200 Required Examination of Welds for Fabrication and Preservice Baseline (cont.)** | | | | | |
| *NB 5244: Weld metal build up at openings for nozzles, branch and piping connections* | | PNAE G-7-010-89 (1.1, 9.1.12, 9.1.1) | The same as above. | | **B2** |
| *NB 5245: Fillet welded and partial penetration welded joints* | | PNAE G-7-010-89 (1.1, 9.1.12, 9.1.1) | The same as above. | | **B2** |
| *NB 5246: Oblique full penetration nozzles, branch and piping connections* | | PNAE G-7-010-89 (1.1, 9.1.12, 9.1.1) | The same as above. | | **B2** |
| NB 5250 not used | | | | | |
| NB-5260 Fillet, Partial Penetration, Socket, and Attachment Welded Joints<br>*NB 5261: Fillet, partial penetration and SW joints* | | PNAE G-7-010-89 (9.11.12, 9.11.14, Table 6) | PNAE G-7 additional requires radiographic control for some cases. | | **A2** |
| *NB 5262: Structural attachment welded joints* | | PNAE G-7-010-89 (9.11.12, 9.11.14, Table 6) | | | **A2** |
| NB-5270 Special Welded Joints<br>*NB 5271: Welded joints of specially designed seals* | | PNAE G-7-010-89 (9.1.12, 9.1.1) | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 5272: Weld metal cladding* | | PNAE G-7-010-89 (9.1.12, 9.1.1) | Different requirements. PNAE G-7 requires visual and ultrasonic examination | | **B2** |
| *NB 5273: Hard surfacing* | | PNAE G-7-010-89 (9.1.12, 9.1.1) | Methods and volume of examination are determined by design organization according to PNAE | | **B2** |
| *NB 5274: Tube-to-tubesheet welded joints* | | PNAE G-7-010-89 (9.1.12, 9.1.1) | In some cases PNAE G-7 requires radiographic and magnetic particle examination methods | | **B2** |
| *NB 5274: Brazed joints* | | | There is no such entry in PNAE G-7 | | **B1** |
| *NB 5276: Inertia and continuous drive friction welds* | | | There is no such entry in PNAE G-7 | | **B1** |
| *NB 5277: Electron beam welds* | | | There is no such entry in PNAE G-7 | | **B1** |
| *NB 5278: Electroslag welds* | | | There is no such entry in PNAE G-7 | | **B1** |
| *NB 5279: Special exemptions* | | PNAE G-7-010-89 (9.11.10) | | | **A2** |
| NB-5280 Preservice Examination<br>*NB 5281: General requirements* | | PNAE G-7-008-89 (7.6.1) | | | **B2** |
| *NB 5282: Examination requirements* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 5283: Components exempt from preservice examination* | | | No equivalent provision in PNAE G-7. | | **B1** |
| **Article NB-5000 Examination (cont.)** | | **PNAE G-7-008-89 (Article 7), PNAE G-7-010-89** | | | |
| **NB-5300 Acceptance Standards (cont.)** | | | | | |
| NB-5320 Radiographic Acceptance Standards | | PNAE G-7-010-89 (11.7) | More detailed and strict limitaions in PNAE G-7. | | **B2** |
| NB-5330 Ultrasonic Acceptance Standards | | | | | |
| *NB 5331: Fabrication* | | PNAE G-7-010-89 (11.8) | More detailed limitaions in PNAE G-7. | | **B2** |
| *NB 5332: Preservice examination* | | PNAE G-7-010-89 (11.8) | There is no such entry in PNAE G-7. | | **B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| NB-5340 Magnetic Particle Acceptance Standards<br>*NB 5341: Evaluation of indications* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 5342: Acceptance standards* | | PNAE G-7-010-89 (11.2, 11.6) | More detailed and strict limitaions in PNAE G-7. | | **B2** |
| *NB 5343: Preservice examination* | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-5350 Liquid Penetrant Acceptance Standards<br>*NB 5351: Evaluation of indications* | | PNAE G-7-010-89 (11.5) | No equivalent provision in PNAE G-7. | | **B2** |
| *NB 5352: Acceptance standards* | | PNAE G-7-010-89 (11.5) | More detailed and strict limitaions in PNAE G-7. | | **B2** |
| *NB 5353: Preservice examination* | | | There is no corresponding entry in PNAE | | **B1** |
| NB-5360 Eddy Current Preservice Examination of Installed Nonferromagnetic Steam Generator Heat Exchanger Tubing | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-5370 Visual Acceptance Standards for Brazed Joints | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-5380 Bubble Formation Testing | | | No equivalent provision in PNAE G-7. | | **B1** |
| **NB-5400 Final Examination of Vessels** | | | | | |
| NB-5410 Examination After Hydrostatic Test | | | There is no corresponding entry in PNAE G-7. | | **B1** |
| **NB-5500 Qualifications and Certification of Nondestructive Examination Personnel** | | | | | |
| NB-5510 General Requirements | | PNAE G-7-010-89 (4.1) | Different approaches, different terminology. | | **B2** |
| NB-5520 Personnel Qualification, Certification, and Verification<br>*NB 5521: Qualification procedure* | | PNAE G-7-010-89 (4.2) | Different approaches, different terminology. | | **B2** |
