CONSTRUCTION CODE FOR PRESSURE VESSELS

Notification No.196 of the Ministry of Health, Labour and Welfare
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In Japanese

Based on the provisions of the Paragraph 2 of the Article 37 and the Article 42 of the Industrial Safety and Health Law (Law No.57, 1972), the entire Construction Code for Pressure Vessels (Notification No.66 of the Ministry of Labour, 1989) shall be amended as stated below.

Part 1. Construction Code for First Class Pressure Vessels

Chapter 1. General Provisions

Article 1. Main Materials

1. Main materials for First Class pressure vessels shall be ferrous or nonferrous materials with chemical compositions and mechanical properties that can be used safely under the possible chemical and physical influences of the maximum allowable working pressure and working temperature.

Article 2. Restrictions on Use of Materials

The materials described in each row in the left column of the following table shall not be used for any of the First Class pressure vessels or the parts thereof exposed to pressure which are listed in the same row in the right column of the table.

Material	First Class pressure vessels or the parts thereof exposed to pressure
1. Carbon steels or low alloy steels with a carbon content exceeding 0.35%	Parts to be welded
2. Steels specified in JIS G3106 (Rolled Steels for Welded Structure) (except SM400A, SM490A, and SM490YA specified in this Standard) and materials with equivalent or inferior mechanical properties	Shells, head plates or any other similar parts of First Class pressure vessels exceeding 3 MPa in maximum allowable working pressure
3. Steels specified in JIS G3101 (Rolled Steel for General Structure), and SM400A, SM490A, and SM490YA specified in JIS G3106 (Rolled Steels for Welded Structure), steel pipes specified in JIS G3457 (Arc Welded Carbon Steel Pipes), and materials with equivalent or inferior mechanical properties	Parts of pressure vessels listed below: a. Shells, head plates and other similar parts of pressure vessels Class 1 exceeding 1.6 MPa in maximum allowable working pressure; b. Shells with longitudinal welded joints and head plates with similar welded joints of First Class pressure vessels exceeding 1 MPa in maximum allowable working pressure; c. Those shells, head plates and other similar parts of First Class pressure vessels which have a base metal of weld zones exceeding 16 mm in thickness; and d. Shells, head plates and other similar parts of those First Class pressure vessels which are intended to contain lethal substances.
4. Carbon steel pipes specified in JIS G3452 (Carbon Steel Pipes for Ordinary Piping), and	Pressure vessels or their parts specified below: a. First Class pressure vessels exceeding 1 MPa

materials with equivalent or inferior mechanical properties	in maximum allowable working pressure or any parts thereof; b. First Class pressure vessels exposed to a working temperature below 0 °C or over 100 °C (or over 200 °C for pressure vessels for containing compressed air, steam or water; or 350 °C for those intended to contain a liquid with a maximum allowable working pressure of less than 0.2 MPa; or any part thereof; and c. First Class pressure vessels intended to contain any lethal substance or any of the dangerous materials listed in the Attached Table 1 of the Enforcement Order of the Industrial Safety and Health Law (Cabinet Order No. 318 of 1972).
5. Cast iron	First Class pressure vessels for containing any inflammable, combustible or toxic liquid or any part of such pressure vessels
6. Materials specified in JIS G5501 (Grey Iron Castings) and Pearlite malleable iron castings specified in JIS G5705 (Malleable Iron Castings), and materials with equivalent or inferior mechanical properties	First Class pressure vessels or their parts specified below: a. First Class pressure vessels for containing any inflammable, combustible or toxic liquid or any part of such pressure vessels; b. First Class pressure vessels exceeding 1.1 MPa in maximum allowable working pressure or any part thereof (not including fittings); and c. Those fittings of First Class pressure vessels which are intended for use in a working environment exposed to pressure exceeding 1.6 MPa
7. FCD400 and FCD450 specified in JIS G5502 (Spheroidal Graphite Iron Castings), blackheart malleable iron castings specified in JIS G5705 (Malleable Iron Castings), and materials with equivalent or inferior mechanical properties	First Class pressure vessels or their parts described below: a. First Class pressure vessels for containing inflammable, combustible or toxic liquid or any part of such pressure vessels; b. First Class pressure vessels exceeding 1.8 MPa in maximum allowable working pressure or any part thereof (not including fittings); and c. Those fittings of First Class pressure vessels which are intended for use in a working environment exposed to pressure over 2.4 MPa

Article 3. Allowable Tensile Stresses of Materials

The allowable tensile stress values of ferrous or nonferrous materials shall be in accordance with the following:
(1) The allowable tensile stress of ferrous or nonferrous materials shall be the minimum of the following values:
a. 1/4 of the minimum tensile strength at room temperature
b. 1/4 of the tensile strength at the working temperature
c. 1/1.5 of the minimum value of the yield point or of 0.2% proof stress at room temperature
d. 1/1.5 of the yield point or of 0.2% proof stress at the working temperature (90% of the 0.2% proof stress at the working temperature may apply to austenitic stainless steels if such material is used for any of the appropriate parts specified by the Director-General of the Prefectural Labour Bureau)
(2) Notwithstanding the provisions in (1) above, the allowable tensile stress of the steels specified in JIS G3115 (Steel Plates for Pressure Vessels for Intermediate Temperature Service), JIS G3120 (Manganese-Molybdenum and Manganese- Molybdenum- Nickel Alloy Steel Plates Quenched and Tempered for Pressure Vessels), JIS G3126 (Carbon Steel Plates for Pressure Vessels for Low Temperature Service), JIS G3127 (Nickel Steel Plates for Pressure Vessels for Low Temperature Service), and those having equivalent or superior mechanical properties may take the smaller of the following values:
(a) A value obtained by multiplying the minimum value of the yield point or the 0.2% proof stress at room temperature by 0.5 (1.6 -γ)
(b) A value obtained by multiplying the yield point or the 0.2% proof stress at the working temperature by 0.5 (1.6 -γ);
(Where γ means the ratio of the yield point or 0.2% proof stress to the tensile strength except when the value of γ is less than 0.7, in which case it shall be 0.7 whatever such ratio may be.)
(3) Notwithstanding the provisions in the item 1 of this paragraph, the allowable tensile stress for bolts that are strengthened using such measures as heat treatment shall be the minimum of the values determined under the said item and those specified below;
(a) 1/5 of the minimum tensile strength at room temperature;
(b) 1/4 of the minimum value of the yield point or the 0.2% proof stress at room temperature.
2. Notwithstanding the provisions in the preceding paragraph, the allowable tensile stress when the allowable working temperature of materials is within their creep range shall be the minimum of the following values:
(a) Mean value of the stress producing a 0.01% creep in 1,000 hours at the said temperature
(b) 1/1.5 of the mean value of the stress producing a rupture in 100,000 hours at the said temperature
(c) 1/1.25 of the minimum value of the stress producing a rupture in 100,000 hours at the said temperature

