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**Flux cored wires for gas shielded
and self-shielded metal arc welding
of mild steel, high strength steel
and low temperature service steel**

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Foreword

This translation has been made based on the original Japanese Industrial Standard 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 Welding Engineering Society (JWES)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS Z 3313** :2006 is replaced with this Standard.

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Flux cored wires for gas shielded and self-shielded metal arc welding of mild steel, high strength steel and low temperature service steel

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of **ISO 17632** published in 2004 and the first edition of **ISO 18276** published in 2005 with some modifications of the technical contents. **ISO 17632** is a combined standard of **EN 758** and the standard used around the Pacific Rim, and **ISO 18276** is a combined standard of **EN 12535** and the standard used around the Pacific Rim. Either of corresponding Standards permit that either or both of the combined standards may be applied to the specific global markets. According to this, this Standard gives requirements corresponding to the standards used in Pacific Rim (**ISO 17632** System B and **ISO 18276** System B) except the flux core wires for metal arc welding of atmospheric corrosion resistance in the text, those corresponding to **EN 758** and **EN 12535**, and **ISO 17632** System A in Annex A, and those corresponding to **ISO 18276** System A in Annex B.

The portions given dotted underlines are the matters in which the contents of the corresponding International Standards have been modified. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies the flux cored wires (hereafter referred to as “the wire”) for gas shielded and self-shielded metal arc welding of mild steel, high strength steel of 490 MPa Class to 830 MPa Class, and low temperature service steel.

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

ISO 17632:2004 *Welding consumables — Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels — Classification*

ISO 18276:2005 *Welding consumables — Tubular cored electrodes for gas-shielded and non-gas-shielded metal arc welding of high-strength steels — Classification* (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**.

2 Normative references

The following standards contain provisions which, 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 G 0321 Product analysis and its tolerance for wrought steel

JIS G 3101 Rolled steels for general structure

JIS G 3106 Rolled steels for welded structure

JIS G 3126 Carbon steel plates for pressure vessels for low temperature service

JIS G 3127 Nickel steel plates for pressure vessels for low temperature services

JIS G 3136 Rolled steels for building structure

JIS Z 3001-1 Welding and allied processes—Vocabulary—Part 1: General

JIS Z 3001-2 Welding and allied processes—Vocabulary—Part 2: Welding processes

JIS Z 3011 Welding position defined by means of angles of slope and rotation

NOTE : Corresponding International Standard: ISO 6947 Welds—Working positions—Definitions of angles of slope and rotation (MOD)

JIS Z 3111 Methods of tension and impact tests for deposited metal

NOTE : Corresponding International Standard: ISO 15792-1 Welding consumables—Test methods—Part 1: Test methods for all-weld metal test specimens in steel, nickel and nickel alloys (MOD)

JIS Z 3118 Method for measurement of amount of hydrogen evolved from steel welds

NOTE : Corresponding International Standard: ISO 3690 Welding and allied processes—Determination of hydrogen content in ferritic steel arc weld metal (MOD)

JIS Z 3121 Methods of tensile test for butt welded joints

JIS Z 3129 Test method and preparation of test specimens for single-run and two-run welding technique in steel

NOTE : Corresponding International Standard: ISO 15792-2 Welding consumables—Test methods—Part 2: Preparation of single-run and two-run technique test specimens in steel (MOD)

JIS Z 3181 Method of fillet weld test for welding consumables

NOTE : Corresponding International Standard: ISO 15792-3 Welding consumables—Test methods—Part 3: Classification testing of positional capacity and root penetration of welding consumables in a fillet weld (MOD)

JIS Z 3184 Method of preparing deposited metal pad and samples for chemical analysis

NOTE : Corresponding International Standard: ISO 6847 Welding consumables—Deposition of a weld metal pad for chemical analysis (MOD)

JIS Z 3200 Welding consumables—Technical delivery conditions for welding filler materials—Type of product, dimensions, tolerances and markings

