Topics

JIS/ASME activities (related to structural materials)

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As for our standardization activities related to structural materials, we have contributed to the deliberation of standards related to thermal power generation facilities under the jurisdiction of the Ministry of Economy, Trade and Industry (METI) and private voluntary standards established by academic associations, in addition to Japanese Industrial Standards (JIS) and ASME (American Society of Mechanical Engineers) boiler pressure vessel standards. Regarding the JIS standard, in addition to our activities related to the drafting of the JIS standard, we are contributing through the deliberation on JIS standard drafts at the Japanese Industrial Standards Committee (JISC). NIMS's research results have been reflected in the establishment of JIS Z 2384:2019 “Atmospheric Corrosion Monitoring Sensor”, revision of allowable stress and life evaluation formula for high chromium steel concerning thermal power plant specifications for power generation, etc. We have participated in the standard activities as members of the ASME Standards Committee for many years, and contributed by reflecting the research results of NIMS in the code and standard.

1. Introduction

In addition to the Japanese Industrial Standards (JIS) and the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, there are also standards related to thermal power generation facilities under the jurisdiction of the Ministry of Economy, Trade and Industry (METI) and private voluntary standards established by academic associations. This paper outlines the activities of NIMS staff in the development of these various standards.

2. JIS standards

2.1 Japanese Industrial Standards (JIS)

Drafts relating to the establishment, revision, and abolishment of JIS standards are prepared by numerous private organizations such as the Japan Iron and Steel Federation, the Japan Stainless Steel Association, and the Japan Society of Corrosion Engineering, and then the JIS standards drafts are submitted to the competent ministers. After that, the JIS standard drafts are deliberated by the Japanese Industrial Standards Committee (JISC). The approved JIS standard drafts are established through a reporting to the competent minister. Therefore, the activities related to JIS standards are roughly divided into activities related to the drafting by private organizations and the deliberation of JIS standard proposals in JISC.

2.2 Preparation of JIS standards draft

The Japan Iron and Steel Federation, Standardization Center, Steel Standards Tripartite Committee produces many drafts of JIS standards concerning steel materials such as steel terminology, analysis methods, tensile tests, Charpy impact tests, and various hardness tests in addition to various steel standards. Dr. Ogata, NIMS special researcher, has been engaged in the drafting of JIS standards as a vice-chairman of the committee. The Japan Stainless Steel Association has prepared drafts of JIS standards for stainless steel materials and their tests, inspections, and certifications, etc. Dr. Kimura has served as the chairman of the drafting committee for many JIS standards drafts preparations.

The atmospheric corrosion monitoring sensor (ACM sensor) using the galvanic couples is a sensor that was researched and developed for monitoring the corrosion rate of metallic materials in the 1990s. In recent years, it has been used for bridges, houses, chemical plants, electric power

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plants, automobiles, etc. It is widely used in a wide range of fields for purposes such as corrosion life prediction and corrosion environment evaluation. Therefore, to ensure the quality and reliability of ACM sensors, JIS Z2384: 2019 " Atmospheric Corrosion Monitoring Sensor" was standardized in September 2019. The Japan Society of Corrosion Engineering created this draft, and a former Special Researcher Dr. Shinohara Tadashi, who researched and developed the ACM sensor, compiled this draft JIS standard as the secretary of the drafting committee and the subcommittee chief.

2.3 Deliberation of JIS standard drafts

The JISC has "Basic Policy Board", "Standards Board for ISO area", and "Standards Board for IEC area" under the "Council" planning basic matters of business operation, etc. Under each board, there are technical committees that discuss JIS standards. Many of the JIS standard drafts regarding metallic materials are deliberated and approved by the "Technical Committee on Metal and Inorganic Materials"., After approval, the report is submitted to the competent minister. Dr. Kimura has served as Chairman of the Technical Committee on Metal and Inorganic Materials, and also as a member of the Standard Boards for the ISO area. Dr. Katayama, Deputy Director, and Dr. Hiromoto, Principal Researcher serves on the Technical Committee on Metal and Inorganic Materials.