Article 4. Allowable Tensile Stress of Castings
The allowable tensile stress of castings shall be as set forth in the followings:
(1) The allowable tensile stress of iron castings shall be either of the values specified for different categories of the said castings in (a) and (b) below:
(a) 1/6.25 of the tensile strength at the working temperature for FCD400 and FCD450 specified in JIS G5502 (Spheroidal Graphite Iron Castings), blackheart malleable iron castings specified in JIS G5705 (Malleable Iron Castings), and iron castings having equivalent or superior mechanical properties

(b) 1/10 of the tensile strength at the working temperature for other iron castings
(2) The allowable tensile stress of steel castings shall be the value obtained by multiplying the appropriate one of the values obtained from the item 1 of the paragraph 1 or the paragraph 2 of the preceding Article by the applicable one of the casting factors given in (a) and (b) below:
(a) 0.8 for the steel castings in JIS G5101 (Carbon Steel Castings) with a chemical composition not exceeding the chemical contents specified in the right column of the following table for each type of steel castings shown in the left column of the same table, and for the steel castings in JIS G5102 (Steel Castings for Welded Structure), JIS G5121 (Stainless Steel Castings), JIS G5151 (Steel Castings for High Temperature and High Pressure Service) and JIS G5152 (Steel Castings for Low Temperature and High Pressure Service), and steel castings having equivalent or superior mechanical properties, while 0.9 or 1.0 can be used for those steel castings which have met the requirements of the tests prescribed by the Director-General of the Prefectural Labour Bureau, depending on the category and method of the test performed.

Type of steel castings	Chemical composition							
	Carbon	Manganese	Phosphorus	Sulfur	Silicon	Nickel	Chromium	Copper
SC360 and SC410	0.25	0.7	0.04	0.04	0.6	0.5	0.5	0.5
SC450 and SC480	0.35	0.7	0.04	0.04	0.6	0.5	0.5	0.5

Remarks:
1. The chemical contents are given in percentage.
2. The manganese content may be increased by 0.04% for every 0.01% decrease in the carbon content, compared with the levels specified in the table. However, the manganese content shall never exceed 1.10% .
3. The nickel, chromium and copper contents shall not exceed 1.0% in combined total.

(b) casting factor of 0.67 for other steel castings
(3) The allowable tensile stress of nonferrous metal castings shall be the value obtained by multiplying the value derived from the item 1 of the paragraph 1 of the preceding Article by a casting factor of 0.8.

Article 5. Allowable Tensile Stress of Clad Steels
The allowable tensile stress of clad steels shall be determined by the following equation:

$$\sigma a = \frac{\sigma a1 t1 + \sigma a2 t2}{t1 + t2}$$

Where σa = allowable tensile stress of the clad steel (N/mm^2)
$\sigma a1$ = allowable tensile stress of the base metal (N/mm^2)
$t1$ = thickness of the base metal (mm)
$\sigma a2$ = allowable tensile stress of the cladding metal (N/mm^2)
$t2$ = thickness of the cladding metal (mm)

Article 6. Allowable Compressive Stress of Materials

1. The allowable compressive stress of any material (other than cast iron) shall be equal to the allowable tensile stress of the material.
2. The allowable compressive stress of cast iron shall be twice as large as the allowable tensile stress of the said material.

Article 7. Allowable Bending Stress of Materials

1. The allowable bending stress of materials shall be 1.5 times as large as the allowable tensile stress of material.
2. Notwithstanding the provisions in the preceding paragraph, the allowable bending stress of ferrous and nonferrous materials when the working temperature is in a creep range shall be equal to their respective allowable tensile stresses.

Article 8. Allowable Shearing Stress of Materials

The allowable shearing stress of materials shall be 80% of their respective allowable tensile stresses.

Part 1. Construction Code for First Class Pressure Vessels

Chapter 2. Construction

Section 1. General

Article 9. Allowable Range of Thickness

1. The thickness of piping shall be not less than the required minimum value.
2. The thickness of any part, other than piping, of the pressure vessel shall be not less than the result of deducting 0.25 mm or 6% of the nominal thickness, whichever smaller, from the required minimum thickness.

Section 2. Shells

Article 10. Thickness of Plates

The thickness of plates used for the shell and other pressure parts of the pressure vessel shall be as specified below for each type of the plates:
(1) Not less than 2.5 mm for carbon and low alloy steel plates
(2) Not less than 1.5 mm for high alloy steel and nonferrous metal plates if they are not expected to corrode, and not less than 2.5 mm if corrosion is expected to occur

Article 11. Corrosion Allowances

The corrosion allowance for plates used for the shell and other pressure parts of the pressure vessel shall be not less than 1 mm unless such plates are made of the material which is not expected to corrode (not including carbon steel or low alloy steel).

Article 12. Minimum Thickness of Plates for Cylindrical Shells or Spherical Shells Subject to Internal Pressure

The minimum thickness of plates for the cylindrical shells or spherical shells which are subject to exposure to internal pressure shall be the summation of the followings:
(a) the thickness in which the stress generated in the said plate when it is subject to exposure to the maximum allowable working pressure becomes equal to the allowable tensile stress of the plate;
(b) the corrosion allowance.

Article 13. Minimum Thickness of Plates for Cylindrical Shells or Spherical Shells Subject to External Pressure

1. The minimum thickness of plates for the cylindrical shells which are subject to exposure to external pressure shall be the summation of the followings:
(a) the thickness in which the stress generated in the said plate when it is subject to exposure to three times as high pressure as maximum allowable working pressure becomes equal to the stress that causes buckling to the plate;
(b) the corrosion allowance.
2. The preceding paragraph shall apply to the minimum thickness of plates for the spherical shells which are subject to exposure to external pressure. In that case the phrase "three times" in the paragraph shall be replaced with the phrase "four times".

