



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS K 6774 : 2022

(JGA/JPIF/JSA)

**Polyethylene pipes for the supply of
gaseous fuels**

ICS 75.200 ; 83.140.30

Reference number : JIS K 6774 : 2022 (E)

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K 6774 : 2022

Date of Establishment: 1979-03-01

Date of Revision: 2022-01-20

Date of Public Notice in Official Gazette: 2022-01-20

Investigated by: Japanese Industrial Standards Committee

Standards Board for ISO area

Technical Committee on Chemical Products and

Analytical Methods

JIS K 6774 : 2022, First English edition published in 2022-11

Translated and published by: Japanese Standards Association
Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Gas Association (JGA)/The Japan Plastics Industry Federation (JPIF)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS K 6774** : 2013), which has been technically revised.

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Polyethylene pipes for the supply of gaseous fuels

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 4437-1** : 2014, Edition 1, and **ISO 4437-2** : 2014, Edition 1, with some modifications of the technical contents.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JF.

1 Scope

This Standard specifies the requirements for buried polyethylene pipes (hereafter referred to as pipes) used for the supply of town gas and liquefied petroleum gas.

NOTE The International Standards corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 4437-1 : 2014 *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 1 : General*

ISO 4437-2 : 2014 *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 2 : Pipes* (Overall evaluation : MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standards and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

The maximum operating pressure (MOP) of the polyethylene pipe-fittings for the supply of gaseous fuels conforming to **JIS K 6775-1**, **JIS K 6775-2** and **JIS K 6775-3** and their joints, and joints with components of polyethylene or other materials is based on the design stress determined from the compound minimum required strength (MRS) divided by *C* factor [overall service (design) coefficient], and taking into account rapid crack propagation (RCP) requirements.

2 Normative references

Part or all of the provisions of the following standards, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7502 *Micrometers*

JIS B 7503 *Mechanical dial gauges*

JIS B 7507 *Vernier, dial and digital callipers*

JIS K 2231 *Liquid paraffin*

JIS K 6775-1 *Polyethylene pipe-fittings for the supply of gaseous fuels — Part 1 : Heatfusion fittings*

JIS K 6775-2 *Polyethylene pipe-fittings for the supply of gaseous fuels — Part 2 : Spigot fittings*

JIS K 6775-3 *Polyethylene pipe-fittings for the supply of gaseous fuels — Part 3 : Electrofusion fittings*

JIS K 6812 *Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds*

NOTE Normative reference in the corresponding International Standard : ISO 18553 *Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds*

JIS K 6814 *Thermoplastics pipes — Thermal reversion test method*

NOTE Normative reference in the corresponding International Standard : ISO 2505 *Thermoplastics pipes — Longitudinal reversion — Test method and parameters*

JIS K 6815-1 *Thermoplastics pipes — Determination of tensile properties — Part 1 : General test method*

NOTE Normative reference in the corresponding International Standard : ISO 6259-1 *Thermoplastics pipes — Determination of tensile properties — Part 1 : General test method*

JIS K 6815-3 *Thermoplastics pipes — Determination of tensile properties — Part 3 : Polyolefin pipes*

NOTE Normative reference in the corresponding International Standard : ISO 6259-3 *Thermoplastics pipes — Determination of tensile properties — Part 3 : Polyolefin pipes*

JIS K 6900 *Plastics — Vocabulary*

NOTE Normative reference in the corresponding International Standard : ISO 472 *Plastics — Vocabulary*

JIS K 6922-2 *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 2 : Preparation of test specimens and determination of properties*

JIS K 7111-1 *Plastics — Determination of Charpy impact properties — Part 1 : Non-instrumented impact test*

JIS K 7112 *Plastics — Methods of determining the density and relative density of non-cellular plastics*

JIS K 7139 *Plastics — Test specimens*

JIS K 7161-1 *Plastics — Determination of tensile properties — Part 1 : General principles*

JIS K 7161-2 *Plastics — Determination of tensile properties — Part 2 : Test con-*

ditions for moulding and extrusion plastics

JIS K 7210-1 *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1 : Standard method*

NOTE Normative reference in the corresponding International Standard : ISO 1133-1 *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1 : Standard method*

JIS K 7219-1 *Plastics — Methods of exposure to solar radiation — Part 1 : General guidance*

JIS K 7219-2 *Plastics — Methods of exposure to solar radiation — Part 2 : Direct weathering and exposure behind window glass*