| *NB 5522: Certification of personnel* | | PNAE G-7-010-89 (4.2, 4.3) | Different approaches, different terminology. | | **B2** |
| *NB 5523: Verification of NDE personnel certification* | | PNAE G-7-010-89 (4.2) | Different approaches, different terminology. | | **B2** |
| NB-5530 Records | | PNAE G-7-010-89 (4.3) | | | **B2** |
| **Article NB-6000 Testing** | | | | | |
| **NB-6100 General Requirements** | | | | | |
| NB-6110 Pressure Testing of Components, Appurtenances, and Systems<br>*NB 6111: Scope of pressure testing* | All pressure-retaining components, appurtenances, and completed systems shall be pressure tested. The preferred method shall be a hydrostatic test using water as the test medium. Bolts, studs, nuts, washers, and gaskets are exempted from the pressure test. | PNAE G-7-008-89 (5.1.1, 5.1.3, 5.1.5) | According to p. 5.1.3 of PNAE G-7 it is permitted not to do pressure testing for vessels of research reactors retaining pressure only from weight of fluid if all of weld joints are 100% controlled. | | **A2** |
| *NB 6112: Pneumatic testing: limitations, precautions* | Limitations and precautions of pneumatic testing. | | In ASME there are more common limitations and in PNAE G-7 are more specific. | | |
| NB 6112.1 Pneumatic Test Limitations<br>NB 6112.2 Precautions to Be Employed in PneumaticTesting | Limitations of pneumatic testing.<br>Precautions of pneumatic testing. | PNAE G-7-008-89 (5.1.3)<br>PNAE G-7-008-89 (5.5.7) | | | **B2**<br>**A2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-6000 Testing (cont.)** | | | | | |
| **NB-6100 General Requirements (cont.)** | | | | | |
| *NB 6113: Witnessing of pressure test* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 6114: Time of pressure testing: system pressure test, component and appurtenance pressure test, material pressure test* | | PNAE G-7-008-89 (5.1.2, 5.1.9) | | | **B2** |
| *NB 6115: Machining after pressure test* | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-6120 Preparation for testing<br>*NB 6121: Exposure of join* | All the joints must be left uninsulated for pressure testing. | PNAE G-7-008-89 (5.1.7, 5.1.8) | According to PNAE G-7 not only joints but all of the components and piping during fabrication shall be tested before application of insulation. During operation before pressure testing all detachable insulation must be removed. | | **A2** |
| *NB 6122: Addition of temporary support* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 6123: Restraint or isolation of expansion joints* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 6124:Isolation of equipment not subjected to pressure test* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 6125: Treatment of flanged joints containing blanks* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 6126: Precautions against test medium expansion* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 6127: Check of test equipment before applying pressure* | | | No equivalent provision in PNAE G-7. | | **B1** |
| **NB-6200 Hydrostatic Tests** | | | | | |
| NB-6210 Hydrostatic Test Procedure<br>*NB 6211: Venting during fill operation* | The component or system in which the test is to be conducted shall be vented during the filling operation to minimize air pocketing. | PNAE G-7-008-89 (5.4.6) | | | **A2** |
| *NB 6212: Test medium and test temperature* | Thermal and test medium requirements. | PNAE G-7-008-89 (5.3, 5.4.4) | Much more detailed requirements are in PNAE G-7. | | **B2** |
| NB-6220 Hydrostatic Test Pressure Requirements<br>*NB 6221: Minimum hydrostatic test pressure* | | PNAE G-7-008-89 (5.2) | Much more detailed requirements are in PNAE G-7. The value of test pressure is higher in PNAE G-7. | | **B2** |
| *NB 6222: Maximum permissible test pressure* | | PNAE G-7-008-89 (5.2) | Much more detailed requirements are in PNAE G-7. | | **B2** |
| *NB 6223: Hydrostatic test pressure holding time* | Holding time. | PNAE G-7-008-89 (5.4.1) | | | **A1** |
| *NB 6224: Examination of leakage after application of pressure* | | PNAE G-7-008-89 (5.7) | More detailed requirements are in ASME. | | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-6000 Testing (cont.)** | | | | | |
| **NB-6300 Pneumatic Tests** | | | | | |
| NB-6310 Pneumatic Testing Procedures<br>*NB 6311: General requirements* | Links to NB 6100. | PNAE G-7-008-89 (5.1) | | | **B2** |
| *NB 6312: Test medium and test temperature* | | PNAE G-7-008-89 (5.4.4, 5.3) | Requirement of noninflammability are the same but approaches to determine test temperature differs . | | **B2** |
| *NB 6313: Procedure for applying pressure* | The pressure in the system shall be increased gradually. | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-6320 Pneumatic Test Pressure Requirements | | | | | |