Article 14. Minimum Thickness of Plates for Conical Shells Subject to Internal Pressure

1. The Article 12 applies to the minimum thickness of plates for conical shells which are subject to exposure to internal pressure.
2. When connecting conical and cylindrical shells, such measures shall be used that ensure that the joints have necessary strength for safety.

Article 15. Minimum Thickness of Plates for Conical Shells Subject to External Pressure

The paragraph 1 of the Article 13 applies to the minimum thickness of plates for conical shells subject to exposure to external pressure.

Article 16. Strength of Tubes
1. The Article 12 applies to the minimum thickness of those tubes which are subject to exposure to internal pressure.
2. The paragraph 1 of the Article 13 applies to the minimum thickness of those tubes which are subject to exposure to external pressure.
3. The bent radius of U-tubes measured at their center line shall be such value that does not cause any excessive stress concentration.
4. Notwithstanding the provisions in the paragraph 1, the minimum thickness of threaded ends, if any, of tubes subject to exposure to internal pressure shall be the sum of the minimum thickness determined under the said paragraph plus the height of threads. For those tubes which are subject to exposure to external pressure, the minimum thickness of threaded ends, if any, of tubes, notwithstanding the provisions in the paragraph 2,shall be the sum of the minimum thickness determined under the said paragraph plus the height of threads.

Section 3. Head Plates, Cover Plates, Flat Plates and Tube Plates

Article 17. Limitation in Thickness of Head Plates
The thickness of head plates (other than those in full hemispherical shape) shall be not less than the minimum thickness of shell plates.

Article 18. Requirements for Shapes of Head Plate
The head plates shall be of the shape that does not cause any excessive stress concentration.

Article 19. Minimum Thickness of Unstayed Head Plates Subject to Pressure on Concave Side
The Article 12 applies to the minimum thickness of those unstayed spherical head plates which are subject to exposure to pressure on their concave side.

Article 20. Unreinforced Openings in Head Plates
Any opening in the head plate, if it is to be left unreinforced based on the proviso in the Article 33, such measures shall be taken that does not cause any excessive stress concentration around a manhole or the knuckle part of the head plate.

Article 21. Minimum Thickness of Conical Head Plates etc. Subject to Internal Pressure
1. The Article 12 applies to the minimum thickness of those conical head plates which are subject to exposure to internal pressure and to the minimum thickness of the head portion of those dished cover plates with bolted flanges which are subject to exposure to pressure on their concave side.
2. When the conical head plates are attached to the shell, the attaching shall be made by suitable measures to ensure that the attached parts have necessary strength for safety.

Article 22. Minimum Thickness of Unstayed Head Plates Subject to Pressure on Convex Side

The minimum thickness of unstayed spherical head plates (excluding those made of cast iron) which are subject to exposure to pressure on their convex side shall be the greater of:
(1) the summation of the followings:
(a) the value obtained by multiplying such thickness as the stress that is generated in the head plate when its concave side is subject to exposure to the maximum allowable working pressure becomes equal to the allowable tensile stress of the head plate, by 1.67;
(b) the corrosion allowance.
(2) the summation of the followings:
(a) such thickness as the stress that is generated in the head plate when its convex side is subject to exposure to the quadruple of the maximum allowable working pressure becomes equal to the stress that causes buckling to the head plate;
(b) the corrosion allowance.

Article 23. Minimum Thickness of Cast Iron Head Plates Subject to Pressure on Convex Side

The minimum thickness of those unstayed spherical cast iron head plates which are subject to exposure to pressure on their convex side shall be equal to their respective minimum thicknesses calculated on the assumption that their concave side is subject to exposure to pressure, or to 1/100 of the inside diameter of their flange, whichever greater.

Article 24. Minimum Thickness of Conical Head Plates Subject to External Pressure

The paragraph 1 of the Article 13 applies to the minimum thickness of those conical head plates which are subject to exposure to external pressure.

Article 25. Minimum Thickness of Unstayed Flat Plates etc.

1. The Article 12 applies to the minimum thickness of unstayed flat plates, such as flat head plates, flat cover plates and flat bottom plates, and of a jacket closure that is welded to the shell (referred to as "jacket closure" in the following paragraph).
2. The shape of the jacket closure shall be such that does not cause any excessive stress concentration in the jacket closure.

Article 26. Minimum Thickness of Flat Tube Plates etc. without Tube-Stays

1. The minimum thickness of the flat tube plates of heat exchangers and other similar equipment which are not supported by stay-tubes, and of those flat tube plates which function as a flat cover plate shall be the greater of the following values:
(1) the summation of the followings:
(a) such thickness as the stress that is generated in the flat tube plate when it is subject to exposure to the maximum allowable working pressure becomes equal to the allowable bending stress of the flat tube plate; and
(b) the corrosion allowance.
(2) the summation of the followings:
(a) such thickness as the stress that is generated in the flat tube plate when it is subject to exposure to the maximum allowable working pressure becomes equal to the allowable shearing stress of the flat tube plate; and
(b) the corrosion allowance.

Article 27. Expansion Joints
1. If the stresses generated in the shell and tubing of a heat exchanger with both fixed tube plates, depending on their relative elongations, are greater than their respective allowable stresses, the shell shall be fitted with an expansion joint.
2. The expansion joint shall be verified that it has necessary fatigue strength for safety.

Section 4. Stays and Stayed Plates

Article 28. Minimum Sectional Area etc. of Stays
1. The sectional area of stays shall be not less than such an area where the stress generated in the said cross section when it is subject to exposure to the maximum allowable working pressure becomes equal to the value obtained by dividing the allowable tensile stress of the said cross section by 1.1.
2. Notwithstanding the stipulation in the preceding paragraph, the sectional area of welded stays shall be not less than the value that is calculated by dividing by 0.6 such an area where the stress generated in the said cross section when it is subject to exposure to the maximum allowable working pressure becomes equal to the value obtained by dividing the allowable tensile stress of the said cross section by 1.1.
3. When stays are attached, suitable measures shall be taken to ensure that the attaching parts have necessary strength for safety.