3. Standards for thermal power plant

The Interpretation of Technical Standards for Thermal Power Plants for Electricity Generation has been established as a concrete indication of the technical requirements to be met in the Ministerial Ordinance establishing Technical Standards for Thermal Power Plants for Electricity Generation (Ordinance of the Ministry of International Trade and Industry No. 51 of 1997). This interpretation specifies the allowable stresses for materials that can be used in thermal power plants for power generation.

At the ultra-supercritical thermal power plant that was in operation in June 2004, the high-temperature reheat pipe was damaged., As a result of investigating the cause of the failure and examining measures to prevent a recurrence, it became clear that the creep strength of the high chromium steel (火-SUS410J3) weldment, the material used in the failed part, was lower than designed, and the creep strength of the base metal was also found to be reduced in the same way. Therefore, we conducted an evaluation of the overall long-term creep strength of high chromium steels based on the latest finding. Based on the results, the allowable tensile stress of the material specified in the "Interpretation of Technical Standards for Thermal Power Plants for Power Generation," which defines the material, was reviewed[1]. The allowable tensile stresses were reviewed by reevaluating the creep strength using the "domain decomposition analysis method" that Dr. Kimura had proposed. In addition, existing thermal power plants using the same material should continue to be maintained and managed based on appropriate life expectancy diagnosis. In order to perform the life expectancy diagnosis of high-chromium steel in thermal power plants for power generation, a document was issued[2]. This life evaluation formula is set based on the 99% lower confidence limit of the creep rupture life evaluated using the "domain decomposition analysis method". The allowable tensile stress and life evaluation formulas for high-chromium steel have been reviewed several times since then, and in all of these reviews, the creep strength evaluation based on the "domain decomposition analysis method" proposed by Dr. Kimura was used. It also contributed to the July 2019 revision[3] of the allowable tensile stress and life evaluation formulas for the modified 9Cr-1Mo steel (火-STBA28 series steel) .

4. Domestic private standards

4.1 The Japan Society of Mechanical Engineers power generation facilities standards

Japan ratified the WTO Agreement when the World Trade Organization (WTO) was established in 1995, and simultaneously concluded the Technical Barriers to Trade (TBT) Agreement. The TBT Agreement stipulates the principle of establishing national standards based on international standards and ensuring transparency in the creation of standards, so that national standards for industrial products and conformity assessment procedures (standards and standards certification system) do not become unnecessary obstacles to trade. In response to this, the technical standards were "performance specified" in 1997. By confirming compliance with the technical standards under the installer's own responsibility, it became possible to use new technologies and private standards.

Therefore, the Japan Society of Mechanical Engineers (JSME) established the Committee on Standards for Power Generation Equipment in October 1997, and started activities to establish standards for power generation equipment. At the time of its inception, two technical committees, one for thermal power and one for nuclear power, were established under the Power Generation Equipment Standards Committee. Subsequently, technical committees on materials and fusion were established, and now there are four technical committees on thermal power, nuclear power, materials, and fusion. Under the umbrella of each technical committee, subcommittees and working groups are established as permanent organizations. In addition, tasks are established as time-limited organizations for specific issues.

As of December 2022, Dr. Kimura is a member of the Main Committee on Power Generation Facility Codes and the Subcommittee on Materials, and Dr. Sawada is a member of the Subcommittee on Materials , and the Subgroup on Standardization of New Materials under the Subcommittee on Materials, and the Task Group on AM Technical Standards under the Subcommittee on Nuclear Power, participating in standard development activities. In addition, Dr. Masao Hayakawa, group leader of the Environmental Fatigue Property Group, is a member of the Subcommittee on Thermal Power, and Dr. Hideaki Nishikawa, Senior Researcher of the Fatigue Property Group, is a vice-chairman of the Subgroup on Materials under the Subcommittee on Thermal Power, participating in standard development activities.

The Interpretation of Technical Standards for Thermal Power Plants for Power Generation was applicable upon revision on February 25, 2016, and newly established Article 167 in Chapter 11 "Application of Other Standards, etc.".