| *NB 6321: Minimum required pneumatic test pressure* | | PNAE G-7-008-89 (5.5, 5.2) | | | **B2** |
| *NB 6322: Maximum permissible test pressure* | | PNAE G-7-008-89 (5.5, 5.2) | | | **B2** |
| *NB 6323: Test pressure holding time* | Holding time. | PNAE G-7-008-89 (5.5.6) | Minimum pressure holding time is 30 min. according to PNAE G-7. | | **B2** |
| *NB 6324: Examination for leakage after application of pressure* | Requirement to pressure reduced after testing. | PNAE G-7-008-89 (5.5.6,5.7) | Different requirements to pressure while examination of leakage in ASME and PNAE G-7. | | **B2** |
| NB-6400 Pressure Test Gages | | | | | |
| *NB 6411: Type of gages to be used and their location* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 6412: Range of indicating pressure gages* | | PNAE G-7-008-89 (5.4.1) | Requirements to tolerance are close. More strict requirements are in ASME (1% for digital gages of inaccuracy instead of 5% (any types) in PNAE G-7). | | **A2** |
| *NB 6413: Calibration of pressure test gages* | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-6500 not used | | | | | |
| **Article NB-6000 Testing (cont.)** | | | | | |
| NB-6600 Special Test Pressure Situations | | | | | |
| NB-6610 Components Designed for External Pressure | Components designed for external pressure only shall<br>be subjected to an internal or external test pressure at 1.25 times the design external pressure. | PNAE G-7-008-89 (5.1.12, 5.2.1) | PNAE allow to subject components designed for external pressure to internal pressure test. Pressure requirements are close. | | **A2** |
| NB-6620 Pressure Testing of Combination Units<br>*NB 6221: Pressure chambers designated to operate independently* | Each chamber shall be tested without pressure in the adjacent chamber | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB 6222: Common elements designed for a max differential pressure* | | | No equivalent provision in PNAE G-7. | | **B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A<br>B |
|---|---|---|---|---|---|
| **Article NB-7000 Overpressure Protection** | | | | | |
| NB-7100 General Requirements | | | | | |
| NB-7110 Scope<br><br>*NB-7111 Definitions* | Scope. | PNAE G-7-008-89 (2.1.7, 6.2.1) | There is no scope pharagraph for overpressure protection in PNAE<br>No equivalent provision in PNAE G-7.<br>There is no defenition of overpressure in PNAE, only for pressure relief device. | | **B2**<br><br>**B1** |
| NB-7120 Integrated Overpressure Protection | | PNAE G-7-008-89 (2.1.7, 6.2.1) | | | **B2** |
| NB-7130 Verification of the Operation of Reclosing Pressure Relief Devices<br>*NB-7131 Construction* | Requirements for constructing of pressure relief devices. | PNAE G-7-008-89 (6.2.16, 6.2.1) | | | **B2** |
| NB-7140 Installation<br>*NB 7141 Pressure Relieve Devices* | Requirements for installation of pressure relief devices. | PNAE G-7-008-89 (6.2.18, 6.2.21-23, 25) | | | **B2** |
| *NB-7142 Stop valves* | | PNAE G-7-008-89 (6.2.10-11, 6.2.24-26) | | | **B2** |
| *NB-7143 Draining of pressure relieve devices* | Requirements for draining of pressure relief devices. | PNAE G-7-008-89 (6.2.26) | | | **B2** |
| *NB-7150 Acceptable Pressure Relief Devices* | | | | | |
| *NB-7151 Pressure relief valves* | Links to NB-7170 and NB-7500. | | | | |
| *NB-7152 Nonreclosing pressure relief devices* | Links to NB-7170 and NB-7600. | | | | |
| NB-7160 Unacceptable Pressure Relief Devices<br>*NB-7161 Deadweight pressure relief valves* | Dead weight valves shall not be used. | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-7170 Permitted Use of Pressure Relief Devices<br>*NB-7171 Safety valves* | Safety valves, meeting the requirements of NB-7510, may be steam service; air and gas service. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7172 Safety relief valves* | Safety relief valves, meeting the requirements of NB-7510 may be steam service; air and gas service, liquid service. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7173 Relief valves* | Relief valves, meeting the requirements of NB-7510, may be used for liquid service. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7174 Pilot operated pressure relief valves* | Pilot operated pressure relief valves, meeting the requirements of NB-7520, may be used for: steam service; air and gas service; liquid service. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7175 Power actuated pressure relief valves* | Power actuated pressure relief valves, meeting the requirements of NB-7530, may be used for:steam service; air and gas service; liquid service. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7176 Safety valves with auxiliary actuating devices* | Safety valves with auxiliary actuating devices, meeting the requirements of NB-7540, may be used for steam service. | | No equivalent provision in PNAE G-7. | | **B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-7000 Overpressure Protection (cont.)** | | | | | |