Article 29. Thickness of Stayed Plates and Pitch of Stays
1. The thickness of a stayed plate shall be not less than 8 mm except when it is supported by bar stays welded to it.
2. The pitch of the bar stays referred to in the proviso of the preceding paragraph shall be such that does not cause any excessive stress concentration in the attached part.

Article 30. Minimum Thickness of Stayed Flat Plates etc.
The Article 12 applies to the minimum thickness of stayed flat plates and of those stayed flat tube plates for heat exchangers or other similar equipment.

Section 5. Openings and Reinforcement Thereof

Article 31. Openings of First Class Pressure Vessels
First Class pressure vessels shall have, in their shells or head plates, for cleaning and inspection, a manhole large enough to provide an access to the inside, a cleaning hole large enough to remove scale or other sediment, and a inspection hole large enough to carry out inspection. However, this provision does not apply to any of the First Class pressure vessels having an alternative hole due to their structures.

Article 32. Peep Holes
1. Glazed peep holes may be provided in the shells or head plates of those First Class pressure

vessels of which interior conditions have to be watched during operation.
2. The glass plate used for such peep holes is required to come up to the standards in JIS R3206 (Tempered Glass) or to have mechanical properties at least equal to such standards.
3. The minimum thickness of the glass plate specified in the preceding paragraph shall be determined by:

Where t = minimum thickness of the glass plate (mm);
P = maximum allowable working pressure (MPa) of the shell, head plate, etc. in which a peep hole is provided;
A = area of the part of the glass plate (cm^2) subject to exposure to pressure; and
σb = allowable bending stress (N/mm^2) of the glass plate, i.e. 15 (N/mm^2) for tempered glass and 1/10 of the bending strength for other types of glass.

Article 33. Reinforcement of Openings
All openings in shells, head plates, etc. shall be reinforced with stiffeners having sufficient strength. However, this provision does not apply to openings that are in no danger of causing excessive stress concentration around them.

Section 6. Tubes, Nozzle Stubs and Flanges

Article 34. Screwing-in of Tubes, Nozzle Stubs, etc.
1. Tubes or nozzle stubs exceeding 90 mm in outside diameter shall not be screwed into shells or head plates with a maximum allowable working pressure of more than 1MPa. However, this does not apply to threaded plug closures for inspection access holes or any other similar fittings.
2. Tubes exceeding 115 mm in outside diameter shall not be screwed into any of the First Class pressure vessels in which flammable vapours may be generated.

Article 35. Requirements for Attaching of Tubes, Nozzle Stubs, etc.
1.When tubes, nozzle stubs, etc. are to be attached to shell, head plates, tube plates, etc., the attaching shall be made by suitable measures to ensure that the attached parts have necessary strength for safety.
2. If tubes or other similar components are attached to the shells, tube plates, etc. of those First Class pressure vessels in which flammable or toxic vapours may be generated, seal welding shall be provided.

Article 36. Flanges
1. Flanges for pressure vessel shells shall meet the standards in JIS B2220 (Steel Pipe Flanges), JIS B2238(General rules for steel pipe flanges), JIS B2239(General Rules for Cast Iron Pipe Flanges)or JIS B2240 (General Rules for Copper Alloy Pipe Flanges), or shall have the

equivalent or superior mechanical properties, depending on their types. However, these flanges shall not be used under pressure higher than the nominal pressure level specified in JIS B2238, JIS B2239, and JIS B2240.
2. If the product of the outside diameter (mm) of the shell to be fitted with a flange multiplied by its maximum allowable working pressure (MPa) is greater than 500, the shell flange shall be provided with a hub.
3. Flanges, other than those for shells, shall meet the standards in JIS B2220 (Steel Pipe Flanges), JIS B2238(General rules for steel pipe flanges), JIS B2239(General Rules for Cast Iron Pipe Flanges)or JIS B2240 (General Rules for Copper Alloy Pipe Flanges), or shall have the equivalent or superior mechanical properties.

Article 37. Minimum Thickness of Flanges for Dished Cover Plates
The Article 12 applies to the minimum thickness of flanges to be attached with bolts to those dished cover plates which are subject to exposure to pressure on their concave side.

Article 38. Bolts for Cover Plates
1. Bolts for those cover plates which may be removed frequently for operating purposes shall have necessary strength for safety.

Part 1. Construction Code for First Class Pressure Vessels

Chapter 3. Workmanship and Hydraulic Tests

Section 1. Welding

Article 39. Scope
The welding of the any parts of First Class pressure vessels that are subject to pressure shall be in accordance with the provisions in this section unless such parts are free of any stress other than compressive one.

Article 40. Welding Method
1. Welding shall be made in such a way that the weld zones have necessary strength for safety.
2. Welding of any parts which are liable to significant bending stress shall be avoided.

Article 41. Holes in Weld zones
1. No hole may be made in any weld zone (including the adjacent areas within 6 mm from the edges of the welded metal). However, this does not apply to those weld zones that have passed radiographic examination.
2. The radiographic examination referred to in the exceptive clause of the preceding paragraph shall cover an area extending over at least 1.5 times the diameter of the hole from the center of

such hole in both ways.

Article 42. Efficiency of Welded Joints

1. The allowable tensile stress of weld zones shall be the value that is obtained multiplying the figures calculated using the Article 3 or the Article 4 by the efficiency of the welded joint.
2. The efficiency of any welded joint in the preceding paragraph shall be equal to the appropriate one of the values specified in the right column of the following table for different types of welded joints listed in the left column thereof:

Type of welded joint	Efficiency of welded joint (%)		
	Joints subject to full radiographic examination	Joints subject to spot radiographic examination	Joints not subject to radiographic examination
(1) Double-welded butt joint or the single-welded butt joint (the latter process being available only if it is performed with a backing strip or some other method to ensure sufficient penetration: this also applies to the following items.) with the backing removed after welding	100	95	70
(2) Single-welded butt joint with the backing retained in place after welding	90	85	65
(3) Single-welded butt joint other than the preceding two items	-	-	60
(4) Double full fillet lap welded joint	-	-	55
(5) Single full fillet lap welded joint reinforced with plug weld	-	-	50
(6) Single full fillet lap welded joint without plug weld	-	-	45

Remarks:

1. "Full radiographic examination" means a radiographic examination over the full length of the weld line.

2. "Spot radiographic examination" means a radiographic examination covering not less than 20% of the whole weld line.