"Article 167: Thermal power equipment for power generation that conforms to the Japan Society of Mechanical Engineers Basic Standard for Thermal Power Equipment for Power Generation (2012 Edition) JSME S TA0-2012 including the Japan Society of Mechanical Engineers Basic Standard for Thermal Power Equipment for Power Generation (2015 Supplement) JSME S TA0-2015, shall meet the technical requirements specified in the Ministerial Ordinance. In this case, the provisions of Chapter 2 to the preceding Chapter on the equipment concerned shall not apply."

This means that the JSME standard for thermal power plants, which is a private standard, has been officially recognized as a national review standard by the government, and NIMS researchers have contributed greatly to the establishment of this review standard.

4.2 Welding Engineering Standards (WES)

In recent years, many studies on high-cycle fatigue above 10^7 cycles have been reported. The Japan Welding Engineering Society (JWES) conducted researches on ultra-high cycle fatigue of structural materials for nuclear equipment from 2000 to 2011. ultrasonic fatigue tests were also adopted in this process, and round robin tests were conducted by multiple organizations. As a result of this research, various know-hows on ultrasonic fatigue testing were accumulated. With the aim of promoting the widespread use of ultrasonic fatigue testing and expanding ultra-high cycle fatigue data, "Ultrasonic Fatigue Testing Methods for Metallic Materials" was established as a Welding Engineering Standard WES 1112: 2017. Dr. Yoshiyuki Furuya, group leader of Fatigue Property Group, is in charge of drafting this draft and writing the commentary, and the standardization was based on the ultrasonic fatigue test method that Dr. Furuya has been researching and developing for many years.

4.3 High Pressure Institute of Japan Standard (HPIS)

The High Pressure Institute of Japan (HPI) has established the Pressure Equipment Standards Advisory Committee to promote design, manufacturing, construction, testing, inspection, maintenance management technology, safety evaluation technology, etc. related to rational high pressure or related to pressure equipment. The Pressure Equipment Standards Advisory Committee is establishing and revising the technical standards based on the latest technical knowledge. Dr. Kimura is a member of this Committee.

As a committee member, Dr. Kimura participated in the Sub-committee on High Pressure Vessel Codes and Standards for drafting the allowable tensile stress tables for pressure vessels and boiler materials, and prepared HPIS C104, "Allowable Tensile Stress Values for Boilers and Pressure Vessels (Design Margin 4)" and HPIS C105, "Allowable Tensile Stress Values for Boiler and Pressure Vessels (Design Margin 3.5)". HPIS C104 and HPIS C105 are the standards cited in the allowable tensile stress tables in JIS B 8265 "Construction of pressure vessel - General principles" and JIS B8267 "Construction of pressure vessel",

respectively. Dr. Kimura also participated as a member of the drafting committee for HPIS C108 "Nuclear Fuels Reprocessing Facilities and Materials Standard".

5. ASME Boiler and Pressure Vessel Code

In the early 1900s, there were many boiler and pressure vessel explosion accidents in the United States, which resulted in many deaths and injuries. Therefore, the American Society of Mechanical Engineers (ASME) started the development of boiler pressure vessel standards to design boilers and pressure vessels safely. Previously, the revised version of the standard was issued every three years, and the supplement (Addenda) was issued in the year when the revised version was not issued. However, after the 2015 version, the revised version of the standard is issued every two years and the supplement is no longer issued. Table 1 shows the layout of the latest version of the 2019 standard. The ASME Boiler and Pressure Vessels Code is composed of 12 sections in total, Section 1 is for Power Boilers, Section 2 is for Materials, and Section 3 is for Construction of Nuclear Facility Components. There is a standard committee corresponding to each section, and there are many subgroups, working groups, task groups, etc. under the standard committee. The ASME Boiler and Pressure Vessel Code Committee discuss the proposed standards by concentrating over 200 conferences during the Boiler Code Week four times a year.