| **NB-7100 General Requirements(cont.)** | | | | | |
| *NB-7177 Pilot operated pressure relief valves with auxiliary actuating devices* | Pilot operated pressure relief valves with auxiliary actuating devices, meeting the requirements of NB-7540, may be used for: steam service; air and gas service; liquid service. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7178 Nonreclosing devices* | Rupture disk devices may be used on air or gas service in accordance with NB-7600. | PNAE G-7-008-89 (6.2.19) | | | **B2** |
| **NB-7200 Overpressure Protection Report** | | | | | |
| NB-7210 Responsibility for Report | The provisions intended to meet the requirements of Article 7000 shall be the subject of an Overpressure Protection Report prepared by the Owner or his designee. | PNAE G-7-008-89 (6.1.1, 6.1.4) | PNAE: Quantity, type, installation places and another requirements for pressure relief and monitor devices must be defined in design documentation | | **B2** |
| NB-7220 Content of Report | Content of Overpressure Protection Report. | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-7230 Certification of Report | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-7240 Review of Report After Installation | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-7250 Filing of Report | | | No equivalent provision in PNAE G-7. | | **B1** |
| **NB-7300 Relieving Capacity** | | | | | |
| NB-7310 Expected System Pressure Transient Conditions<br>*NB 7311 Relieving capacity of Pressure Relief Devices* | Relieving capacity of Pressure Relief Devices requirements. | PNAE G-7-008-89 (6.2.2, 6.2.3, 6.2.8-9) | According to ASME the total relieving capacity shall be sufficient to prevent a rise in pressure of more than 10% above the Design Pressure, according to PNAE G-7 this value is 15%. | | **B2** |
| *NB-7312 Relieving capacity of pressure relief devices used with pressure-reducing devices* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7313 Required number and capacity of pressure relief devices* | The required relieving capacity for overpressure protection of a system shall be provided by the use of at least two pressure relief devices, no device shall have a capacity less than 50% of the device with the largest capacity. | PNAE G-7-008-89 (6.2.2, 6.2.7) | First requirement for number of pressure relief devices (at least two) are similar in ASME and PNAE, but second capacity requirement is absent in PNAE G-7. | | **B2** |
| *NB-7314 Required number and capacity of pressure relief devices for isolatable components* | The required relieving capacity of an isolatable component shall be provided by at least one pressure relief device meeting the requirements of NB-7500 or NB-7600. Alternatively, pressure relief devices are not required if the design of the component, when isolated, is in compliance with NB-7120. | PNAE G-7-008-89 (6.2.2, 6.2.7) | Requirements are close. | | **A2** |
| NB-7320 Unexpected System Excess Pressure Transient Conditions<br>*NB-7321 Relieving capacity of pressure relief devices* | | PNAE G-7-008-89 (6.2.2, 6.2.3, 6.2.8-9) | | | **B2** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-7000 Overpressure Protection (cont.)** | | | | | |
| **NB-7400 Set Pressures of Pressure Relief Devices** | | | | | |
| NB-7410 Set Pressure Limitations for Expected System Pressure Transient Conditions | The stamped set pressure of at least one of the pressure relief devices connected to the system shall not be greater than the Design Pressure of any component within the pressure-retaining boundary of the protected system. | PNAE G-7-008-89 (6.2.4) | In PNAE: If pressure relief device protects some connected components it shall be chosen and tuned on the basis of the least design pressure of each component. | | **B2** |
| NB-7420 Set Pressure Limitation for Unexpected System Excess Pressure Transient Conditions | Links to NB-7320. | PNAE G-7-008-89 (6.2.2, 6.2.3) | | | **B2** |
| **NB-7500 Operating and Design Requirements for Pressure Relief Valves** | | | | | |
| NB-7510 Safety, Safety Relief, and Relief Valves<br>*NB-7511 General requirements* | Description of valve types | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7512 Safety valve operating requirements* | Antichattering and Lift Requirements, Set Pressure Tolerance for valves | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7513 Safety relief and relief valve operating requirements* | Antichattering and Lift Requirements, Set Pressure Tolerance for safety relief and relief valves | PNAE G-7-008-89 (6.2.2, 6.2.3) | No strict requirements for set pressure tolerance of relief valves are in PNAE. According to PNAE in the components with design pressure up to 0.3 Mpa the overpressure shall be not more than 0.05 Mpa (tolerance 6%), relief valve must close at 0.9 of design pressure (tolerance 10%) | | **B2** |