NOTE : Corresponding International Standard: ISO 544 Welding consumables—Technical delivery conditions for welding filler materials—Type of product, dimensions, tolerances and markings (MOD)

JIS Z 3253 *Shielding gases for arc welding and plasma arc cutting*

NOTE : Corresponding International Standard: ISO 14175 *Welding consumables—Shielding gases for arc welding and cutting* (MOD)

JIS Z 3423 *Procurement guidelines for welding consumables*

NOTE : Corresponding International Standard: ISO 14344 *Welding and allied processes—Flux and gas shielded electrical welding processes—Procurement guidelines for consumables* (MOD)

JIS Z 8401 *Guide to the rounding of numbers*

NOTE : Corresponding International Standard: ISO 31-0 : 1992 *Quantities and units—Part 0: General principles* (MOD)

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in JIS Z 3001-1 and JIS Z 3001-2 shall apply.

4 Classification, symbol indication method and combination thereof

4.1 Classification and symbol indication method

The type of wire shall be classified according to the tensile property (deposited metal or welded joint), impact test temperature, usability characteristics, applicable welding position, type of shielding gas, type of welding (single-run welding or multi-run welding, and state with or without post-weld heat treatment) and chemical composition of deposited metal, and shall be in accordance with figure 1. The classification according to the Charpy absorbed energy level of deposited metal and/or the hydrogen content of deposited metal may also be added. However, the single-run welding shall be classified in the as-welded condition only.

The type may be classified upon the tensile property of deposited metal, impact test temperature and/or Charpy absorbed energy level of deposited metal according to the state with or without post-weld heat treatment. Moreover, the type may be classified according to the combination of shielding gases.

4.2 Combination of classification symbol

The classification symbol and combination thereof shall be in accordance with table 1. The usability characteristics of wire shall be as shown in table 2.

Table 1 Classification symbol and combination thereof

Symbol of tensile property	Symbol of impact test temperature	Symbol of usability characteristics	Symbol of applicable welding position ^{a)}	Symbol of type of welding	Symbol of chemical composition of deposited metal
59, 62, 69, 76, 78, 83 (table 3 deposited metal)	Y, 0, 2, 3, 4, 5, 6, 7, 8, Z	T1, T5, T7, T15, TG	0, 1	A, P, AP	3M2, N2M2, N3M2, G, 3M3, 4M2, N2M1, N3M1, N4M1, N4M2, N4C1M2, N4C2M2, N6C1M4, N3C1M2
		T4	0		
59J ^{b)} (table 3 deposited metal)	1	T1, T5, T15, TG	0, 1		
785 ^{b)} (table 3 deposited metal)	2				
43, 49, 55, 57 (table 3 deposited metal)	Y, 0, 2, 3, 4, 5, 6, 7, 8, 9, 10	T1, T5, T7, T15, TG	0, 1	A, P, AP	3M2, N2M2, N3M2, G, No symbol, K, 2M3, N1, N2, N3, N5, N7, N1M2
		T4, T6	0		
495 ^{b)} , 52 ^{b)} (table 3 deposited metal)	0	T1, T5, T15, TG	0, 1		
575 ^{b)} (table 3 deposited metal)	1				
43, 49, 55, 57 (table 5 welded joint)	No symbol	T1, T5, T7, T15, TG, T13, T14	0, 1	S	Ditto
		T2, T3, T4, T6, T10	0		
NOTE : In the second row, third row and fifth row, the symbol commonly specified in each row is described first.					
Notes ^{a)} 0: PA (flat position) and PB (horizontal vertical position) 1:All positions (according to table 7)					
^{b)} “49J”, “52”, “57J”, “59J” and “78J” are applicable to the type whose symbol of Charpy absorbed energy level is U.					