JIS K 7251 *Plastics — Determination of water content*

NOTE Normative reference in the corresponding International Standard : ISO 15512 *Plastics — Determination of water content*

JIS K 7350-4 *Plastics — Methods of exposure to laboratory light sources — Part 4 : Open-flame carbon-arc lamps*

JIS K 8105 *Ethylene glycol (Reagent)*

JIS K 8839 *2-Propanol (Reagent)*

JIS K 8858 *Benzene (Reagent)*

JIS K 8891 *Methanol (Reagent)*

JIS Z 8401 *Rounding of numbers*

ISO 161-1 *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1 : Metric series*

ISO 1167-1 *Thermoplastics, pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1 : General method*

ISO 1167-2 *Thermoplastics, pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 2 : Preparation of pipe test pieces*

ISO 4065 *Thermoplastics pipes — Universal wall thickness table*

ISO 11357-6 *Plastics — Differential scanning calorimetry (DSC) — Part 6 : Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)*

ISO 12162 *Thermoplastics materials for pipes and fittings for pressure applications — Classification, designation and design coefficient*

ISO 13477 *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Small-scale steady-*

state test (S4 test)

- ISO 13478 *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Full-scale test (FST)*
- ISO 13479 *Polyolefin pipes for the conveyance of fluids — Determination of resistance to crack propagation — Test method for slow crack growth on notched pipes*
- ISO 13953 *Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*
- ISO 13954 *Plastics pipes and fittings — Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions, and those given in **JIS K 6900** apply.

3.1

dimensions for Class 1

Terms and definitions related to dimensions for Class 1 are given in Table 1.

Table 1 Terms and definitions related to dimensions for Class 1

Term	Definition
nominal diameter	numerical designation of the diameter of the pipe
basic outside diameter, D	basic dimension of outside diameter
mean outside diameter, D_0	arithmetic mean of four outside diameter measurements taken at equal intervals of 45°, or measured circumference divided by the circular constant 3.142
maximum out-of-roundness	difference between the maximum and minimum outside diameters measured in the same cross-sectional plane of the pipe
basic wall thickness, t	basic dimension of wall thickness
wall thickness, t_1	wall thickness measured at any point of the pipe
standard dimension ratio, SDR	ratio of the basic outside diameter to the basic wall thickness of the pipe $SDR = D/t$

3.2

dimensions for Class 2

Terms and definitions related to dimensions for Class 2 are given in Table 2.

Table 2 Terms and definitions related to dimensions for Class 2

Term	Definition
nominal outside diameter, d_n	numerical designation of the size of the pipe related to the outside diameter
mean outside diameter, d_{em}	value of the measurement of the outer circumference of the pipe divided by the circular constant 3.142
minimum mean outside diameter, $d_{em, min}$	minimum value for the mean outside diameter (d_{em}), equal to the nominal outside diameter, d_n
maximum mean outside diameter, $d_{em, max}$	maximum value for the mean outside diameter (d_{em})
maximum out-of-roundness	difference between the maximum and minimum outside diameters measured in the same cross-sectional plane of the pipe. It is also referred to as ovality.
nominal wall thickness, e_n	numerical designation of wall thickness based on the nominal outside diameter and SDR given in ISO 4065 Note 1 to entry This is equal to the minimum wall thickness at any point ($e_{y, min}$).
wall thickness at any point, e_y	wall thickness at any point around the circumference of the pipe
minimum wall thickness, $e_{y, min}$	minimum wall thickness of the pipe to which dimensions for Class 2 apply
standard dimension ratio, SDR	ratio of the nominal outside diameter to the nominal wall thickness of the pipe $SDR = d_n/e_n$
tolerance, t_y	permitted difference between the wall thickness at any point, e_y , and nominal wall thickness, e_n Note 1 to entry $e_n \leq e_y \leq e_n + t_y$

3.3

compound

homogenous kneaded mixture or homogenous mixture of base polymer (PE) and additives, i.e. anti-oxidants, pigments, stabilizers, and others at a dosage level necessary for the processing and use of components conforming to the requirements of this Standard

Note 1 to entry Compounds are classified into coloured compounds and master batch compounds.