For many years, Emeritus Researcher Dr. Fujio Abe from the National Institute for Materials Science has been working as a member of on many committees on Materials for Section II as an active member on Subgroup on Strength, Ferrous Alloy, Working Group on Creep Strength Enhanced Ferritic Steels, Working Group on Data Analysis, Working Group on Materials Database, etc. Dr. Kimura has been a member of the Committee on Materials in Section II since 2019 and participated in the standard development activities as a member of Subgroup on High Temperature Reactor and Working Group on Allowable Stress Criteria on the construction of nuclear facility components in Section III. As a result of the activities so far, the members of NIMS proposed a material strength standard value for 9Cr-1Mo-V steel (Grade 91, Modified 9Cr-1Mo steel) up to a maximum of 500,000 hours, and the proposed revision of the material strength standard values up to 300,000 hours established by the existing standard was proposed, and a new material strength standard value for 500,000 hours was approved and reflected in the 2019 Edition of the standard. A Stress Rupture Factor for weld joint strength reduction of up to 500,000 hours for the same steel grade was also approved after years of deliberation and will be reflected in the 2023 edition of the standard. In Japan, the United States, and Europe, while a material strength standard value of up to 500,000 hours was being considered as a design standard for the fourth generation (Generation IV) reactor, we contributed to the world's first establishment of the material strength standard for 500,000 hours of 9Cr-1Mo-V steel.

6. Summary

This paper has outlined the efforts of NIMS researchers for JIS/ASME standards, as well as for METI's thermal power plant standards and other private standards. There may be other contributions by NIMS researchers to standardization activities than those described here. Standardization is an important task for NIMS researchers as well, as it is directly related to our daily life. It is important for NIMS to take organizational actions to further enhance these activities.

References

1) The Interpretation for the technical standards for thermal power plant, Nuclear and Industrial Safety Agency, Ministry of Economy, Trade and Industry, December 14, 2005, NISA-234c-05-8. (in Japanese)
2) A Life evaluation formula for high chromium steel in thermal power plants, Nuclear and Industrial Safety Agency, Ministry of Economy, Trade and Industry, December 14, 2005, NISA-234c-05-9. (in Japanese)
3) Regulations to revise a part of the interpretation for the technical standards for thermal power plant, Ministry of Economy, Trade and Industry, July 4, 2019, 20190628 Hokyoku No. 1 (in Japanese)

Table 1: List of sections of ASME Boiler and Pressure Vessel Code (2021 Edition)

I	Rules for Construction of Power Boilers
II	Materials
	• Part A — Ferrous Material Specifications
	• Part B — Nonferrous Material Specifications
	• Part C — Specifications for Welding Rods, Electrodes, and Filler Metals
	• Part D — Properties (Customary)
	• Part D — Properties (Metric)
III	Rules for Construction of Nuclear Facility Components
	• Subsection NCA — General Requirements for Division 1 and Division 2
	• Appendices
	• Division 1
	– Subsection NB — Class 1 Components
	– Subsection NCD — Class 2 and Class 3 Components*
	– Subsection NE — Class MC Components
	– Subsection NF — Supports
	– Subsection NG — Core Support Structures
	• Division 2 — Code for Concrete Containments
	• Division 3 — Containment Systems for Transportation and Storage of Spent Nuclear Fuel and High-Level Radioactive Material
	• Division 5 — High Temperature Reactors
IV	Rules for Construction of Heating Boilers
V	Nondestructive Examination
VI	Recommended Rules for the Care and Operation of Heating Boilers
VII	Recommended Guidelines for the Care of Power Boilers
VIII	Rules for Construction of Pressure Vessels
	• Division 1
	• Division 2 — Alternative Rules
	• Division 3 — Alternative Rules for Construction of High Pressure Vessels
IX	Welding, Brazing, and Fusing Qualifications
X	Fiber-Reinforced Plastic Pressure Vessels
XI	Rules for Inservice Inspection of Nuclear Power Plant Components
	• Division 1 — Rules for Inspection and Testing of Components of Light-Water-Cooled Plants
	• Division 2 — Requirements for Reliability and Integrity Management (RIM) Programs for Nuclear Power Plants
XII	Rules for Construction and Continued Service of Transport Tanks
XIII	Rules for Overpressure Protection