SOCIALIST REPUBLIC OF VIETNAM
Ministry of Industry and Trade (MOIT)

Guideline for Technical Regulation Volume 2

Design of Thermal Power Facilities

Book 11/12

« Welding »

Final Draft

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List of Acronyms/Abbreviations

ABS	American Bureau of Shipping
API	American Petroleum Institute
AS/NZS	Australia Standards / New Zealand Standards
ASME	American Society of Mechanical Engineer
AWS	American Welding Society
BPVC	Boiler & Pressure Vessel Code
BS	British Standard
CSA	Canadian Standards Association
DIN	Deutschen Industrie Normen
EN	European Norm
FCAW	Flux Cored Arc Welding
GMAW	Metal Inert Gas Welding
ISO	International Organization of Standardization
JGA	Japan Gas Association
JIS	Japanese Industrial Standard
JPI	Japanese Petroleum Institute
JWES	Japanese Welding Engineering Society
NK	Nippon Kaiji Kyoukai
PD	Published Document
PQR	Procedure Qualification Record
SEW	Süddeutsche Elektromotoren Werke
SMAW	Shield Metal Arc Welding
YAG	Yttrium Aluminum Garnet
WPS	Welding Procedure Specification

Chapter-1. Comparison between Technical Regulation and Technical Guideline of welding

The article number of this guideline is shown in the Table-1 contrasted technical regulation with technical guideline for easy understanding.

Table- 1: Comparison between technical regulation and technical guideline of welding

Technical Regulation		Technical Guideline	
Article 228	General provision	Article 228	General provision
-1.	Necessity of welding management	-1.	Necessity for welding management
Article 229	Pressure parts	Article 229	Pressure parts
-1.	Classification by object	-1.	Classification by object
Article 230	Shape, etc. of welding parts	Article 230	Shape, etc. of welding parts
-1.	Sound welding	-1.	Sound welding

Chapter-2. Each Items of Guideline

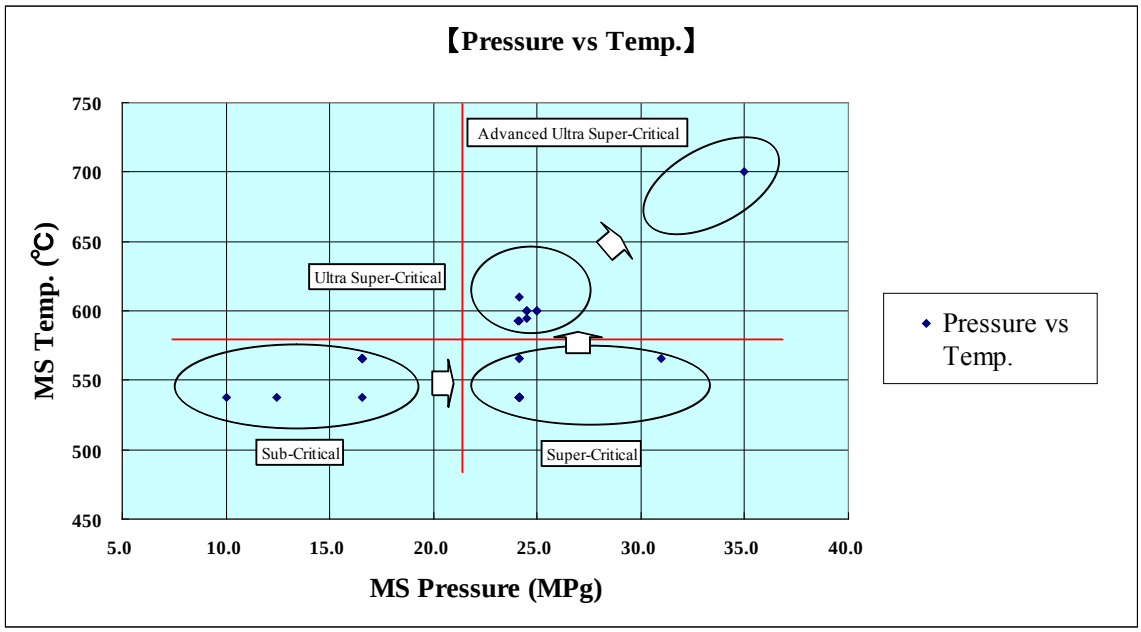
Article 228.General provision

Article 228-1. Necessity of welding management

1. The improvement of the performance of power generation facilities, reduction of manufacturing cost and conservation cost rely on the technical innovation as shown in Fig-1 and Fig-2. In response to it, the welding technology has been sophisticated and the importance of welding management and requirement on the design has become larger.
2. When manufacturing the equipment of power plant, it is often performed in the factory where environment has been well developed. On the other hand, those which must be assembled by welding in the field are often constructed depending on the skill of worker in more severe environment in terms of temperature, humidity, wind, foreign material, position and the like. Therefore, training and confirmation of welding skill of welder or welding operator will affect the quality of the product.
3. Prior confirmation of the welding procedure specification and welding management during welding work is important, though non-destructive test and pressure test after welding are also important, since it is sensitive to the quality of welding depend on not only surface but also inner one.
4. The development of welding technology is carried out followed by increasingly sophisticated and expanding the scope of progress corresponding to the object, material, equipment to use, operation condition and the like as shown in Photo-1 to Photo-24.

(1) Welding of high temperature part

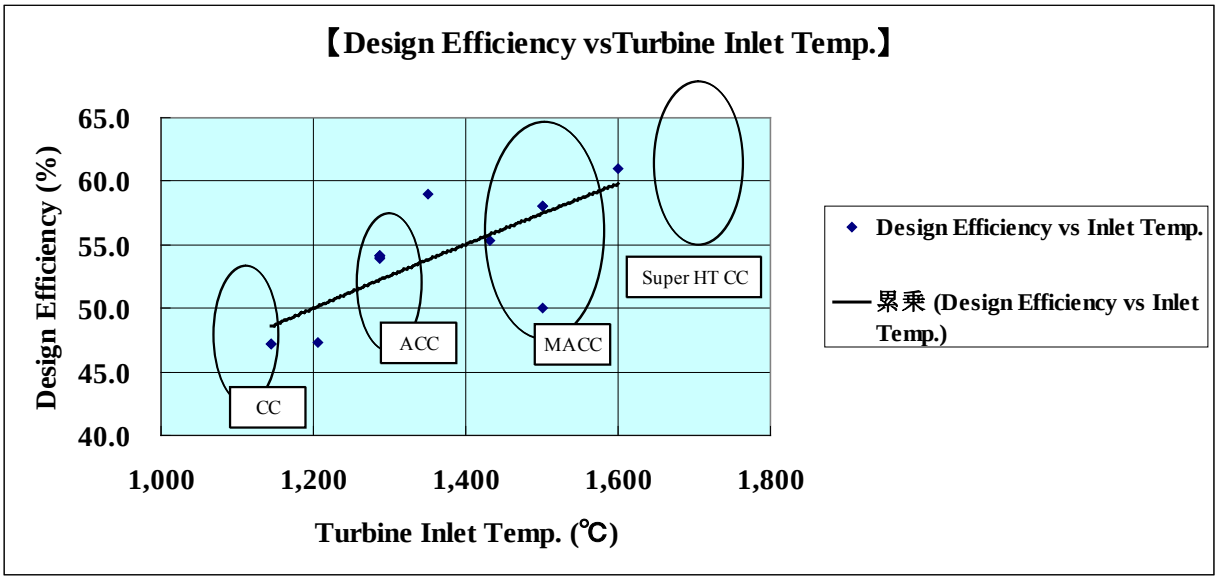
1) Temperature rise in steam boiler and steam turbine