3.4

coloured compound

kneaded mixture of base polymer (PE), pigments and other additives

3.5

master batch compound

mixture of a master batch material which contains a high concentration of pigments and a suitable amount of other additives, and an uncoloured material which contains no pigments and a suitable amount of other additives

Note 1 to entry In some of these compounds, the uncoloured material constituting the master batch, i.e. the material before addition of pigments, is different from the other uncoloured material.

3.6

own reprocessable material

material prepared from clean, rejected, and unused pipes, fittings, or valves, including trimmings from the production of pipes, fittings, or valves, that is reprocessed in a manufacturer's plant after having been previously processed by the same manufacturer

3.7

lower confidence limit of predicted hydrostatic strength, σ_{LPL}

quantity which represents the 97.5 % lower confidence limit of the predicted hydrostatic strength at a temperature T and time t

Note 1 to entry It is an index of material property and expressed in MPa (megapascals).

3.8

overall service (design) coefficient, C

coefficient with a value greater than 1 which takes into consideration service conditions as well as properties of the components of a piping system

Note 1 to entry The minimum value for gas supply components is 2.0.

3.9

minimum required strength, MRS

value of lower confidence limit of predicted hydrostatic strength, σ_{LPL} , at 20 °C and 50 years

Note 1 to entry It is obtained by conversion from σ_{LPL} using Table 1 of ISO 12162.

3.10

maximum operating pressure, MOP

maximum effective pressure of the gas in the piping system, which is allowed in continuous use

Note 1 to entry It is expressed in MPa (megapascals).

Note 2 to entry It is calculated using the following formula :

$$MOP = \frac{2 \times MRS}{C \times (SDR - 1)}$$

3.11

virgin material

material in a form such as granules or powder that has not been subjected to use and to which no reprocessable or recyclable materials have been added

3.12**design stress, σ**

allowable stress for a given application at 20 °C, that is derived from the MRS by dividing it by the design coefficient C , i.e. $\sigma = \text{MRS}/C$

Note 1 to entry It is expressed in MPa (megapascals).

3.13**melt mass-flow rate, MFR**

value relating to the viscosity of the molten material at a specified temperature and load

Note 1 to entry It is expressed in grams per 10 min (g/10 min).

4 Quality**4.1 Material****4.1.1 Technical file**

The manufacturer of the pipes shall ensure the availability of a technical description to users that contain all data relevant to the material used. Any change in the choice of materials that may affect the quality of the product shall require a new qualification of the pipe according to Table 5.

4.1.2 Compound

The compound used for production of pipes shall be made by adding to the base polymer (polyethylene or copolymer mainly composed of ethylene) only those additives necessary for the manufacture, use and fusion-jointing of pipes conforming to this Standard. It shall be ensured that additives are uniformly dispersed.

4.1.3 Own reprocessable material

Own reprocessable material shall not be used for production of pipes as it may affect the long-term properties of the pipes.

However, it may be used if so agreed between the parties concerned with delivery.

4.1.4 Additives

The compound shall be made by adding to the polyethylene base polymer only those additives and pigments necessary for the manufacture of pipes and fittings conforming to this Standard and JIS K 6775-1 to JIS K 6775-3 as applicable, for their fuseability, storage, and use. Use and control of additives shall take into account the Industrial Safety and Health Act, Poisonous and Deleterious Substances Control Act, and Act on Confirmation, etc. of Release Amounts of Specific Chemical Substances in the Environment and Promotion of Improvements to the Management Thereof.

4.1.5 Colour

The colour of the pipe shall be yellow (PE 80).

NOTE Some of the buried pipes manufactured in Japan are green.

4.1.6 Classification of compounds

The classification of compounds shall be based on MRS as shown in Table 3, and shall be indicated by the compound manufacturer.

When the pipe is manufactured from a master batch compound composed of a kneaded mixture of multiple uncoloured materials, the pipe manufacturer shall indicate the classification of the compound based on the MRS evaluation of the kneaded mixture they have conducted.

Table 3 Classification of compounds

Type	σ_{LPL} (20 °C, 50 years, 97.5 %)	MRS
PE 80	$8 \text{ MPa} \leq \sigma_{LPL} < 10 \text{ MPa}$	8.0 MPa
PE 100	$10 \text{ MPa} \leq \sigma_{LPL} < 11.2 \text{ MPa}$	10.0 MPa

NOTE The classification is based on ISO 12162.

4.1.7 Performance of compound

The performance of compound shall be tested in accordance with Clause 6, and satisfy the requirements in Table 4.