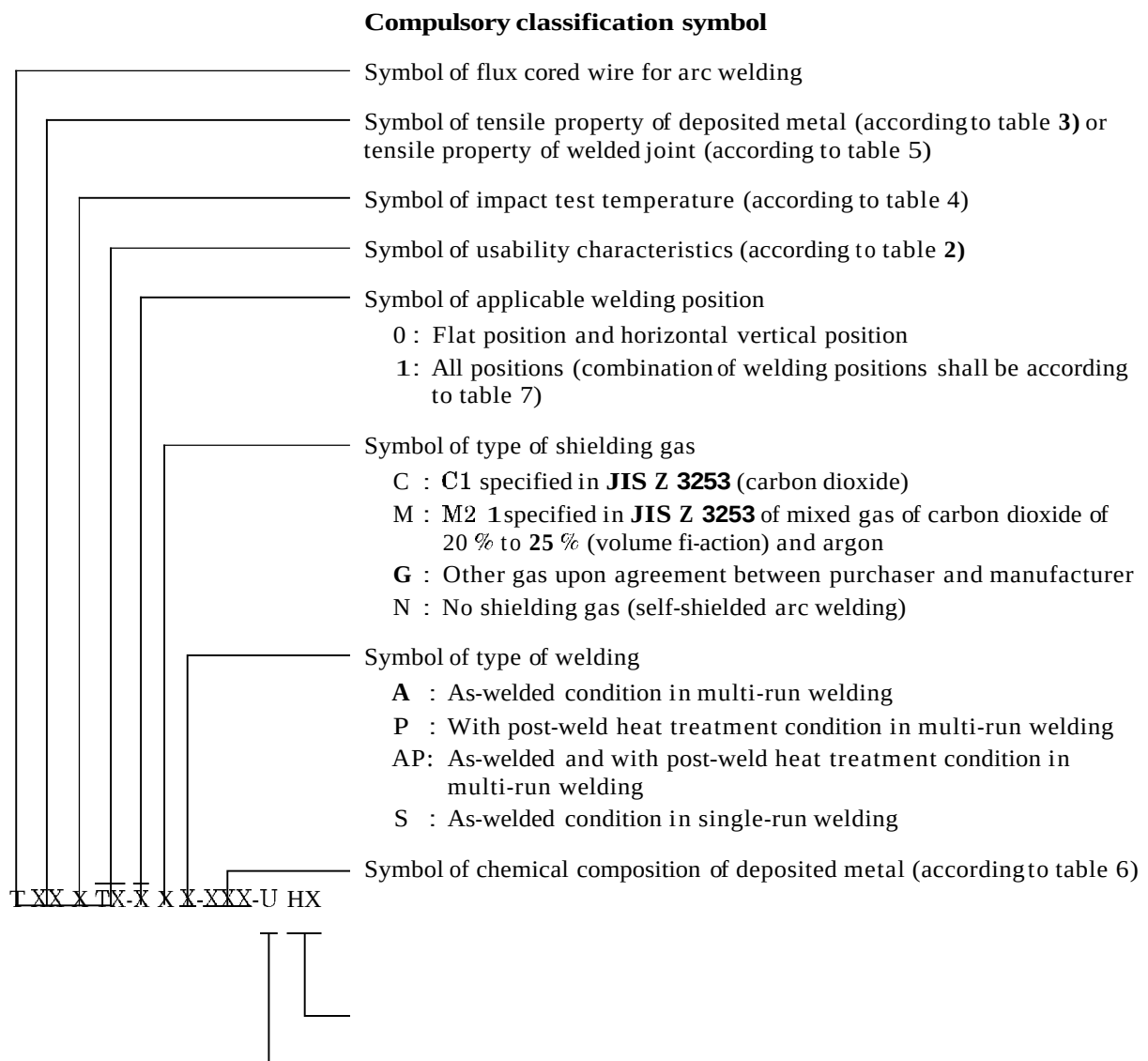


Figure 1 Type and symbol indication method of wire

Table 2 Symbol of usability characteristics

Symbol	Shielding gas	Type of current ^{a)}	Flux type	Usability characteristics (informative)
T1	Yes	DC (+)	Rutile type	That of spray transfer type of droplets, low spatter loss, high deposition rate and flat or slightly convexed bead
T2	Yes	DC (+)	Rutile type	That of spray transfer type of droplets, similar to “T1” but of higher addition amount of Mn and/or Si
T3	No	DC (+)	No specification	That of spray transfer type of droplets, and suitable for high welding speed
T4	No	DC (+) or AC	Basic type	That of globular transfer type of droplets, high deposition rate, and excellent resistance to hot cracking and low penetration
T5	Yes	DC (+) or DC (-)	Lime type	That of globular transfer type of droplets, slightly convexed bead, thin slag without completely covering, but excellent impact property and resistance to hot cracking
T6	No	DC (+)	No specification	That of spray transfer type of droplets, and excellent impact property, good penetration into root of weld and slag removal in groove
T7	No	DC (-)	No specification	That of spray transfer type of droplets, high deposition rate and excellent resistance to hot cracking
T10	No	DC (-)	No specification	That of spray transfer type of droplets on any thickness, and suitable for high welding speed
T13	No	DC (-)	No specification	That of short circuiting transfer type of droplets, and suitable for one-side welding without backing
T14	No	DC (-)	No specification	That of spray transfer type of droplets, and suitable for single-layer welding of coated or plated steel sheet
T15	Yes	DC (+)	Metal type	That of spray transfer type of droplets, flux consisting of iron powder and metal alloy as main components, and minimal slag
TG ^{b)}	Upon agreement between purchaser and manufacturer			