Sub-critical	with drum type boiler	MS temperature is less than 22.1Mpa
Super Critical		MS temperature is more than 22.1Mpa and temperature is less than 566℃
Ultra Super Critical		MS temperature is more than 566℃ of Super Critical

Fig- 1: Changes in main steam temperature

2) Gas temperature rise at gas turbine inlet



CC	1100°C	Combined Cycle
ACC	1300°C	Advanced combined cycle
MACC	1450°C	More advanced combined cycle
	1500°C	
	1600°C	
Super HT CC	1700°C	Super high temperature combined cycle

Fig- 2: Changes in gas turbine inlet temperature

(2) Welding of low temperature part

1) LNG storage tank

Photo- 1: Welding of LNG tank

http://www.hydrocarbonprocessing.com/Article/2599294/LNG-storage-tanks-advancements-in-weld-inspections.html

Photo- 2: Welding of 9% Ni LNG tank

http://alltimewelding.blog.com/products/automatic-tank-welding-tank-welder/automatic-girth-welder/

(3) Welding of thick part

1) Boiler header and header

Photo- 3: Longitudinal welding of thick part

http://www.tfes.com/pressureVessel03.htm

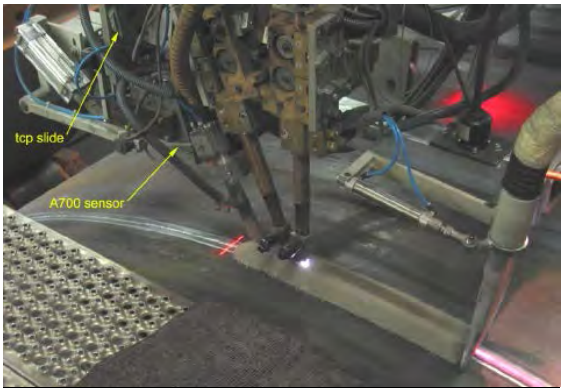


Photo- 4: Submerge arc welding

http://www.meta-mvs.com/techincal-papers/LaserTrackingSAWMultiPass.pdf

2) Welding of heavy wall pipe

Photo- 5: Welding of thick parts

http://www.morimatsu.jp/industrial/03.html

Photo- 6: Welding of heavy wall piping

http://matc.edu/robot/01Deep_Groove_Robotic_GMAW_Welding.pdf

(4) Welding of thin part

1) Membrane welding of LNG inner tank

Photo- 7: Plasma automatic welding of LNG membrane

http://www.kilony.com/V6/0001M.pdf

Photo- 8: Membrane

http://www.tokyo-gas.co.jp/techno/stp3/project/k2d1.html

2) Welding of gas turbine combustor

Photo- 9: Welding of GT combustor (MHI)

http://www.mpshq.com/service/gas_turbine_service/component_repair.html

Photo- 10: Laser beam welding of GT swirler

http://www.hitekmfg.com/Products/CasingsCombustors.aspx

(5) Hard-facing by welding or overlay welding

1) Hard-facing of crusher and roller

Photo- 11: Crusher hammers after repair

http://www.teknobirindustrial.com/teknobir_industrial_hardfacing_coating.html

Photo- 12: Hard-facing repair of screw conveyor

http://weldingshow.eventplatform.jp/find/show/286?preference_type_id=1&event_id=35

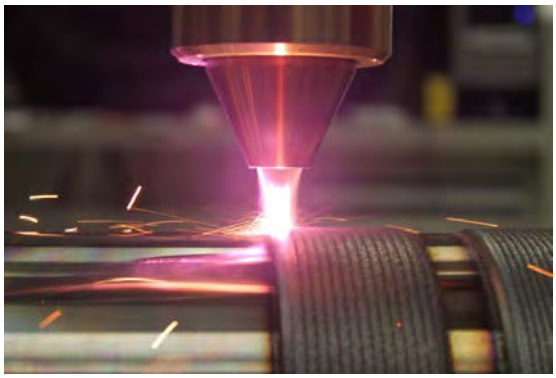


Photo- 13: Hard-facing of roller laser welding

http://spraywerx.com/coax-laser-cladding-systems

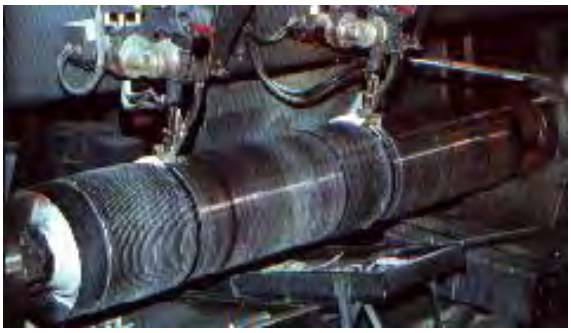


Photo- 14: Hard-facing welding of roller

http://www.lincolnelectric.co.jp/HP%20Tech/Consumables/Hardface/Hardface.htm

2) Hard-facing repair welding of coal mill parts

Photo- 15: Repair welding of roller tire

http://www.jungwonco.co.kr/rt2.html

Photo- 16: Hard-facing of roller table

http://www.remoterm.com/catalogue/VRM_Flyer_English.pdf

3) Overlay welding of boiler water wall

Photo- 17: Overlay welding of incineration boiler

http://www.waj.co.jp/images/integra_jp/hydro/BoilerPanel2.html

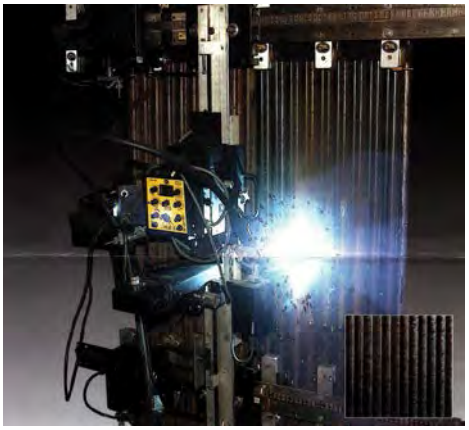


Photo- 18: Overlay welding of boiler furnace wall

http://news.thomasnet.com/news/welding-equipment-supplies/800

(5) Diversification of welding method

1) Assembly of gas turbine rotor by laser welding

Photo- 19: Laser welding of gas turbine rotor (ALSTOM)

http://www.power-technology.com/projects/flamanvillenuclear/flamanvillenuclear5.html