Table 4 Performance requirements of compound

Item	Requirement	Test condition	Test sub-clause
Density ^{a)}	0.930 g/cm ³ min.	Laboratory temperature 23 °C ± 2 °C Laboratory humidity (50 ± 5) %	6.4
Melt mass-flow rate ^{b)}	±20 % of the value indicated by the manufacturer, or 0.2 g/10 min ≤ MFR ≤ 1.40 g/10 min	Test temperature 190 °C ± 1 °C Load 49.03 N	6.5
Thermal stability ^{c)}	Over 20 min	Test temperature 200 °C ± 0.5 °C	6.6
Volatile content	350 mg/kg max.	Test temperature 105 °C ± 2 °C	6.7
Water content ^{d)}	300 mg/kg max.	Karl Fischer method	6.8
Pigment dispersion	3 max. A1, A2, A3 or B	Observation under microscope	6.9
Tensile yield stress	17.7 MPa min.	Test rate 200 mm/min ± 20 mm/min	6.10

Table 4 (continued)

Item		Requirement	Test condition	Test sub-clause								
Resistance to gas constituents		Mass change ratio ± 1 mg/cm ²	Immersion in the test liquids ① to ③ : ① liquid paraffin ② mixture of 2-methyl-2-propanethiol and liquid paraffin ③ methanol, 2-propanol, ethylene glycol For ③, one of the three liquids may be selected.	6.11								
		Mass change ratio ± 2 mg/cm ²	Immersion in mixture of benzene and methanol									
		Change ratio of tensile yield stress ± 12 %	Test rate 200 mm/min $\pm$ 20 mm/min									
Charpy impact		9.8 kJ/m ² min.	Test temperature 23 °C $\pm$ 2 °C	6.12								
Resistance to weathering ^{e)}	Outdoor exposure test ^{d)}	Hot internal-pressure creep test	Test temperature 80 °C $\pm$ 1 °C Test time 165 h <table><tr><td>Classification</td><td>Circumferential stress</td></tr><tr><td>PE 80</td><td>4.5 MPa</td></tr><tr><td>PE 100</td><td>5.4 MPa</td></tr></table>	Classification	Circumferential stress	PE 80	4.5 MPa	PE 100	5.4 MPa	6.21		
		Classification	Circumferential stress									
		PE 80	4.5 MPa									
	PE 100	5.4 MPa										
Tensile elongation test	350 % min.	Test temperature 23 °C $\pm$ 2 °C <table><tr><td>Test piece thickness mm</td><td>Test rate mm/min</td></tr><tr><td>$t, e_n \leq 5$</td><td>100</td></tr><tr><td>$5 < t, e_n \leq 12$</td><td>50</td></tr><tr><td>$t, e_n > 12$</td><td>25</td></tr></table>	Test piece thickness mm	Test rate mm/min	$t, e_n \leq 5$	100	$5 < t, e_n \leq 12$	50	$t, e_n > 12$	25	6.22	
Test piece thickness mm	Test rate mm/min											
$t, e_n \leq 5$	100											
$5 < t, e_n \leq 12$	50											
$t, e_n > 12$	25											
	Peel decohesion test	The brittle fracture length shall be not more than 33.3 % of the length of the sample fitting, l_2 .	Tensile rate 20 mm/min to 50 mm/min	6.23								
	Accelerated weathering test ^{e)}	Tensile elongation test	Test temperature 23 °C $\pm$ 2 °C <table><tr><td>Test piece thickness mm</td><td>Test rate mm/min</td></tr><tr><td>$t, e_n \leq 5$</td><td>100</td></tr><tr><td>$5 < t, e_n \leq 12$</td><td>50</td></tr><tr><td>$t, e_n > 12$</td><td>25</td></tr></table>	Test piece thickness mm	Test rate mm/min	$t, e_n \leq 5$	100	$5 < t, e_n \leq 12$	50	$t, e_n > 12$	25	6.22
Test piece thickness mm	Test rate mm/min											
$t, e_n \leq 5$	100											
$5 < t, e_n \leq 12$	50											
$t, e_n > 12$	25											
Resistance to rapid crack propagation ⁱ⁾		Full scale test limit pressure p_c $p_c \geq 1.5$ MOP (unit : MPa), where p_c is defined in relation to $p_{c,s4}$ as follows : $p_c = 3.6 p_{c,s4} + 0.26$ ⁱ⁾	Test temperature Full scale test 0 °C $\pm$ 1.5 °C S4 test 0 ⁰ ₋₂ °C	6.15								