Article 43. Post Weld Heat Treatment

1. Post weld heat treatment shall be carried out for any weld zones in carbon steels and alloy steels. However, this does not apply to weld zones that do not need post weld heat treatment such as seal welding or weld zones of austenitic stainless steels.
2. Notwithstanding the provisions in the preceding paragraph, preheating or some other available method may be used instead of post weld heat treatment to reduce the stress of weld zones in any of the large First Class pressure vessels which are to be field-welded at their installation sites and

for which it is difficult to perform post weld heat treatment.
3. The post weld heat treatment shall be performed in furnace satisfying the requirements in JIS Z 3700 (Methods of Post Weld Heat Treatment Procedures) or standards that can be recognized as equivalent (hereinafter referred to as "the JIS etc." in this article). However, for such weld zones as circumferential joints in shells, tubes, etc. for which a local heating method is considered to be possible, the post weld heat treatment may be done by a local heating method. In both cases (in-furnace and local heating), the holding temperature and holding time prescribed in the JIS etc. may be reduced only if the performance of post weld heat treatment at the specified holding temperature and time is hardly feasible or otherwise unsuitable because of such factors as the need for site welding, the materials used or structural restraints.
4. In the case where use of a special material and/or a special structure or some other factors make it difficult or unsuitable to perform post weld heat treatment by either of the methods specified in the preceding paragraph, such treatment may be made by the method prescribed elsewhere by the Director-General of the Prefectural Labour Bureau.

Article 44. Requirements for Weld Zones
All weld zones shall have sufficient penetration and shall be free of such defects as cracks, undercuts, overlaps, craters, slag inclusion, blowholes, etc. that are harmful.

Article 45. Mechanical Tests for Weld Zones
Weld zones shall be found acceptable by the mechanical tests specified in the Articles 47 through 53 herein on test plates prepared in accordance with one of the followings:
(1) For the welding of a longitudinal joint of a shell, one test plate shall be prepared for the whole shell and welded to the end of the shell in the same sequence of weld as for the longitudinal joint with the weld line of the former aligned with the latter. However, if longitudinal joints in different sections of a shell are not welded under the same conditions, one test plate shall be prepared for each section of the shell.
(2) For the welding of a circumferential joint etc. of a shell (except when the test plate specified in the preceding item is welded under the same conditions as the circumferential joints etc. of the shell and is subjected to the mechanical tests prescribed in Articles 47 through 53 herein), one test plate shall be prepared for the whole shell separately from the shell and the likes and be welded under the same conditions as the circumferential joint etc. immediately after the latter is welded.

Article 46. Test Plates
1. Test plates shall be made of a material coming under the same classification in the same JIS standards or any standards recognized as equivalent and in the same thickness as the base metal of the weld assembly, and care shall be taken to preclude any warping of the test plates due to the effects of welding.
2. Any test plate, if warped by welding, shall be straightened before it is given post weld heat treatment.
3. Test plates shall receive the same post weld heat treatment as the weld zones of the pressure vessel proper.

Article 47. Mechanical Tests and Test Pieces
The type of mechanical tests applicable to test plates and the number of test pieces needed for

each of such tests shall be as specified in the following table, depending on the thickness range of the test plates:

Thickness of test plate	Type of mechanical tests	Number of test pieces
Below 19 mm	Tensile test	1
	Face bend test	1
	Root bend test	1
	Impact test	3 each for weld metal and heat-affected zone
19 mm and over	Tensile test	1
	Root bend test(which may be replaced by a face bend test in examining double-butt-welded test plates)	1
	Side bend test	1
	Impact test	3 each for weld metal and heat-affected zone

Remarks:

1. If there is a significant difference of elongation between the base metal of the test plate and that of the weld assembly or between the weld assembly and weld metals, the mechanical test may be performed by the appropriate one of the procedures specified below:

a. For test plates less than 19 mm in thickness, longitudinal face bend and longitudinal root bend tests may be substituted for face bend and root bend tests, respectively.

b. For test plates not less than 19 mm in thickness, longitudinal root bend tests may be substituted for root bend tests (except in examining double-butt-welded test plates, for which a longitudinal face bend test may be used in place of a face bend test).

2. Any First Class pressure vessel with a minimum allowable working temperature below −10 °C shall be subject to an impact test unless the base metal of the said pressure vessel is austenitic stainless steel or a nonferrous metal, in which case such test may be omitted.

2. Test pieces for the mechanical tests shall be prepared in accordance with the prescription in the Appendix 11 of JIS B 8265 (Construction of pressure vessel -- General principles) or any standards recognized as equivalent.

Article 48. Tensile Test

1. The method of tensile tests and the shape and dimensions of test pieces for such tests shall be in accordance with JIS Z3121 (Method of Tensile Test for Butt Welded Joints) or any standards recognized as equivalent.
2. Notwithstanding the provision in the preceding paragraph, any test piece which is too thick to be subjected to a tensile test may be cut by a thin saw into slices of proper thickness for the test purposes, and then a tensile test may be conducted on each of such slices. In this instance, all slices of the test piece shall meet the requirement of the said test.

Article 49. Acceptance Criteria for Tensile Test Results
1. In a tensile test, the test piece shall be deemed acceptable if its tensile strength is found to be not less than the appropriate one of the values given below, depending on the type of base metal:
(1) For 9% nickel steels, aluminum and aluminum alloys, copper and copper alloys, and titanium and titanium alloys, not including those which may be used under conditions beyond their allowable tensile stress - 4 times the allowable tensile stress of the base metal;
(2) For base metals other than those mentioned in the preceding item - specified minimum tensile strength of the base metal.
2. Those test pieces which break at any part of their base metals during the tensile test referred to in the preceding paragraph may be considered acceptable if their tensile strength is found to be not less than 95% of the appropriate one of the values specified in the two items of the preceding paragraph and if their weld zones are found to be free of any defect.
3. In the case where a test piece is rejected in the tensile test mentioned in the paragraph 1 of this Article because of any defect in the base metal of the test piece, such test may be deemed not valid.