| *NB-7514 Credited relieving capacity* | The credited relieving capacity of safety, safety relief, and relief valves shall be based on the certified relieving capacity | | No equivalent provision in PNAE G-7. | | |
| *NB-7515 Sealing of adjustments* | Means shall be provided in the design of all valves for sealing all adjustments or access to adjustments that can be made without disassembly of the valve… | PNAE G-7-008-89 (6.2.14) | PNAE: In all relief valves possibility of adjustment shall be excluded. | | **A2** |
| NB-7520 Pilot Operated Pressure Relief Valves<br>*NB-7521 General requirements* | Pilot operated pressure relief valves shall operate independently of any external energy source. | PNAE G-7-008-89 (6.2.17) | | | **A2** |
| *NB-7522 Operating requirements* | Actuation, response time, Main Valve Operation, Sensing Mechanism Integrity, Set Pressure Tolerance,Blowdown. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7523 Credited relieving capacity* | Links to NB- 7700. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7524 Sealing of adjustments* | Links to NB- 7515. | PNAE G-7-008-89 (6.2.14) | PNAE: In all relief valves possibility of adjustment shall be excluded. | | **A2** |
| NB-7530 Power Actuated Pressure Relief Valves | | | | | |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-7000 Overpressure Protection (cont.)** | | | | | |
| **NB-7500 Operating and Design Requirements for Pressure Relief Valves (cont.)** | | | | | |
| *NB-7531 General requirements* | Power actuated pressure relief valves which depend upon an external energy source, such as electrical, pneumatic, or hydraulic systems, may be used provided the requirements of NB-7530 are met. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7532 Operating requirements* | Actuation, response time, Main Valve Operation, Sensors, Controls, and External Energy Sources. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7533 Certified relieving capacity* | Links to NB- 7700. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7534 Credited relieving capacity* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7535 Sealing of adjustments* | | PNAE G-7-008-89 (6.2.14) | | | **A2** |
| NB-7540 Safety Valves and Pilot Operated Pressure Relief Valves With Auxiliary Actuating Devices<br>*NB-7541 General requirements* | Links to NB-7510, NB-7520. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7542 Construction* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7543 Auxiliary device sensors and controls* | Links to NB-7532.2. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7544 Relieving capacity* | Relieving Capacity at Expected System Pressure Transient<br>Conditions, unexpected System Pressure Transient Conditions, Credited Relieving Capacity. | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7545 Response time* | Links to NB-7532.2. | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-7550 Alternative Test Media<br>*NB-7551 General requirements* | Pressure relief devices may be subjected to set pressure tests using a test medium of a fluid type or temperature other than that for which they are designed, provided the testing complies with NB-7552 through NB-7554. | | No equivalent provision in PNAE G-7.<br>No equivalent provision in PNAE G-7. | | **B1**<br>**B1** |
| *NB-7552 Correlation* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7553 Verification of correlation procedure* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7554 Procedure* | | | | | **B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-7000 Overpressure Protection (cont.)** | | | | | |
| **NB-7600 Nonreclosing Pressure Relief Devices** | | | | | |
| NB-7610 Rupture Disk Devices | Rupture disk devices shall not be used as the sole pressure relief devices; rupture disk devices used in conjunction with pressure relief valves shall be located only on the outlet side of the valve (NB-7623). | PNAE G-7-008-89 (6.2.19) | PNAE allows to locate rupture disk devices before the relief valve at specific conditions. | | **B2** |
| *NB-7611 Burst pressure tolerance* | Burst Pressure Tolerance requirements. | PNAE G-7-008-89 (6.2.19) | No strict requirements for burst pressure tolerance are in PNAE. At C group of components and components with liquid metal heat carrier burst pressure is 1.25 of operating pressure. | | **B2** |