Table 4 (continued)

Item		Requirement	Test condition	Test sub-clause						
Resistance to slow crack growth ^{k)}	Notch-type internal-pressure creep test	No fracture	Test temperature 80 °C ± 1 °C Test time 500 h <table><tr><td>Classification</td><td>Internal pressure (for SDR11)</td></tr><tr><td>PE 80</td><td>0.8 MPa</td></tr><tr><td>PE 100</td><td>0.92 MPa</td></tr></table>	Classification	Internal pressure (for SDR11)	PE 80	0.8 MPa	PE 100	0.92 MPa	6.16
	Classification	Internal pressure (for SDR11)								
	PE 80	0.8 MPa								
PE 100	0.92 MPa									
	Full notch tensile creep test	No fracture	Test temperature 80 °C ± 1 °C <table><tr><td>Nominal stress</td><td>Test duration</td></tr><tr><td>4.9 MPa</td><td>20 h</td></tr><tr><td>3.9 MPa</td><td>36 h</td></tr></table>	Nominal stress	Test duration	4.9 MPa	20 h	3.9 MPa	36 h	6.17
Nominal stress	Test duration									
4.9 MPa	20 h									
3.9 MPa	36 h									
	Full notch tensile fatigue test	No fracture	Test temperature 80 °C ± 1 °C <table><tr><td>Nominal stress</td><td>Number of repetitions</td></tr><tr><td>4.9 MPa</td><td>2 400</td></tr><tr><td>3.9 MPa</td><td>5 300</td></tr></table>	Nominal stress	Number of repetitions	4.9 MPa	2 400	3.9 MPa	5 300	6.18
Nominal stress	Number of repetitions									
4.9 MPa	2 400									
3.9 MPa	5 300									
Fusion compatibility ^{l)}	Butt fusion joint strength test ^{m)}	The type of fracture observed is ductile fracture.	Method A Test rate : 5 mm/min ± 1 mm/min	6.20						
			Method B Test rate : 200 mm/min ± 20 mm/min							
	Charpy impact test	6.9 kJ/m ² min.	Test temperature 23 °C ± 2 °C	6.12						
	Internal-pressure creep test	No cracks or other defects ^{j)}	Test temperature 80 °C ± 1 °C	6.21						
		Full notch tensile creep test	No fracture	Test temperature 80 °C ± 1 °C <table><tr><td>Nominal stress</td><td>Test duration</td></tr><tr><td>4.9 MPa</td><td>10 h</td></tr><tr><td>3.9 MPa</td><td>18 h</td></tr></table>	Nominal stress	Test duration	4.9 MPa	10 h	3.9 MPa	18 h
Nominal stress	Test duration									
4.9 MPa	10 h									
3.9 MPa	18 h									
	Full notch tensile fatigue test	No fracture	Test temperature 80 °C ± 1 °C <table><tr><td>Nominal stress</td><td>Number of repetitions</td></tr><tr><td>4.9 MPa</td><td>1 100</td></tr><tr><td>3.9 MPa</td><td>2 900</td></tr></table>	Nominal stress	Number of repetitions	4.9 MPa	1 100	3.9 MPa	2 900	6.18
Nominal stress	Number of repetitions									
4.9 MPa	1 100									
3.9 MPa	2 900									

Table 4 (concluded)