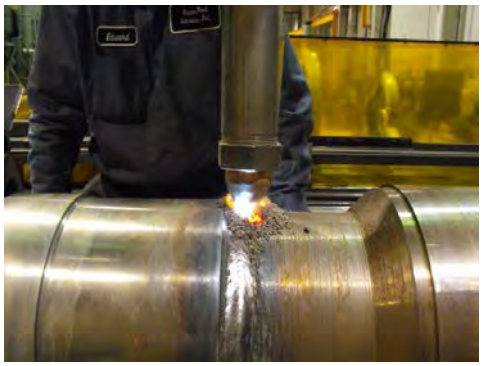


Photo- 20: Submerged arc welding of GT rotor

http://www.ppsvcs.com/services/repair-field-machining

2) Welding of subsea pipeline

Photo- 21: Divers welding subsea pipeline

http://www.oceaneering.com/3951/oceaneering-divers-welding-subsea/

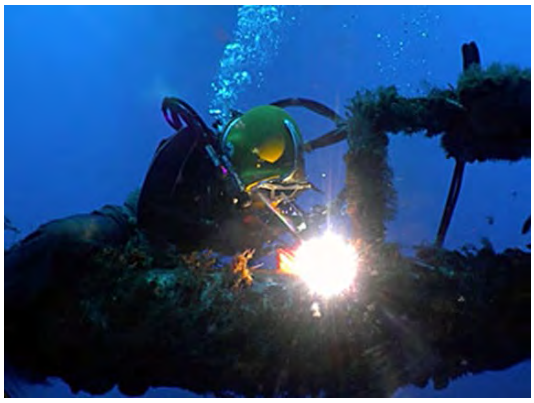


Photo- 22: Divers welding subsea pipeline

http://rangeroffshoreinc.com/pipeline_subsea_construction.htm

(6) Welding of special material

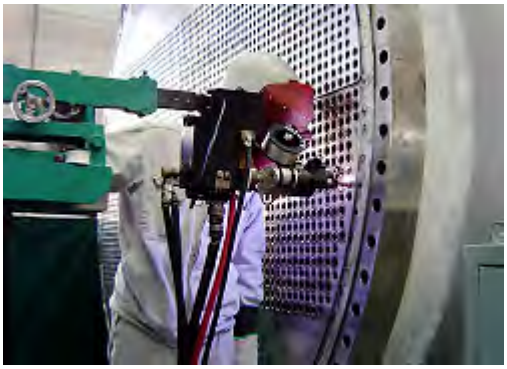


Photo- 23: Titanium seal welding of tube

http://www.morimatsu.jp/industrial/03.html

Photo- 24: Aluminum welding of IPB

http://www.lilama45-1.com/index.php?do=subcat&id=8

Article 229.Pressure parts

Article 229-1.Classification by object

1. Classification pressure items in the power plant

Table- 2: Classification pressure items in the power plant

Pressure item	Classification			
(1) Boiler (2) Independent SH (3) Independent economizer (4) Steam accumulator (5) Heat exchanger (6) Liquefied gas storage tank (7) Liquefied gas vaporizer (8) Gasholder (9) Piping (outside diameter 150mm and more)	For water	Vessel and piping	100ºC≤ T	Longitudinal joint: 5kg/cm^2 ≤ P (vessel: 1kg/cm^2 ≤ P)
				Circumference: 10kg/cm^2 ≤ P (vessel: 1kg/cm^2 ≤ P)
			T<100ºC	20kg/cm^2 ≤ P
	For liquefied gas	Vessel		0kg/ cm^2 ≤ P
		piping		0kg/ cm^2 ≤ P
	Others			Longitudinal joint: 5kg/cm^2 ≤ P (vessel: 1kg/cm^2 ≤ P)
				Circumference: 10kg/cm^2 ≤ P (vessel: 1kg/cm^2 ≤ P)

Note: 1kg/cm^{2}abs=0.098MPa

Article 229-2. Classification by pressure

1. Classification by operation pressure and temperature

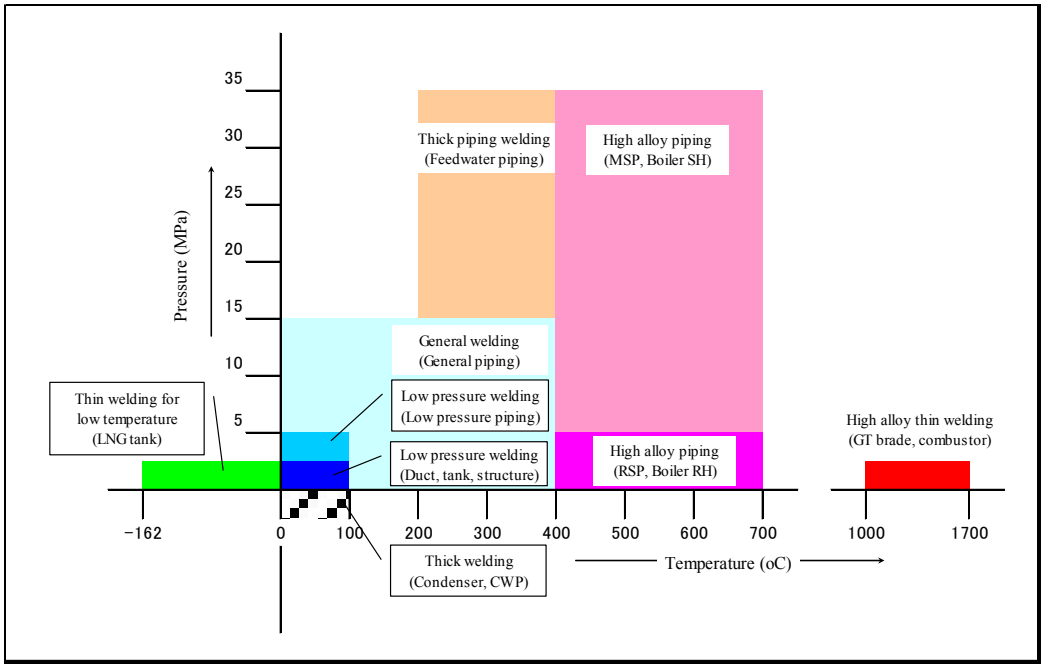


Fig- 3: Conceptual schematic of welding object in the power plant

Article 230. Shape, etc. of welding parts

Article 230-1. Sound welding

1. General requirement

"Shall not have a discontinuous and peculiar shape" stipulated in design technical regulation Article 230-1 must be pursuant as follows;

(1) "Those which have not a discontinuous and peculiar shape" stipulated in design technical regulation Article 230-1-(1) means those which has not discontinuous and peculiar shape such as sharp notch considering with welding groove when designing welding joint.

(2) "Those which is with no fear of cracks due to welding" stipulated in design technical regulation Article 230-1-(2) means those which is confirmed by non-destructive examination and has no fear of cracks due to welding. "to be no harmful lack of fusion or other defects to keep solidness of welding part" means those which has proper design and shape of welding joint to prevent lack of fusion and has no fear of cracks on the surface or inside of welding part.

(3) "Non-destructive examination" stipulated in design technical regulation Article 203-1-(2) means the radiographic examination, ultrasonic examination, magnaflux examination, liquid penetrant examination, visual inspection and the like.

(4) "Shall have the appropriate strength" stipulated in design technical regulation Article 230-1-(3) means to confirm that has mechanical strength more than equal to the base metal by the welding

procedure test or pressure test and the like.

(5) "Which have been confirmed beforehand" stipulated in design technical regulation Article 230-1-(4) means those which the welding procedure, welding equipment and welder has been confirmed as appropriate in advance. The welding procedure specification must be confirmed by welding procedure examination or mechanical examination and the like.