| *NB-7612 Tests to establish stamped burst pressure* | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-7620 Installation<br>*NB-7621 Provisions for venting or draining* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7622 Systems obstructions* | Piping and other components downstream of the rupture disk shall be constructed so that bursting of the rupture disk will not impair the function of the pressure relief valve by the release of rupture disk material. | PNAE G-7-008-89 (6.2.19) | According to PNAE it is allowed to install rupture disk before relief valve if a special device which prevents ingress pieces of the bursted rupture disk into valve is installed between them. | | **B2** |
| *NB-7623 Rupture disk devices at the outset side of pressure relief valves* | | | No equivalent provision in PNAE G-7. | | **B1** |
| **NB-7700 Certification** | | | | | **B1** |
| NB-7710 Responsibility for Certification of Pressure Relief Valves | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-7720 Responsibility for Certification of Nonreclosing Pressure Relief Devices | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-7730 Capacity Certification Pressure Relief Valves — Compressible Fluids<br>*NB-7731 General requirements* | | | No equivalent provision in PNAE G-7.<br>No equivalent provision in PNAE G-7. | | **B1**<br>**B1** |
| *NB-7732 Flow model test method* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7733 Slope method* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7734 Coefficient of discharge method* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7735 Single valve method* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7736 Proration of capacity* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7737 Capacity conversions* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7738 Laboratory acceptance of pressure relieving capacity tests* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7739 Laboratory acceptance of demonstration of function tests* | | | No equivalent provision in PNAE G-7. | | **B1** |

| ASME NB Paragraphs | Brief Description of paragraph content | PNAE G-7 corresponding Paragraphs | Brief Description of differences | Comments | A B |
|---|---|---|---|---|---|
| **Article NB-7000 Overpressure Protection (cont.)** | | | | | |
| **NB-7700 Certification (cont.)** | | | | | |
| *NB-7740 Capacity Certification of Pressure Relief Valves — Incompressible Fluids* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7741 General requirements* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7742 Valve designs in excess of test facility limits* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7743 Slope method* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7744 Coefficient of discharge method* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7745 Single valve method* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7746 Laboratory acceptance of pressure relieving capacity tests* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7747 Proration of capacity* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7748 Capacity conversions* | | | No equivalent provision in PNAE G-7. | | **B1** |
| *NB-7749 Laboratory acceptance of demonstration of function tests* | | | No equivalent provision in PNAE G-7. | | **B1** |
| **NB-7800 Marking, Stamping, and Data Reports** | | | | | |
| NB-7810 Pressure Relief Valves<br>*NB-7811 Marking and stamping* | Each pressure relief valve shall be plainly marked by the Certificate Holder with the required data in such a way that the marking will not be obliterated in service. | PNAE G-7-008-89 (6.1.6) | PNAE: all accesoires shall have designation of extreme positions of the lock and indermediate positions. Presence of designation of indermediate positionsis defined by design documentation. | | **B2** |
| *NB-7812 Report form for pressure relief valves* | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-7820 Rupture Disk Devices<br>*NB-7821 Rupture disks* | | | No equivalent provision in PNAE G-7.<br>No equivalent provision in PNAE G-7. | | **B1**<br>**B1** |
| *NB-7822 Disk holders (if used)* | | | No equivalent provision in PNAE G-7. | | **B1** |
| NB-7830 Certificate of Authorization to Use Code Symbol Stamp | Each pressure relief valve within the scope of Article 7000 shall be constructed by a Manufacturer possessing a Code. NV Symbol Stamp and valid Certificate of Authorization. Pressure relief valves shall have the Code NV Symbol<br>applied in accordance with the rules of NB-8100. | | No equivalent provision in PNAE G-7. | | **B1** |

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