Notes ^{a)} The meaning of symbol used in the type of current shall be as follows. AC : alternative current DC (+) : wire plus DC (-) : wire minus ^{b)} Applicable to other than those specified in T1 to T15.				

5 Quality

5.1 Dimensions, tolerances and product conditions of wire

The dimensions, tolerances and product conditions of wire shall be as specified in **JIS Z 3200**.

5.2 Mechanical properties of deposited metal or welded joint

The mechanical properties of deposited metal or welded joint shall be as follows.

- The tensile property of deposited metal of multi-run welding shall conform to the specification given in table 3 when the tensile test is carried out in accordance with the method of **6.2**.

- b) The impact property of deposited metal of multi-run welding shall conform to the specification given in table 4 when the impact test is carried out in accordance with the method of 6.2.
- c) The tensile property of welded joint of single-run welding shall conform to the specification given in table 5 when the tensile test is carried out in accordance with the method of 6.3.

The manufacturer shall provide the recommended welding condition suitable for satisfying the specification of tensile property of table 5.

Table 3 Tensile property of deposited metal in multi-run welding

Symbol	Tensile strength MPa	Proof stress ^{a)} MPa	Elongation %
43	430 to 600	330 min.	20 min.
49	490 to 670	390 min.	18 min.
495	490 to 670	400 min.	18 min.
52	520 to 700	420 min.	17 min.
55	550 to 740	460 min.	17 min.
57	570 to 770	490 min.	17 min.
575	570 to 770	500 min.	17 min.
59	590 to 790	490 min.	16 min.
595	590 to 790	500 min.	16 min.
62	620 to 820	530 min.	15 min.
69	690 to 890	600 min.	14 min.
76	760 to 960	680 min.	13 min.
78	780 to 980	680 min.	13 min.
785	780 to 980	700 min.	13 min.
83	830 to 1030	745 min.	12 min.