2. Welding standards

There are many voluntary standards related to the welding procedure and welder qualification in each country, in each field and each domain, for example, building structure, storage tank, pipeline, pressure vessel and the like. The reliable and proven international standards have been observed, though TCVN will be applied to the welding of power facility in Vietnam in preference. The international standards related to welding such as ASME, API, BS, ISO, EN, AWS and the like are organized in Table-32, JIS standards related to welding are organized in Table-33, TCVN related to welding are organized in Table-34.

In addition, the comparison between JIS standards and international standards related to welding are organized in Table-30 and 31. Blank part is the part that needs to be verified on the perusal.

3. Welding procedure

(1) Who performing welding work must carry out welding according to the appropriate welding method depending on the welding method as shown in Table-3, items to be confirmed as shown in Table-4, every element as shown in Table-6, by the testing method as shown in Table-8.

Table- 3: Classification of welding method

Class. of welding method	Type	Hand		Auto.
		Hand	Semi -auto	
A	Shield metal arc welding (both side welding or one side welding with backing strip)	O	—	—
A_O	Shield metal arc welding (one side welding without backing strip)	O	—	—
G	Gas welding	O	—	—
T	Tig welding (one side welding without backing strip)	O	O	—
T_B	Tig welding (both side welding or one side welding with backing strip)	O	O	—
T_F	First layer Tig welding (without backing strip)	O	O	—
T_{FB}	First layer Tig welding (with backing strip)	O	O	—
M	Mig welding (both side welding or one side welding with backing strip)	—	O	—
M_O	Mig welding (one side welding without backing strip)	—	O	—
PA	Plasma arc welding	O	O	—
J	Submerge arc welding	—	—	O
E_S	Electro slag welding	—	—	O
E_O	Electro gas welding	—	—	O
ST	Tig welding	—	—	O
SM	Mig welding	—	—	O
SPA	Plasma arc welding	—	—	O

Note-1: When the welding is performed in combination of two or more welding method, each combination must be a classification respectively.

Note-2: Mag welding must be included in Mig welding.

Reference: Appendix-7 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 4: Check item for welding procedure

Welding method / Items to be confirmed	A	A_o	G	T	T_B	T_F	T_{FB}	M	M_O	PA	J	E_S	E_G	ST	SM	SPA
Base metal	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Welding rod	O	O	O	—	—	—	—	—	—	—	—	—	—	—	—	—
Weld metal	O※1	O※1	O※1	—	—	—	—	—	—	—	—	—	—	—	—	—
Pre-heat	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Post heat treatment	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Sealed gas	—	—	—	O	O	O	O	O	O	O	—	—	O	O	O	O
Gas shield from back	—	—	—	O	O	O	O	O	O	O	—	—	O	O	O	O
Filler metal	—	—	—	O	O	O	O	O	O	O	—	—	—	O	—	O
Weld insert	—	—	—	O	—	O	—	—	—	O	—	—	—	O	—	O
Electrode	—	—	—	O※2	O※2	O※2	O※2	O	O	O※2	O	O	O	O	O	O
Flux	—	—	—	—	—	—	—	—	—	—	O	O	—	—	—	—
Core wire	—	—	—	—	—	—	—	O	O	—	O	O	O	—	O	—
Welding machine	—	—	—	O※2	O※2	O※2	O※2	O	O	O※2	O	O	O	O	O	O
Layer	—	—	—	—	—	—	—	—	—	—	O	O	O	O	O	O
Thickness of base metal	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Nozzle	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
Electric voltage & current	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
Weaving	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
Backing strip	—	—	—	—	—	—	—	—	—	—	—	O	O	—	—	—
Impact test	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Note:

(1) The symbol and type of welding method is shown in Table-3.

(2) "O" symbol shows the items to be confirmed.

(3) Shield gas must include replacement gas when the classification of orifice gas for plasma arc welding and the classification of base metal are P-51 or P-52 as shown in Table-5 and performing welding in the closed vessel.

(4) The core wire must include the flux shield wire.

(5) "Remark-1"in the column "weld metal" must be confirmed in case of steel.

(6) "Remark-2"in the column "electrode" must be confirmed in case of semi-auto. Welding machine.

(7) A combination welding as shown in note of Table-3 must be confirmed related all items.

Reference: Appendix-8 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 5: Classification of base metal

Classification of base metal	Group No.	Type
P-1	—	Carbon steel
P-3	1	Molybdenum steel which sum of standard content of alloy is 2.75% or less and minimum tensile strength is less than 480N/mm^2 by the standard (excluding those which standard chromium alloy content is more than 0.75%)
	2	Molybdenum steel which sum of standard content of alloy is 2.75% or less and minimum tensile strength is at least 480N/mm^2 and less than 550 N/mm^2 by the standard (excluding those which standard chromium alloy content is more than 0.75%)
	3	Molybdenum steel which sum of the standard component of alloy is 2.75% or less and minimum tensile strength is at least 550N/mm^2 and less than 660N/mm^2 by the standard (excluding those which standard chromium alloy content is more than 0.75%)
P-4	—	Chromium molybdenum steel, chromium nickel steel or nickel molybdenum steel which sum of standard content of alloy is 2.75% or less (excluding those which standard chromium alloy content is more than 2.0% and listed in P-3).
P-5	1	Chromium molybdenum steel having sum of standard content of alloy is more than 2.75% and 5% or less (excluding those which standard chromium alloy content is more than 3.5%)
	2	Chromium molybdenum steel having sum of standard content of alloy is more than 5% and 12% or less
P-6	—	Martensitic stainless steel
P-7	—	Ferritic stainless steel
P-8	—	Austenitic stainless steel
P-9A	—	Nickel steel which standard content of nickel alloy is 2.5% or less
P-9B	—	Nickel steel which standard content of nickel alloy is more than 2.5% and 3.50% or less
P-11A	1	Nickel steel which standard content of nickel alloy is more than 3.5% and 9.0% or less
	2	Steel alloy which minimum tensile strength is at least 660 N/mm^2 and less than 730 N/mm^2 by the standard (excluding those listed in group 1)
P-11B	—	Steel alloy which minimum tensile strength is at least 730 N/mm^2 by the standard
P-21	—	Aluminum having aluminum content at least 99%, Aluminum manganese alloys having manganese content at least 1.0% and 1.5% or less
P-22	—	Aluminum alloys having magnesium content at least 2.0% and 3.9% or less
P-23	—	Aluminum silicon magnesium alloys having magnesium content at least 0.45% and less than 1.4%, silicon content at least 0.2% and 0.8% or less
P-25	—	Magnesium aluminum alloy having magnesium content more than 3.9% and 5.6% or less
P-31	—	Copper and copper alloys other than those listed in P-35, P-34 and P-35
P-32	—	Naval brass for condenser or naval brass
P-34	—	Cupronickel or cupronickel for condenser
P-35	—	Aluminum bronze
P-42	—	Nickel-copper alloys having standard nickel alloy component of 66.5% or less, and standard standard copper alloy component of more than 25% and 33% or less
P-43	—	Nickel-chromium-iron alloy
P-45	—	Nickel-chromium alloy iron
P-51	—	Titanium which minimum tensile strength is t 340N/mm^2 or less by the standard
P-52	—	Titanium which minimum tensile strength is more than 340N/mm^2 by the standard