Note a)	The value of density shall be that of the uncoloured material. Where the uncoloured material is not available for testing, the coloured compound may be used upon agreement between the parties concerned with delivery.
Note b)	In the case of master batch system, perform the test using the uncoloured material.
Note c)	In the case of master batch system, perform the test on a sample obtained after kneading the master batch compound.
Note d)	Applicable only when the volatile content requirement is not satisfied.
Note e)	For weathering test, carry out either the outdoor exposure test or accelerated weathering test.
Note f)	Expose to radiation energy of 3.5 GJ/m ² or more before carrying out the tests (see 6.13).
Note g)	Expose to radiation by the accelerated exposure test apparatus specified in JIS K 7350-4 for 600 h before carrying out the test (see 6.14).
Note h)	Only brittle fracture shall be taken into account. If a ductile failure occurs before the specified test time has elapsed, the test can be repeated at a lower stress. In this case, the test time shall be selected from a line based on the stress/time points given in Table 20.
Note i)	Applicable to pipes with MOP ≥ 0.01 MPa and an outside diameter of 250 mm or over, or to pipes with MOP > 0.4 MPa and an outside diameter of 90 mm or over.
Note j)	Full scale/S4 correlation factor is equal to 3.6 and is defined as the full scale/S4 critical absolute pressures ratio : $(p_c + 0.1) = 3.6(p_{c,s4} + 0.1)$ If the requirement for S4 test is not met or S4 test equipment is not available, then retesting by using the full scale test shall be performed in accordance with ISO 13478.
Note k)	For the test of resistance to slow crack growth, select one among the notch-type internal-pressure creep test, the full notch tensile creep test, and the full notch tensile fatigue test.
Note l)	Where evaluation of fusion compatibility is required, the parties concerned with delivery may specify the butt fusion joint strength test, Charpy impact test and internal-pressure creep test as the fusion compatibility tests. The internal-pressure creep test may be substituted by the full notch tensile creep test or the full notch tensile fatigue test.
Note m)	For the butt fusion joint strength test, select either Method A or Method B.

4.2 Performance of pipes

4.2.1 General

The performance of pipes shall be in accordance with Tables 5 and 6. Where evaluation of performance after squeeze-off is required, the squeeze-off test (see Annex A) may be carried out upon agreement between the parties concerned with delivery.

4.2.2 Mechanical performance of pipes

The mechanical performance of pipes shall be tested in accordance with Clause 6 and shall satisfy the requirements in Table 5.

Table 5 Mechanical performance of pipes

Item		Requirement	Test condition	Test sub-clause								
Internal-pressure creep ^{a)}	Ordinary-temperature internal-pressure creep test	No cracks or other defects	Test temperature 20 ⁺³ ₋₁ °C Test time 100 h <table><tr><td>Classification</td><td>Circumferential stress</td></tr><tr><td>PE 80</td><td>9.0 MPa</td></tr><tr><td>PE 100</td><td>12.0 MPa</td></tr></table>	Classification	Circumferential stress	PE 80	9.0 MPa	PE 100	12.0 MPa	6.21		
	Classification	Circumferential stress										
	PE 80	9.0 MPa										
PE 100	12.0 MPa											
Hot internal-pressure creep test	No cracks or other defects	Test temperature 80 °C ± 1 °C Test time 165 h <table><tr><td>Classification</td><td>Circumferential stress</td></tr><tr><td>PE 80</td><td>4.5 MPa</td></tr><tr><td>PE 100</td><td>5.4 MPa</td></tr></table>	Classification	Circumferential stress	PE 80	4.5 MPa	PE 100	5.4 MPa				
Classification	Circumferential stress											
PE 80	4.5 MPa											
PE 100	5.4 MPa											
Long-term hot internal-pressure creep test	No cracks or other defects	Test temperature 80 °C ± 1 °C Test time 1 000 h <table><tr><td>Classification</td><td>Circumferential stress</td></tr><tr><td>PE 80</td><td>4.0 MPa</td></tr><tr><td>PE 100</td><td>5.0 MPa</td></tr></table>	Classification	Circumferential stress	PE 80	4.0 MPa	PE 100	5.0 MPa				
Classification	Circumferential stress											
PE 80	4.0 MPa											
PE 100	5.0 MPa											
Tensile elongation ^{a)}		350 % min.	Test temperature 23 °C ± 2 °C <table><tr><td>Test piece thickness mm</td><td>Test rate mm/min</td></tr><tr><td>$t, e_n \leq 5$</td><td>100</td></tr><tr><td>$5 < t, e_n \leq 12$</td><td>50</td></tr><tr><td>$t, e_n > 12$</td><td>25</td></tr></table>	Test piece thickness mm	Test rate mm/min	$t, e_n \leq 5$	100	$5 < t, e_n \leq 12$	50	$t, e_n > 12$	25	6.22
Test piece thickness mm	Test rate mm/min											
$t, e_n \leq 5$	100											
$5 < t, e_n \leq 12$	50											
$t, e_n > 12$	25											
Resistance to rapid crack propagation ^{b)}		Full scale test limit pressure p_c $p_c \geq 1.5$ MOP (unit : MPa), where p_c is defined in relation to $p_{c,s4}$ as follows : $p_c = 3.6 p_{c,s4} + 0.26$ ^{c)}	Test temperature Full scale test 0 °C ± 1.5 °C S4 test 0 ⁰ ₋₂ °C	6.15								
Note ^{a)} The test shall be carried out on the pipe or the test piece cut out from the pipe without carrying out treatment such as exposure. Note ^{b)} Applicable to pipes with MOP > 0.01 MPa and an outside diameter of 250 mm or over, or to pipes with MOP > 0.4 MPa and an outside diameter of 90 mm or over. Note ^{c)} Full scale/S4 correlation factor is equal to 3.6 and is defined as the full scale/S4 critical absolute pressures ratio : $(p_c + 0.1) = 3.6(p_{c,s4} + 0.1)$ If the requirement for S4 test is not met or S4 test equipment is not available, then retesting by using the full scale test shall be performed in accordance with ISO 13478.												