Article 50. Bend Test
1. The shape and dimensions of test pieces for a face bend, root bend, side bend and longitudinal bend test, and the methods and jigs thereof, shall be in accordance with the prescription in JIS Z 3122 (Methods of Bend Test for Butt Welded Joint) or any standards recognized as equivalent.
2. The paragraph 2 of the Article 48 applies to the bend test

Article 51. Acceptance Criteria for Bend Test Results
In any of the bend tests, the test piece shall be deemed acceptable if no crack exceeding 3 mm in length (not including minute cracks at corners of the test piece edges) appears on the outside of its weld.

Article 52. Impact Test
1. Impact tests shall be conducted separately on the heat-affected zone and weld of the test plate in accordance with the specifications in JIS Z 2242 (Method of Impact Test for Metallic Materials) or any standards recognized as equivalent. The applicable test temperature shall be not higher than the minimum working temperature for the First Class pressure vessel covered by the test.

2. The shape and dimensions of impact test pieces shall be the V-notch test specimen prescribed in JIS Z 2202 (Test Pieces for Impact Test for Metallic Materials) or any specimen that is prescribed in standards recognized as equivalent to the said JIS standard, and such test pieces shall be prepared in accordance with the Appendix 11 of JIS B 8265 (Construction of pressure vessel -- General principles) or any standards recognized as equivalent.

Article 53. Acceptance Criteria for Impact Test
As for the acceptance criteria for the impact test, the prescription in JIS B 8265 (Construction of pressure vessel -- General principles) or in standards recognized as equivalent shall apply.

Article 54. Eligibility Requirements for Retests

As for the conditions of conducting retests for test pieces rejected in mechanical tests specified in the Article 49 or the article 51, or by the provision in the preceding Article, the prescription in JIS B 8265 (Construction of pressure vessel -- General principles) or in standards recognized as equivalent shall apply.

Article 55. Test Pieces and Acceptance Criteria for Retests

1.Any retest for a tensile test or a bend test shall be conducted on two new test pieces prepared for each of the test pieces rejected in either of these tests, from the test plate which had been the base metal of the rejected test pieces or from another which was made at the same time as the said test plate, and the new test pieces shall be deemed acceptable if both of them are found by the tensile or bend retest to come up to the acceptance criteria in Article 49 or 51, whichever applicable.

2. As for the acceptance criteria for the retest of an impact test, the prescription in JIS B 8265 (Construction of pressure vessel -- General principles) or in standards recognized as equivalent shall apply.

3. If the test plate is not large enough to make the additional test pieces under any of the preceding two paragraphs, a new test plate may be prepared by the same welder who made the older test plate from which the rejected test pieces were taken, and under the same conditions as those under which such older test plate was prepared.

Article 56. Radiographic Examination

1. Any of the welded joints specified in the following items shall be subject to radiographic examination over its full length, and the results of such examination shall meet the requirements set forth in the applicable items of Article 58 (referred to simply as the "applicable requirements" in the following paragraph and in the paragraph 2 of the Article 62). However, this does not apply to those parts of any welded joint on which it is difficult to conduct radiographic examination.

(1) Welded joints in shells, head plates or other similar pressure vessel components which are made of carbon steel plates exceeding 38 mm in thickness

(2) Welded joints in shells, head plates or other similar pressure vessel components which are made of low alloy steel or austenitic stainless steel plates exceeding 25 mm in thickness

(3) Welded joints in shells, head plates or other similar pressure vessel components which are made of high alloy steel plates (not including austenitic stainless steel plates) and which are designated by the Director-General of the Prefectural Labour Bureau

(4) Welded joints in those First Class pressure vessels which are required to have an airtight construction to contain harmful substances, specifically radioactive or lethal materials

(5) Welded joints in those First Class pressure vessels which are made of any of the steels whose allowable tensile stress is determined under the item 2 of the paragraph 1 of the Article 3.

(6) Welded joints in those First Class pressure vessels which are subject to a pneumatic pressure test

2. Any longitudinal joint, circumferential joint, etc., other than the welded joints specified in each item of the preceding paragraph, shall be subject to radiographic examination for its portion corresponding to 20% of its total length (including an intersection, if any, of a longitudinal and circumferential joint; in case that the length corresponding to 20% of its total length is less than 300 mm, the length to be examined shall be 300 mm), and the results of such examination shall meet the applicable requirements. However, this does not apply to those welded joints which are

recognized by the Director-General of the Prefectural Labour Bureau to require no radiographic examination or which are subject to exposure only to external pressure.
3. Notwithstanding the provisions in the preceding two paragraphs, radiographic examination may be omitted for any circumferential joint in a shell whose longitudinal joints have been found by radiographic examination to meet the applicable requirements, provided that such circumferential joint has been welded by the same boiler welder and by the same method that were employed in welding the longitudinal joints.

Article 57. Height of Reinforcement of Weld
1. The reinforcement of weld for any of those joints which are subject to radiographic examination shall be such that does not interfere with the said examination.
2. Radiographic examination of single-butt-welded joints using a backing may be conducted with the backing retained in place unless it interferes with such examination.

Article 58. Methods and Acceptance Criteria for Radiographic Examination
The method and results of radiographic examination shall meet one of the requirements in the followings, depending on the type of base metal:
(1) Steel (excluding stainless steel) -The examination shall be conducted in accordance with JIS Z3104 (Methods of Radiographic Examination for Welded Joints in Steel), and the defects of the Grade 1 through the Grade 4 shall be the Class 1 or the Class 2 of the classification by the image on radiograph specified in the said JIS standard, or the examination shall be conducted in accordance with other method that is recognized as equivalent to the said standard and the equivalent results shall be obtained.
(2) Stainless steel - The examination shall be conducted in accordance with JIS Z3106 (Methods of Radiographic Examination for Welded Joints in Stainless Steel), and the defects of the Grade 1 through the Grade 4 shall be the Class 1 or the Class 2 of the classification by the image on radiograph specified in the said standard, or the examination shall be conducted in accordance with other method that is recognized as equivalent to the said standard and the equivalent results shall be obtained.
(3) Aluminum and aluminum alloys -The examination shall be conducted in accordance with JIS Z3105 (Methods of Radiographic Examination for Welded Joints in Aluminum), and the number and length of the defects shall be the Class 1 or the Class 2 of the classification by the image on radiograph specified in the said standard and there shall be no crack, copper inclusion, or the examination shall be conducted in accordance with other method that is recognized as equivalent to the said standard and the equivalent results shall be obtained.
(4) Titanium and titanium alloys -The examination shall be conducted in accordance with JIS Z3107 (Methods of Radiographic Examination for Titanium Welds by X-ray), and the level of the defects shall be the Class 1 or the Class 2 of the classification by the image on radiograph specified in the said standard and there shall be no crack, copper inclusion, inadequate penetration or inadequate fusion, or the examination shall be conducted in accordance with other method that is recognized as equivalent to the said standard and the equivalent results shall be obtained.