Reference: Appendix-9 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 6: Classification of the elements of the check items

Items to be confirmed	Classification of the elements
Base metal: (P-No.)	The classification of base metal must be pursuant to the classification as shown in Table-5, if there is in that table. (However, every group number in that table, in case of P-5 and P-11A). If there is no classification, the combination of type of base metal and component and the combination of different base metal must be considered as a classification.
Welding rod (F-No.)	The classification of welding rod must be pursuant to the classification as shown in Table-25, if there is in that table. If there is no classification, the combination of type of welding rod and component and the combination of different welding rod must be considered as a classification.
Weld metal (A-No.)	The classification of weld metal must be pursuant to the classification as shown in Table-26, if there is in that table. If there is no classification in that table, each one must be considered as a classification.
Pre-heat	The classification of shield gas must be pursuant as follows; 1. "Applying or not" is considered as a classification. When heating and cooling in order to remove moisture, it must be classified as "non-applying". 2. When performing pre-heating, the lower temperature must be considered as a classification.
Post heat treatment	The classification of shield gas must be pursuant as follows; 1. "Applying or not" is considered as a classification. 2. The combination of lowest retention temperature and minimum retention time for thickness of unit welding part must be considered as a classification.
Shield gas	The classification of shield gas must be pursuant as follows; 1. "Using or not" is considered as a classification. 2. The combination of shield gas must be considered as a classification.
Gas shield from back	The classification of gas shield from back must be pursuant as follows; 1. "Using or not" is considered as a classification. 2. When conforming to the test with no back shield, gas shield from back must be considered as a classification, regardless of above. (1)
Filler metal (R-No.)	The classification must be pursuant to Table-27 and combination of type and component of filler metal must be considered as a classification.
Weld insert	The classification of shield gas must be pursuant as follows; 1. "Using or not" is considered as a classification. 2. When using weld insert, the classification must be pursuant to Table-27 and combination of type and component of weld insert must be considered as a classification.
Electrode	Number of electrode must be considered a classification.
Flux	Brand of flux (including combination of type and component) must be considered a classification.
Core wire	The classification must be pursuant to Table-27 and combination of type and component of core wire must be considered as a classification.
Welding machine	"Automatic or semi-automatic welding machine" is considered as a classification.
Layer	The classification of layer must be pursuant as follows; 1. "Multi-layer or single layer" is considered as a classification. 2. When performing multi layer welding after passing test for the single layer, it must be considered as a classification. (1)
Thickness of base metal	The classification of thickness of base metal must be pursuant as follows; 1. The upper limit of thickness for base metal must be considered as a classification. 2. Notwithstanding the preceding item, (1)
Nozzle	"Consumable or not" is considered as a classification of nozzle.
Electric voltage & current	The classification of backing strip must be pursuant as follows; 1. "Electric voltage and current" is considered as a classification. 2. When the value of voltage and current is within the range of 15% regardless of item-1., it must be considered as a classification. (1)

Items to be confirmed	Classification of the elements
Weaving	The classification of backing strip must be pursuant as follows; 1. "Weaving or not" is considered as a classification. 2. "Width of weaving, frequency and stop time is considered as a classification when weaving in above case.
Backing strip	The classification of backing strip must be pursuant as follows; 1. "Using or not" is considered as a classification. 2. "Non-ferrous or non-melting" is considered as a classification when using backing strip in above case.
Impact test	If impact test is required, the lower temperature limit of impact test must be one classification.

Note: (1) It must be the classification of welding.

Reference: Appendix-10 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

(2) The welding and equipment as shown in Table-7 must be performed according to the welding procedure that conforms to the impact testing.

Table- 7: Impact test temperature

Classification of equipment	Classification of welding part	Impact test temperature
Liquefied gas facility	Longitudinal joint and circumferential joint	Minimum operating temperature

Note: The following classification of welding part of the liquefied gas facility must be excluded.

1) Welding part with thickness less than 4.4mm.

2) Welding part with minimum operation temperature more than 30°C.

3) Following welding part other than 1) or 2).

a. Classification of base metal is P-8 (limited to those contain carbon less than 0.10%) or heat affected zone of no-ferrous metal.

b. Welding part welded by austenic stainless steel, nickel chromium iron alloy steel or no-ferrous metal.

Reference: Appendix-12 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

(3) Criterion

1) When performing the test for welding procedure performance specification (WPS), it must conform to the criterion as stipulated in Table-8.
2) When performing the impact test as prescribed in preceding paragraph, it must conform to the criterion as stipulated in Table-8.

Table- 8: Test method and criterion for welding procedure qualification test

Testing method	Criterion
1. Thickness of test piece must be as follow; (1) The value from 1/2 of upper limit value to upper limit value of the thickness of base metal classified in the elements of check item (hereinafter referred "thickness of base metal" except in case of (2) to (4). (2) The following cases, the value of the upper limit of thickness of the base metal; 1) When the outside diameter is 140mm or less and the upper limit of thickness of base metal is more than 19mm, if the test piece to check is piping. 2) 32mm in P-1, 13mm in P-3, if the classification of base metal as shown in Table-5 is P-1 and P-3 and the lower limit of pr-heating temperature is 100°C. 3) The classification of base metal as shown in Table-5 is P-11A-1, P-11A-2 and P-11B. 4) When performing one side and one layer welding, in case of gas welding, Tig welding, plasma arc welding and semi-auto. Welding or automatic welding. 5) When welding on both sides as to make more servings on each side (limited to in case that thickness of base metal is more than 50mm). (3) Value from 0.9 times of upper limit of thickness of base metal to upper limit, in case of electro-slug welding or electro-gas welding. (4) Greater than equal to the thickness which can be collected specimen for v-notch test as stipulated in JIS Z2202-1998 "impact test specimen of metal material" other than from (1) to (3), in case performing impact test. 2. The method to install test piece as follow. However, if it is not proper when using special automatic welding machine, it must be the actual position. (1) Downward, if the test piece is a plate. (2) Horizontal mounting or horizontal rotation, if the test piece is piping. 3. The type, number and position of test specimen must be pursuant to Fig-4, 5 and Fig-6. 4. The shape and dimension and testing method must be pursuant as follows; (1) In case of butt welding; 1) Joint tensile test must be pursuant to the test specimen and test method according to the type of test as shown in *"the test method"*. 2) Bending test must be pursuant to the test specimen and test method according to *"the test method"*. However, the face bend test must be equivalent to the root bend test. 3) Impact test must be pursuant to the test specimen and test method according to *"the test method"*.	1) Criterion of joint tensile test must be pursuant to the test specimen and test method according to *"the test method"*. 2) Criterion of bend test must be pursuant to the test specimen and test method according to *"the test method"*. 3) Criterion of impact test for liquefied gas facility must be pursuant to the test specimen and test method according to *"the test method"*.

Note: "The test method" means the method for joint tensile test, guide bend test, roller bend test, impact test.

Reference: Appendix-11 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

(4) Welding equipment

1) The type and capacity of welding machine and equipment for post heat treatment must conform to its welding procedure.