Table 4 Impact property of deposited metal in multi-run welding

Symbol of impact test temperature	Impact test temperature °C	Charpy absorbed energy	
		Specified value of 27 J (no symbol)	Specified value of 47 J (Symbol: U)
		Number of impact test pieces: five ~~or~~ three	Number of impact test pieces: three
Y	+20	For the case of five test pieces, three values excluding the maximum value and minimum value of obtained test values shall be evaluated. Mean value of three: 27 J or over, and minimum value of three: 20 J or over, and at least two are 27 J or over	Mean value of three: 47 J or over
0	0		
1	-5		
2	-20		
3	-30		
4	-40		
5	-50		
6	-60		
7	-70		
8	-80		
9 ^{a)}	-90		
10 ^{a)}	-100		
Z ^{b)} or no symbol ^{c)}	Impact test is not required.		
Notes ^{a)} 9 and 10 shall only be applicable to the types whose symbol of tensile property of deposited metal is 43 , 49, 55 or 57. ^{b)} Z shall only be applicable to the types whose symbol of tensile property of deposited metal is 59, 62, 69, 76, 78 or 83 . ^{c)} No symbol shall only be applicable to the types whose symbol of tensile property of deposited metal is 43 , 49, 55 or 57 and symbol of the type of welding is S only.			

Table 5 Tensile property of welded joint in single-run welding

Unit: MPa

Symbol	Tensile strength ^{a)}
43	430 min.
49	490 min.
55	550 min.
57	570 min.
NOTE : 1MPa = 1N/mm² Note ^{a)} The breakage position may be any of the deposited metal, bonded part, thermal effected part or parent metal.	

5.3 Chemical composition of deposited metal

The chemical composition of deposited metal shall conform to the specification given in table 6 when the chemical analysis test is carried out in accordance with the method of **6.4**.

Table 6 Chemical composition of deposited metal

Unit : % (mass fraction)

Symbol	Chemical composition ^{a), b), c)}									
	C	Si	Mn	P	S	Ni	Cr	Mo	V	Al ^{d)}
No symbol	0.18 ^{e)} max.	0.90 max.	2.00 max.	0.030 max.	0.030 max.	0.50 ^{f)} max.	0.20 ^{f)} max.	0.30 ^{f)} max.	0.08 ^{f)} max.	2.0 max.
K	0.20 max.	1.00 max.	1.60 max.	0.030 max.	0.030 max.	0.50 ^{f)} max.	0.20 ^{f)} max.	0.30 ^{f)} max.	0.08 ^{f)} max.	—
2M3	0.12 max.	0.80 max.	1.50 max.	0.030 max.	0.030 max.	—	—	0.40 to 0.65	—	1.8 max.
3M2	0.15 max.	0.80 max.	1.25 to 2.00	0.030 max.	0.030 max.	0.90 max.	—	0.25 to 0.55	—	1.8 max.
3M3	0.15 max.	0.80 max.	1.00 to 1.75	0.030 max.	0.030 max.	0.90 max.	—	0.40 to 0.70	—	1.8 max.
4M2	0.15 max.	0.80 max.	1.65 to 2.25	0.030 max.	0.030 max.	0.90 max.	—	0.25 to 0.55	—	1.8 max.
N1	0.12 max.	0.80 max.	1.75 max.	0.030 max.	0.030 max.	0.30 to 1.00	—	0.35 max.	—	1.8 max.
N2	0.12 max.	0.80 max.	1.75 max.	0.030 max.	0.030 max.	0.80 to 1.20	—	0.35 max.	—	1.8 max.
N3	0.12 max.	0.80 max.	1.75 max.	0.030 max.	0.030 max.	1.00 to 2.00	—	0.35 max.	—	1.8 max.
N5	0.12 max.	0.80 max.	1.75 max.	0.030 max.	0.030 max.	1.75 to 2.75	—	—	—	1.8 max.
N7	0.12 max.	0.80 max.	1.75 max.	0.030 max.	0.030 max.	2.75 to 3.75	—	—	—	1.8 max.
N1M2	0.15 max.	0.80 max.	2.00 max.	0.030 max.	0.030 max.	0.40 to 1.00	0.20 max.	0.20 to 0.65	0.05 max.	1.8 max.
N2M1	0.15 max.	0.80 max.	2.25 max.	0.030 max.	0.030 max.	0.40 to 1.50	0.20 max.	0.35 max.	0.05 max.	1.8 max.
N2M2	0.15 max.	0.80 max.	2.25 max.	0.030 max.	0.030 max.	0.40 to 1.50	0.20 max.	0.20 to 0.65	0.05 max.	1.8 max.
N3M1	0.15 max.	0.80 max.	2.25 max.	0.030 max.	0.030 max.	1.00 to 2.00	0.20 max.	0.35 max.	0.05 max.	1.8 max.
N3M2	0.15 max.	0.80 max.	2.25 max.	0.030 max.	0.030 max.	1.25 to 2.25	0.20 max.	0.20 to 0.65	0.05 max.	1.8 max.
N4M1	0.12 max.	0.80 max.	2.25 max.	0.030 max.	0.030 max.	1.75 to 2.75	0.20 max.	0.35 max.	0.05 max.	1.8 max.
N4M2	0.15 max.	0.80 max.	2.25 max.	0.030 max.	0.030 max.	1.75 to 2.75	0.20 max.	0.20 to 0.65	0.05 max.	1.8 max.
N4C1M2	0.15 max.	0.80 max.	2.25 max.	0.030 max.	0.030 max.	1.75 to 2.75	0.20 to 0.60	0.20 to 0.65	0.05 max.	1.8 max.
N4C2M2	0.15 max.	0.80 max.	2.25 max.	0.030 max.	0.030 max.	1.75 to 2.75	0.60 to 1.00	0.20 to 0.65	0.05 max.	1.8 max.
N6C1M4	0.12 max.	0.80 max.	2.25 max.	0.030 max.	0.030 max.	2.50 to 3.50	1.00 max.	0.40 to 1.00	0.05 max.	1.8 max.