4.2.3 Physical performance of pipes

The physical performance of pipes shall be tested in accordance with Clause 6 and shall satisfy the requirements in Table 6.

Table 6 Physical performance of pipes

Item	Requirement	Test condition	Test sub clause														
Thermal stability	Over 20 min	Test temperature 200 °C ± 0.5 °C	6.6														
Melt mass-flow rate	Ratio of change due to manufacture less than 20 % ^{a)}	Test temperature 190 °C ± 1 °C Load 49.03 N	6.5														
Thermal reversion ^{b)}	Length change ratio ±3 % No abnormality on surface	Test temperature 110 °C ± 2 °C <table><tr><th rowspan="2">Test piece thickness mm</th><th colspan="2">Heating time min</th></tr><tr><th>Heating bath</th><th>Oven</th></tr><tr><td>$e_n \leq 8$</td><td>15</td><td>60</td></tr><tr><td>$8 < e_n \leq 16$</td><td>30</td><td>120</td></tr><tr><td>$e_n > 16$</td><td>60</td><td>240</td></tr></table>	Test piece thickness mm	Heating time min		Heating bath	Oven	$e_n \leq 8$	15	60	$8 < e_n \leq 16$	30	120	$e_n > 16$	60	240	6.24
Test piece thickness mm	Heating time min																
	Heating bath	Oven															
$e_n \leq 8$	15	60															
$8 < e_n \leq 16$	30	120															
$e_n > 16$	60	240															

Note^{a)} The change ratio of the value of pipe measured by the pipe manufacturer to the measured value of compound, which is calculated by the following formula :

$$R = \frac{F_1 - F_0}{F_0} \times 100 (\%)$$

where,..... R ∴ ratio of change due to manufacture (%)
 F_0 ∴ measured MFR of compound (g/10 min)
 F_1 ∴ measured MFR of pipe (g/10 min)

Note^{b)} The thermal reversion test shall be performed according to JIS K 6814.

4.3 Appearance and shape

The appearance and shape of pipe shall be as follows.

- Inside and outside surfaces of the pipe shall be smooth and clean, and free from flaws which may affect its performance or other defects.
- The ends of the pipe shall be smoothly cut and square to the pipe axis.

5 Dimensions

5.1 General

Pipe dimensions for Class 1 and Class 2 and their tolerances are given in Tables 7 to 15.

Measurement of pipe dimensions shall be performed according to 6.2.

5.2 Dimensions for Class 1

5.2.1 Classification

Pipes shall be classified by SDR as shown in Table 7.

Table 7 Classification of pipes by SDR

Type	SDR of pipe
No. 1	11
No. 1U	13.5
No. 2	17
No. 3	21

5.2.2 Outside diameter, wall thickness, and their tolerances

The outside diameter, wall thickness, and their tolerances shall be as shown in Tables 8 to 11.

Table 8 Dimensions of No. 1 (SDR 11)