Table- 9: Welding procedure specification (WPS)

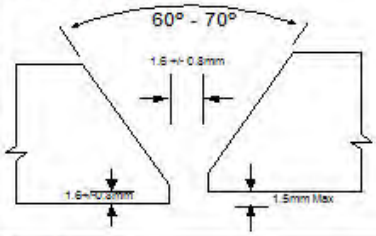
Welding Procedure Specification

Client:	Mobil	Project:	221010Goatee	REF No.	WPS 6 R1
Procedure Description:	12" Heavy Wall Offshore Tie-in				0290/1/WPS5
Material:	AS3679.1 Grade 250API 5L X65	Diameter:	168.3	Thickness:	18.3
Position:	6G	Clamp Type:	Internal		
Preheat °C (Min):	100	Interpass °C (Max):	300		

	ROOT	HOT PASS	FILL & CAP
Welding Process	SMAW	SMAW	SMAW
Welding Direction	Vertical Down	Vertical Down	Vertical Down
Filler	Lincoln SA70+	Lincoln SA70+	Bohler BVD90M
Polarity	DC +ve	DC +ve	DC +ve
Shielding Gas	N/A	N/A	N/A
Purge Gas	N/A	N/A	N/A

Pass No	Filler Size (mm)	Amps	Volts	Speed (mm/sec)	Heat Input (kJ/mm)
1	3.2mm	70-130	18-33	3.3-6.6	0.4-0.8
2	4.0mm	110-210	18-35	2.9-6.8	0.6-1.3
FILL	4.0mm	145-260	16-27	1.6-7.0	0.6-2.2
CAP	4.0mm	130-230	16-26	1.8-5.3	0.6-1.7

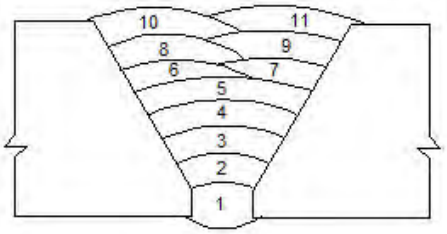
Weld Preparation



NOTES

1. API Std 1104BP3094-SP-PL-3010R1
2. Clamp removal stage : **100% completion of root (external clamp may be used in the event of a breakdown – removed after 50% minimum completion of the root.)**
3. Time lapse between root and second pass : **16 Minutes**
4. Time lapse between second pass and 1st fill : **12 Minutes**
5. Minimum number of passes before pipe movement : **2 passes**
6. Minimum number of passes before break in welding : **3 passes**
7. Minimum Number of welders- **Root & second pass: 2 , Fill & Cap : 1**
8. Method of cleaning : **Grinder / Wire brush**
9. Method of Preheat : **Gas Torch**
10. Qualification reference number : **48280/PP/WP6 R1**

Pass Location



Company Welding Engineer Approved ..... **Approved for Client** .....

Table- 10: Welding procedure qualification record (PQR)

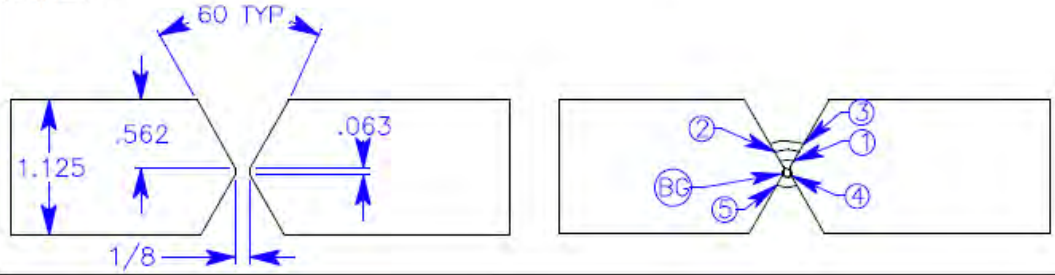
WELDING PROCEDURE SPECIFICATION

Welding Procedure Specification No. FERMI CS-2 Date 1/8/2008
Revision No. 1*changed joint root gap Date 01/16/08 Supporting PQR No.(s) FERMI CS-2
Welding Processes 1) SMAW Type 1) Manual
2) Type 2)
(Manual, Auto, Semi)

JOINTS (QW-402)

Joint Design Double "V" Backing: Yes X No
Backing Material (Type) Root: Base Metal Remainder: Filler metal
Retainer: Yes No Type: Non-Metallic Metallic (non-fusing)

DETAILS *



BASE METALS (QW-403)

P No. 1 Group 1 To P No. 1 Group 1
Specification Type and Grade SA 105 to SA 105
To Specification Type and Grade
OR
Chemical Analysis and Mech. Properties
To Chemical Analysis and Mech. Properties

Thickness Range:	PROCESS 1		PROCESS 2	
Base Metal	Groove 3/16-2.25	Fillet unl	Groove	illet
Deposited Weld Metal	Groove 3/16-2.25	Fillet unl.	Groove	Fillet
Pipe Diameter Range	Groove 2 7/8 min	Fillet unl.	Groove	Fillet

FILLER METALS (QW-404)	PROCESS 1	PROCESS 2
Specification No. (SFA)	5.1	
AWS No. (Class)	E7018	
F-No.	4	
A-No.	1	
Size of Filler Metals	3/32, 1/8, 5/32, 3/16	
Deposited Weld Metal Thickness Range	Groove 3/16-2.25 Fillet 2.25 max	Groove Fillet
Electrode-Flux (Class)	N/A	
Flux Trade Name	N/A	
Consumable Insert	None	

EACH BASE METAL-FILLER METAL COMBINATION SHOULD BE RECORDED INDIVIDUALLY

WELDING PROCEDURE SPECIFICATION

FERMI CS-2

POSITIONS (QW-405)

Positions of Groove 1G

Welding Progression: Up n/a Down

Positions of Fillet N/A

POSTWELD HEAT TREATMENT (QW-407)

Temperature Range None

Time Range

Other

PREHEAT (QW-408)

Preheat Temperature Minimum 32°F

Interpass Temperature Maximum Not Measured

Preheat Maintenance

Minimum Temperature for Welding 32°F

GAS (QW-408)

	Gas(es)	Percent Composition Mixture	Flow Rate
Shielding	N/A		
Trailing	N/A		
Backing	N/A		

ELECTRICAL CHARACTERISTICS (QW-409)

Current AC or DC Direct Polarity Reverse Characteristics:

AMPS (Range) See Chart Volts (Range) See Chart

Tungsten Electrode Size and Type N/A

Mode of Metal Transfer for GMAW N/A

Electrode Wire Feed Speed Range N/A

TECHNIQUE (QW-410)

String or Weave Bead String or weave. Weave not to exceed 1/8 wide

Orifice or Gas Cup Size N/A

Initial Interpass Cleaning (Brushing, Grinding, etc.) Grind flame cut 1/16 minimum. Wire brush with steel brushes between passes. Grinding is allowed between passes.