Article 59. Ultrasonic Examination
1. An ultrasonic flaw detection test shall be conducted on those of the welded joints (other than weld zones not exceeding 10 mm in thickness or those in austenitic stainless steel or in 9%

nickel steel) specified in each item of the paragraph 1 of the Article 56 on which it is difficult to conduct radiographic examination, and the results of such test shall satisfy the requirements set forth in the following paragraph.
2. An ultrasonic flaw detection test on any of such welded joints shall be conducted in accordance with JIS Z 3060 (Method of Ultrasonic Examination for Welds of Ferritic Steel), and the defect classification of the welded joint based on the ranges of flaw echo height and indicated flaw length shall be the Class1 or the Class 2 of the classification specified in the said JIS standard, or the examination shall be conducted in accordance with other method that is recognized as equivalent to the said standard and the equivalent results shall be obtained.

Article 60. Magnetic Particle Examination
1. The welded joints specified in the item 5 of the paragraph 1 of the Article 56 and the weld zones for openings in, and for attaching reinforcements or some other fittings to, those First Class pressure vessels which are required to have an airtight construction to contain harmful substances, specifically radioactive or lethal materials, (referred to simply as the "welded joints" in the rest of this paragraph and in the paragraph 1 of the Article 61 below) shall be subject to magnetic particle examination over their whole length, and the results of such examination shall meet the requirements set forth in the following paragraph. However, this does not apply where the welded joints are nonmagnetic or where it is otherwise difficult to perform magnetic particle examination on the said joints.
2. Magnetic particle examination of any of such welded joints shall be conducted in accordance with JIS G 0565 (Methods for Magnetic Particle Testing of Ferromagnetic Materials and Classification of Magnetic Particle Indication), or standards recognized as equivalent.
3. The acceptance criteria for magnetic particle examination shall be in accordance with JIS B 8270 (Pressure vessels--General standard) or standards recognized as equivalent.

Article 61. Liquid Penetrant Examination
1. Welded joints covered by the proviso in the paragraph 1 of the Article 60 shall be subject to liquid penetrant examination over its whole length, and the results of such examination shall meet the requirements set forth in the paragraph 3 of this Article.
2. Liquid penetrant examination of such welded joints shall be conducted in accordance with JIS Z 2343 (Non-destructive Testing -- Penetrant Testing -- Part 1: General Principles -- Method for Liquid Penetrant Testing and Classification of the Penetrant Indication), or standards recognized as equivalent.
3. The acceptance criteria for liquid penetrant examination shall be in accordance with JIS B 8270 (Pressure vessels--General standard) or standards recognized as equivalent.

Article 62. Retests for Nondestructive Tests
If the results of any radiographic examination fail to meet the applicable requirements, the welded joint examined shall be subject to repairs and a retest in accordance with the appropriate one of the following items, depending on the type of such joint:
(1) In the case of any of the welded joints specified in each item of the paragraph 1 of the Article 56, its defective part or parts that are the cause of its failure to meet the applicable requirements shall, after being completely removed and rewelded, be subjected to another radiographic examination, the results of which shall satisfy the requirements. The provision in the paragraph 3 of the Article 58 does not apply to the said reexamination.

(2) In the case of any of the welded joints specified in the paragraph 2 of the Article 56, any two parts thereof (referred to simply as the "two parts" in the rest of this paragraph) shall be subject to radiographic reexamination as prescribed in (a) or (b) below. However, such reexamination may be replaced by the radiographic examination under the paragraph 1 of the Article 56.
(a) If the two parts are found by reexamination to meet the applicable requirements, the defective portion of the welded joint that was the cause of its failure to satisfy the requirements in the first radiographic examination shall, after being completely removed and rewelded, be subjected to another radiographic examination, the results of which shall meet the said requirements.
(b) In any instance other than the one set forth in the (a) above, radiographic examination covering the whole length of the welded joint shall be conducted. After completely removing the defective portion of the welded joint that was the cause of its failure to meet the requirements, rewelding shall be performed. Another radiographic examination shall be conducted for the rewelded portion, and the results shall satisfy the said requirements.
2. If the results of ultrasonic, magnetic particle or liquid penetrant examination fail to meet the requirements specified in the paragraph 2 of the Article 59, the paragraph 3 of the Article 60 or the paragraph 3 of the Article 61 respectively, the defective part of the welded joint causing such failure shall, after being completely removed and rewelded, be subjected to appropriate reexamination, the results of which shall satisfy the applicable requirements.

Section 2. Hydraulic Test

Article 63. Hydraulic Test

1. First Class pressure vessels shall be examined by a hydraulic test at the appropriate one of the pressure levels specified in the following items for their types to prove that there is nothing abnormal with them:
(1) For First Class pressure vessels made of steel or a nonferrous metal - 1.5 times the maximum allowable working pressure as temperature-corrected under the paragraph 5 of this Article;
(2) For cast iron First Class pressure vessels with the maximum allowable working pressure not exceeding 0.1 MPa - 0.2 MPa
(3) For cast iron First Class pressure vessels with the maximum allowable working pressure exceeding 0.1 MPa - two times the maximum allowable working pressure; or
(4) Enameled or glass-lined First Class pressure vessels - appropriate one of the pressure levels specified in the item 1 through the item 3 of this paragraph when these vessels are tested before they are enameled or glass-lined, or the maximum allowable working pressure if they are tested after going through such coating process.
2. For those First Class pressure vessels which are to be plated, a hydraulic test may be conducted on them after their plating is finished.
3. Large First Class pressure vessels and some others which are structurally unfit to fill up with water shall be examined by a pneumatic test, as a replacement for a hydraulic test, to prove that there is nothing abnormal with them. The pressure level applicable to such test shall be 1.25 times the maximum allowable working pressure as temperature-corrected under Paragraph 5 of this Article.
4. The pneumatic test referred to in the preceding paragraph shall be performed with the pressure level first raised to 50% of the maximum allowable working pressure, then increased to the specified test pressure gradually by 10% of the maximum allowable working pressure at a time and finally lowered to the maximum allowable working pressure, at which the pressure vessel

shall be checked to see if there is anything wrong with it.
5. The temperature correction of pressure for a hydraulic or pneumatic test shall be made by the following equation:

$$Pa = P \times \sigma n / \sigma a$$

Where Pa = temperature-corrected pressure (MPa) for the hydraulic or pneumatic test
P = pressure before correction (MPa) for the hydraulic or pneumatic test
σn = allowable tensile stress for the material (N/mm^2) at the temperature at which such test is performed; and
σa = allowable tensile stress for the material (N/mm^2) at the specified working temperature.