Nominal diameter	Mean outside diameter (D_0)		Wall thickness ^{b)} (t_1)		Maximum out-of-roundness ^{c)}	Informative		
	Basic outside diameter (D) mm	Tolerance ^{a)} mm	Basic wall thickness (t) mm	Tolerance mm		Length m	Inside diameter ^{d)} mm	Mass kg/m
15	22.0	±0.15	2.5	+0.5 0	1.4	120	16.5	0.157
					1.3	5		
20	27.0		3.0		1.7	120	20.5	0.229
					1.3	5		
25	34.0		3.4	+0.6 0	2.1	90	26.6	0.332
					1.4	5		
30	42.0		3.9		2.6	90	33.6	0.470
					1.5	5		
40	48.0		4.4	+0.7 0	2.9	60	38.5	0.609
					1.5	5		
50	60.0	±0.20	5.5	+0.8 0	3.7	40	48.2	0.946
					1.6	5.5		
75	89.0	±0.30	8.1	+1.1 0	5.5	30	71.7	2.06
					1.9	5.5		
100	114.0	±0.35	10.4	+1.3 0	2.3	5.5	91.9	3.37
150	165.0	±0.50	15.0	+1.7 0	3.3	5.5	133.3	7.00
200	216.0	±0.65	19.7	+2.2 0	4.3	5.5	174.4	12.0
250	267.0	±0.85	24.3	+2.7 0	5.3	5.5	215.7	18.3
300	318.0	±1.45	29.0	+3.1 0	11.1	5.5	256.7	26.0
350	370.0	±1.70	33.7	+3.6 0	12.9	5.5	299.0	35.2
400	420.0	±1.90	38.2	+4.0 0	14.6	5.5	339.6	45.2
Note ^{a)} Tolerance means the difference between the mean outside diameter measured according to 6.2 and the basic outside diameter.								
Note ^{b)} The basic wall thickness of pipes with nominal diameter of 25 or under shall be as given in this table regardless of the SDR specification.								

Table 8 (concluded)

Note ^{c)}	The given maximum out-of-roundness shall apply only to short straight pipes (straight pipes); the values are informative for long curved pipes (coiled pipes). The maximum out-of-roundness is specified when requested by the user, and upon agreement between the parties concerned with delivery.
Note ^{d)}	Inside diameter is calculated by the following formula :
	$D_i = D - \frac{t_{\max} + t_{\min}}{2} \times 2$
	where, D_i : inside diameter (mm)
	D : basic outside diameter (mm)
	$t_{\max}$: maximum wall thickness (mm)
	$t_{\min}$: minimum wall thickness (mm)

Table 9 Dimensions of No. 1 U (SDR 13.5)

Nomi- nal di- ameter	Mean outside di- ameter (D_0)		Wall thickness ^{b)} (t_1)		Maxi- mum out-of- round- ness ^{c) e)}	Informative		
	Basic outside dame- ter (D) mm	Tolerance ^{a) e)} mm	Basic wall thick- ness (t) mm	Toler- ance ^{e)} mm		Length m	Inside dame- ter ^{d)} mm	Mass kg/m
30	42.0	(±0.15)	3.2	$\left[\begin{smallmatrix} +0.6 \\ 0 \end{smallmatrix} \right]$	(1.5)	5	35.0	0.40
40	48.0	(±0.15)	3.6	$\left[\begin{smallmatrix} +0.6 \\ 0 \end{smallmatrix} \right]$	(1.5)		40.2	0.51
50	60.0	(±0.20)	4.5	$\left[\begin{smallmatrix} +0.7 \\ 0 \end{smallmatrix} \right]$	(1.6)	5.5	50.3	0.79
75	89.0	(±0.30)	6.6	$\left[\begin{smallmatrix} +0.9 \\ 0 \end{smallmatrix} \right]$	(1.9)		74.9	1.71
100	114.0	±0.35	8.5	$\begin{smallmatrix} +1.1 \\ 0 \end{smallmatrix}$	2.3		95.9	2.81
150	165.0	±0.50	12.3	$\begin{smallmatrix} +1.5 \\ 0 \end{smallmatrix}$	3.3		138.9	5.88
200	216.0	±0.65	16.0	$\begin{smallmatrix} +1.8 \\ 0 \end{smallmatrix}$	4.3		182.2	9.97
250	267.0	±0.85	19.8	$\begin{smallmatrix} +2.2 \\ 0 \end{smallmatrix}$	5.3		225.2	15.2
300	318.0	±1.45	23.6	$\begin{smallmatrix} +2.6 \\ 0 \end{smallmatrix}$	11.1		268.2	21.6
350	370.0	±1.70	27.5	$\begin{smallmatrix} +3.0 \\ 0 \end{smallmatrix}$	12.9		312.0	29.3
400	420.0	±1.90	31.2	$\begin{smallmatrix} +3.3 \\ 0 \end{smallmatrix}$	14.6		354.3	37.7
Note ^{a)} to Note ^{d)} See the same Notes in Table 8.								
Note ^{e)} The parenthesized values of tolerances and maximum out-of-roundness are in- formative.								