Method of Back Gouging Arc Gouge and grind or grinding alone to clean metal

Oscillation N/A

Contact Tube to Work Distance N/A

Multiple or Single Pass (per side) Multipass

Multiple or Single Electrodes Single

Travel Speed (Range) As Required

Peening None

Other

Weld Layers	Processes	Filler Metal Class	Diameter	Current Type Polarity	Amp. Range	Volt Range	Travel Speed Range	Other (Power Source)
1-5	SMAW	E7018	3/32	DCRP	70-100	18-20		
Bal.	SMAW	E7018	1/8	DCRP	100-140	19-23		
		E7018	5/32	DCRP	120-200	20-24		

3. Welders qualification

(1) Who performing welding work must carry out welding qualification test depending on the classification as shown in Table-11, according to the testing method as shown in Table-12, 13, 14, 15 and must perform the welding by the qualified welder (limited to 2 years from the date that conforms to the test).

Table- 11: Qualification testing matters for welder (welding method)

<table>
<tr><td>Classification of items to be confirmed</td><td>Classification of detail</td></tr>
<tr><td>Welding method</td><td>Classification of welding method must be as listed
<table>
<tr><th colspan="2">Classification of welding method</th><th>Type</th></tr>
<tr><td colspan="2">A</td><td>Covered metal rod (both-side welding or one-side welding with backing strip)</td></tr>
<tr><td colspan="2">$A_o + A$</td><td>Covered metal rod (both-side welding or one-side welding)</td></tr>
<tr><td colspan="2">G</td><td>Gas welding</td></tr>
<tr><td rowspan="2">$(T, T_B, T_F) + T_{FB}$</td><td>manual</td><td rowspan="2">Tig welding (both-side welding or one-side welding) or first layer Tig welding</td></tr>
<tr><td>semi-auto</td></tr>
<tr><td rowspan="2">$T_B + T_{FB}$</td><td>manual</td><td rowspan="2">Tig welding (both-side welding or one-side welding with backing strip) or first layer Tig welding (with backing strip</td></tr>
<tr><td>semi-auto</td></tr>
<tr><td rowspan="2">$T_F + T_{FB}$</td><td>manual</td><td rowspan="2">First layer Tig welding</td></tr>
<tr><td>semi-auto</td></tr>
<tr><td rowspan="2">T_{FB}</td><td>manual</td><td rowspan="2">First layer Tig welding (with backing strip)</td></tr>
<tr><td>semi-auto</td></tr>
<tr><td colspan="2">M</td><td>Mig welding (both-side welding or onside welding with backing strip)</td></tr>
<tr><td colspan="2">$M_o + M$</td><td>Mig welding (both-side welding or onside welding)</td></tr>
<tr><td colspan="2">PA</td><td>Plasma arc welding</td></tr>
</table></td></tr>
</table>

Reference: Appendix-13 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 12: Qualification testing matters for welder (test piece and welding position)

(Other than aluminum and aluminum alloy)

<table>
<tr><td>Classification of items to be confirmed</td><td>Classification of detail</td></tr>
<tr><td>Test piece and welding position</td><td>Classification of test piece and welding position must be the combination of the classification of test piece and classification of welding position as shown in the following table.
<table>
<tr><th colspan="2">Classification base metal</th><th colspan="2">Classification of position</th><th>Workable range</th></tr>
<tr><td rowspan="20">Other than aluminum and aluminum alloy</td><td rowspan="4">W-0
(plate with thickness 3~3.2mm)</td><td>f</td><td>downward</td><td>In downward position, in base metal thickness less than 7mm</td></tr>
<tr><td>v</td><td>vertical</td><td>In vertical position of plate, in base metal thickness less than 7mm</td></tr>
<tr><td>h</td><td>horizontal</td><td>In horizontal position of plate, in base metal thickness less than 7mm</td></tr>
<tr><td>o</td><td>upward</td><td>In upward position of plate, in base metal thickness less than 7mm</td></tr>
<tr><td rowspan="4">W-1
1(plate with thickness 9mm)</td><td>f</td><td>downward</td><td>In downward position, in base metal thickness less than 19mm</td></tr>
<tr><td>v</td><td>vertical</td><td>In vertical position of plate, in base metal thickness less than 19mm</td></tr>
<tr><td>h</td><td>horizontal</td><td>In horizontal position of plate, in base metal thickness less than 19mm</td></tr>
<tr><td>o</td><td>upward</td><td>In upward position of plate, in base metal thickness less than 19mm</td></tr>
<tr><td rowspan="4">W-2
(plate with thickness at least 25mm)</td><td>f</td><td>downward</td><td>In downward position, no limitation of thickness for base metal</td></tr>
<tr><td>v</td><td>vertical</td><td>In vertical position of plate, no limitation of thickness for base metal</td></tr>
<tr><td>h</td><td>horizontal</td><td>In horizontal position of plate, no limitation of thickness for base metal</td></tr>
<tr><td>o</td><td>upward</td><td>In upward position of plate, no limitation of thickness for base metal</td></tr>
<tr><td rowspan="2">W-3-0
(pipe with diameter at least 100~120mm and thickness 4~5.3mm)</td><td>r</td><td>Horizontal fixing with wall and vertical fixing with wall</td><td>No restrictions of position and thickness of base metal is less than 11mm</td></tr>
<tr><td>e</td><td>Horizontal fixing and vertical fixing</td><td>No restrictions of position and thickness of base metal is less than 11mm (except in the case that there is restriction)</td></tr>
<tr><td rowspan="2">W-3
(pipe with diameter at least 150~170mm and thickness 9~11mm)</td><td>r</td><td>Horizontal fixing with wall and vertical fixing with wall</td><td>No restrictions of position and thickness of base metal is less than 19mm</td></tr>
<tr><td>e</td><td>Horizontal fixing and vertical fixing</td><td>No restrictions of position and thickness of base metal is less than 19mm (except in the case that there is restriction)</td></tr>
<tr><td rowspan="2">W-4
(pipe with diameter at least 200~300mm and thickness at least 20mm)</td><td>r</td><td>Horizontal fixing with wall and vertical fixing with wall</td><td>No restrictions of position and base metal thickness</td></tr>
<tr><td>e</td><td>Horizontal fixing and vertical fixing</td><td>No restrictions of position and base metal thickness (except in the case that there is restriction)</td></tr>
</table>
</td></tr>
</table>

Reference: Appendix-13 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 13: Qualification testing matters for welder (test piece and welding position)

(Aluminum and aluminum alloy)

Classification of items to be confirmed	Classification of detail
Test piece and welding position	Classification of test piece and welding position must be the combination of the classification of test piece and classification of welding position as shown in the following table.