Table 6 (concluded)

Unit: % (mass fraction)

Symbol	Chemical composition ^{a), b), c)}									
	C	Si	Mn	P	S	Ni	Cr	Mo	V	Al ^{d)}
N3C 1M2	0.10 to 0.25	0.80 max.	1.75 max.	0.030 max.	0.030 max.	0.75 to 2.00	0.20 to 0.70	0.15 to 0.65	0.05 max.	1.8 max.
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Notes ^{a)} The analysis value shall be rounded to the same number of significant figures as in the specified value in the table in accordance with **JIS Z 8401**.

^{b)} “—” means that the chemical composition is not specified.

^{c)} For the symbol of tensile property of deposited metal is 59, 595, 62, 69, 76, 78, 785 or **83**, when the composition excluding iron and not specified in this table are detected in the course of **6.4** or when it is intentionally added, the total amount of elements shall be 0.50 % (mass fraction) or under. The analysis of the composition not specified in this table shall be reported when it is added intentionally.

^{d)} Applicable only to the self-shielded metal arc welding.

^{e)} 0.30 % (mass fraction) or under for the self-shielded metal arc welding.

^{f)} When not added intentionally, reporting is unnecessary.

5.4 Applicable welding position of wire

The applicable welding position of wire may differ among diameters of wire; however, when the fillet weld test is carried out in accordance with the method in **6.5**, it shall conform to the acceptance criteria given in table 7.

Table 7 Acceptance criteria for applicability of welding position

Symbol ^{a)}	Applicable welding position ^{b)}	Acceptance criteria		
		Convexity ^{c)} mm	Leg length difference ^{e)} mm	Length of incomplete penetration into root
0	PA and PB	$S < 7$: 2.0 or under	(0.5S - 0.5)	20 % or under of total weld length
1	All positions shall be any of the following. — PA, PB, PC, PD, PE, PF — PA, PB, PC, PD, PE, PG — PA, PB, PC, PD, PE, PG, PF	$S \geq 7$: 2.5 or under	or under	
Notes ^{a)} Symbol of applicable welding position ^{b)} The symbol of welding position shall be in accordance with JIS Z 3011. PA = flat position, PB = horizontal fillet position, PC = horizontal position, PD = overhead and horizontal fillet position, PE = overhead position, PF = vertical and upward position, PG = vertical and downward position ^{c)} S: Size of fillet (mm)				