Part 1. Construction Code for First Class Pressure Vessels

Chapter 4. Fittings

Article 64. Safety Valves and Alternative Safety Devices

1. Any First Class pressure vessel shall be equipped with a safety valve or an alternative safety device for each of those parts which are subject to exposure to different levels of pressure, to ensure that the internal pressure working on any of such parts will not rise above the maximum allowable working pressure. However, this provision does not apply to those parts of a First Class pressure vessel (other than a reactor) which are connected with a boiler or some other source of pressure and of which the maximum allowable working pressure is not lower than that of such pressure source.
2. Safety valves for First Class pressure vessels shall be attached to those parts of the vessel itself or of its tubing which are easily accessible for checkup purposes, and shall be installed in such a manner that their stems will be upright.
3. Safety valves for those First Class pressure vessels in which flammable or toxic vapours may be generated shall be hermetically sealed or so configured that they can burn, absorb or otherwise dispose of such vapours safely.

Article 65. Name Plates

1. Any lift-type safety valve having a lift not less than 1/15 the diameter of its seat aperture or any full-bore safety valve (referred to as "lift-type safety valve" in the following paragraph) provided for First Class pressure vessels with a maximum allowable working pressure of over 0.1 MPa shall conform to the material and structural specifications set forth in JIS B 8210 (Steam Boilers and Pressure Vessels -- Spring Loaded Safety Valves), or have equivalent or superior mechanical properties.
2. A name plate showing the content specified in the following items shall be attached to a conspicuous part of its housing.

(1) Name of the manufacturer or trade mark;
(2) Nominal diameter;
(3) Specified pressure (MPa); and
(4) Discharge capacity (kg/h).

Article 66. Exceptive Case of Two or More First Class Pressure Vessels Installed Close Together

If two or more adjacent First Class pressure vessels are connected with one another and are operated together in such configuration and if there is no valve installed between any two of them, the First Class pressure vessels thus connected and operated together may be deemed one integrated installation, and as such, the provisions in Chapter 4 (except Articles 67 and 69) shall apply to these pressure vessels.

Article 67. Quick Opening-Closing Devices for the Cover

Quick opening-closing devices for the cover plate of First Class pressure vessels shall be so designed that the cover plate can be opened only when the residual pressure in the vessel is equal to the pressure level of its environment.

Article 68. Pressure Gauges

Any First Class pressure vessel shall be equipped with a pressure gauge in accordance with the following items.
(1) It shall be clearly shown whether related valves or cocks are open or closed.
(2) The highest reading on the scale plate of such pressure gauge shall be in a range not lower than 1.5 times, but not higher than 3 times, the specified maximum allowable working pressure.

Article 69. Thermometers

Any First Class pressure vessel shall be equipped with a thermometer to indicate the temperature of the fluid contained in it unless there is no probability that the temperature of any material of such pressure vessel will, while in service, ever exceed the permissible level determined from the maximum allowable working temperature for the vessel.

Part 1. Construction Code for First Class Pressure Vessels

Chapter 5. Miscellaneous Provisions

Article 70. Exceptions

Among First Class pressure vessels which do not meet the requirements in Chapters 1 through 4 herein, the following First Class pressure vessels shall be regarded to meet such requirements when they are recognized by the Director-General of the Prefectural Labour Bureau to have the safety equal or superior to that of those pressure vessels which meet such requirements, judging

from the material, construction, workmanship and other features of such pressure vessel:
(a) pressure vessels which are specially designed;
(b) pressure vessels which are manufactured in accordance with international standards etc.

Article 71. Determination of Maximum Allowable Working Pressure

1. The marking of the maximum allowable working pressure for a double-shell First Class pressure vessel shall state such pressure for each of its parts which are subject to exposure to different levels of pressure, while for any other type of First Class pressure vessel, the maximum pressure for the vessel as a whole shall be stated.
2. Any person who inspects a First Class pressure vessel under the Ordinance on Safety of Boilers and Pressure Vessels (Ordinance No. 33 of the Ministry of Labour, 1972) may determine the maximum allowable working pressure for such vessel by taking into consideration the degree of any fabricating defect, material corrosion, etc. found with such vessel during the inspection.

Part 2. Construction Code for Second Class Pressure Vessels

Article 72. Name Plate

Second class pressure vessels shall have a nameplate showing the following items:
(1) Name of the manufacturer or trade mark;
(2) Year and month of production;
(3) Maximum allowable working pressure; and
(4) Hydraulic test pressure

Article 73. Application of Provisions Mutatis Mutandis

The provisions in Part 1 herein (except the items 2, 3 and 4 in the table under the Article 2, and the Article 43 and the Articles 45 through 62) shall apply to Second Class pressure vessels. In this case, the efficiency of any of the welded joints listed in the table under the paragraph 2 of the Article 42 shall, if they are made by any person other than a licensed boiler welder, be equal to 85% of the appropriate one of the values specified in such table.

Supplementary Provisions

1. This notification shall become effective on the day of official announcement. However, the provisions in the item 3 of the Article 2 (only the part related to JIS G3457 -- Arc Welded Carbon Steel Pipes), the Articles 45, 53, 54, and the paragraph 2 of the Article 55 of the revised construction code for pressure vessels become effective on the first day of June, 2003.
2. Any of the pressure vessels under manufacturing or in service at the date of the effectuation of this notification shall be in accordance with the previous codes which have been in force.
3. The preceding paragraph shall cease to apply to any of such pressure vessels or any part thereof when it comes to meet this notification.