Classification base metal		Classification of position		Workable range
Aluminum and aluminum alloy	W-10 (plate with 3mm thickness)	f	downward	In downward position, in base metal thickness less than 7mm
		v	vertical	In vertical position of plate, in base metal thickness less than 7mm
		h	horizontal	In horizontal position of plate, in base metal thickness less than 7mm
		o	upward	In upward position of plate, in base metal thickness less than 7mm
	W-11 (plate with 8mm thickness)	f	downward	In downward position, in base metal thickness less than 17mm
		v	vertical	In vertical position of plate, in base metal thickness less than 17mm
		h	horizontal	In horizontal position of plate, in base metal thickness less than 17mm
		o	upward	In upward position of plate, in base metal thickness less than 17mm
	W-12 (plate with thickness at least 20mm)	f	downward	In downward position, no limitation of thickness for base metal
		v	vertical	In vertical position of plate, no limitation of thickness for base metal
		h	horizontal	In horizontal position of plate, no limitation of thickness for base metal
		o	upward	In upward position of plate, no limitation of thickness for base metal
	W-13 (pipe with diameter at least 100~150mm and thickness 4mm)	r	Horizontal fixing with wall and vertical fixing with wall	No restrictions of position and thickness of base metal is less than 9mm
		e	Horizontal fixing and vertical fixing	No restrictions of position and thickness of base metal is less than 9mm (except in the case that there is restriction)
	W-14 (pipe with diameter at least 150~200mm and thickness 12~15mm)	r	Horizontal fixing with wall and vertical fixing with wall	No restrictions of position and thickness of base metal is less than 25mm
		e	Horizontal fixing and vertical fixing	No restrictions of position and thickness of base metal is less than 25mm (except in the case that there is restriction)
	W-15 (pipe with diameter at least 200~300mm and thickness at least 20mm)	r	Horizontal fixing with wall and vertical fixing with wall	No restrictions of position and base metal thickness
		e	Horizontal fixing and vertical fixing	No restrictions of position and base metal thickness (except in the case that there is restriction)

Reference: Appendix-13 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 14: Qualification testing matters for welder (welding rod)

<table>
<tr><td>Classification of items to be confirmed</td><td>Classification of detail</td></tr>
<tr><td>Welding rod</td><td>1. Classification of welding rod must be as shown in following table and no stipulation in the table must be one classification of the combination and the type and composition.
<table>
<tr><th colspan="2">Classification of welding rod</th><th>Type</th></tr>
<tr><td rowspan="6">Covered metal rod</td><td>F-0</td><td>Illuminate type welding rod,</td></tr>
<tr><td>F-0 and F-1</td><td>Illuminate type welding rod, high oxidation type rod, high oxide-titanium welding rod (for mild steel and high tension steel (flat, horizontal fillet), iron powder low hydrogen type welding rod (other than molybdenum and chromium steel), iron powder iron-oxide welding rod</td></tr>
<tr><td>F-0 ~ F-2</td><td>Illuminate type welding rod, high oxidation iron type rod, high oxide-titanium welding rod, iron powder low hydrogen type welding rod (other than molybdenum steel and chromium-molybdenum alloy), iron powder iron-oxide welding rod, limetitania type welding rod, high oxide-titanium welding rod</td></tr>
<tr><td>F-0 ~ F-3</td><td>Illuminate type welding rod, high oxidation iron type rod, high oxide-titanium welding rod, iron powder low hydrogen type welding rod (other than molybdenum steel and chromium-molybdenum alloy), iron powder iron-oxide welding rod, limetitania type welding rod, high oxide-titanium welding rod, high cellulose type welding rod</td></tr>
<tr><td>F-0 ~ F-4</td><td>Illuminate type welding rod, high oxidation iron type rod, high oxide-titanium welding rod, iron powder low hydrogen type welding rod, iron powder iron-oxide welding rod, limetitania type welding rod, high oxide-titanium welding rod, high cellulose type welding rod, low hydrogen type welding rod</td></tr>
<tr><td>F-5</td><td>Welding rod stainless steel</td></tr>
<tr><td rowspan="2">Gas welding rod</td><td>F-6-1</td><td>High ductility gas welding rod</td></tr>
<tr><td>F-6-2</td><td>Low ductility gas welding rod</td></tr>
<tr><td>Covered metal rod</td><td>F-40X</td><td>Welding rod for nickel, Welding rod for nickel-copper alloy, Welding rod for nickel-chromium-iron alloy, Welding rod for nickel-molybdenum-iron alloy, welding rod for nickel-chromium -molybdenum-iron alloy</td></tr>
</table>
</td></tr>
</table>

Reference: Appendix-13 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 15: Qualification testing matters for welder (Filler metal (including weld insert) or core wire)

<table>
<tr><td>Classification of items to be confirmed</td><td>Classification of detail</td></tr>
<tr><td>Filler metal (including weld insert) or core wire</td><td>2. Classification of filler metal and core wire must be as shown in following table and no stipulation in the table must be one classification of the combination and the type and composition.
<table>
<tr><th colspan="2">Classification</th><th rowspan="2">Detail classification</th></tr>
<tr><th>Filler metal</th><th>Core wire</th></tr>
<tr><td rowspan="4">R-1X</td><td rowspan="4">E-1X</td><td>Carbon steel (component of weld metal is equivalent to A-1 listed in Table-**)</td></tr>
<tr><td>Molybdenum steel (component of weld metal is equivalent to A-2 listed in Table-**)</td></tr>
<tr><td>Cr-molybdenum steel (component of weld metal is equivalent to A-3 listed in Table-**)</td></tr>
<tr><td>Cr-molybdenum steel (component of weld metal is equivalent to A-4-1 listed in Table-**)</td></tr>
<tr><td rowspan="3">R-5X</td><td rowspan="3">E-5X</td><td>Martensitic stainless steel (component of weld metal is equivalent to A-5 listed in Table-**)</td></tr>
<tr><td>Frrritic stainless steel (component of weld metal is equivalent to A-6 listed in Table-**)</td></tr>
<tr><td>Austenitic stainless steel (component of weld metal is equivalent to A-7~ A-8 listed in Table-**)</td></tr>
<tr><td rowspan="3">R-20X</td><td rowspan="3">E-20X</td><td>Aluminum</td></tr>
<tr><td>Aluminum magnesium alloy</td></tr>
<tr><td>Aluminum silicate alloy</td></tr>
<tr><td rowspan="6">R-30X</td><td rowspan="6">E-30X</td><td>Copper</td></tr>
<tr><td>Silicon bronze</td></tr>
<tr><td>Phosphor bronze</td></tr>
<tr><td>Cupronickel</td></tr>
<tr><td>Aluminum bronze</td></tr>
<tr><td>Special aluminum bronze</td></tr>
<tr><td rowspan="5">R-40X</td><td rowspan="5">E-40X</td><td>Nickel</td></tr>
<tr><td>Nickel-copper alloy</td></tr>
<tr><td>Nickel-Cr-iron alloy</td></tr>
<tr><td>Nickel-Mo-iron alloy</td></tr>
<tr><td>Iron-nickel Cr-Mo alloy</td></tr>
<tr><td>R-51</td><td>E-51</td><td>Titanium</td></tr>
</table>
</td></tr>
</table>

Reference: Appendix-13 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

(2) When it has been confirmed that welder has skill listed in the following cases, it must be deemed to have been carried out by qualified welders, notwithstanding the provisions of the preceding paragraph.

1) In the following cases of welder who do not use automatic welding machine;

a. Who passed the qualification test of welder according to "Rules for steel ship structure JP" and "Rules for safety of boiler &pressure vessel JP", passed the classification as listed in Table-11 and who perform welding depending on the Table-16.
b. Who passed the evaluation test conforming to JIS Z3801-1997 "Standard qualification procedure for manual welding technique", JIS Z3811-2000 "Standard qualification procedure for welding technique of aluminum and aluminum alloy", JIS Z3821-2000 "Standard qualification procedure for welding technique of stainless steel", JIS Z3841-1997 "Standard qualification procedure for semi-automatic welding technique", who has been issued a certificate of eligibility and who perform the welding depending on the Table-17, 18, 19, 20.
c. Who passed qualification test such as TCVN, ASME, API, ISO, EN, AWS, ABS and has valid license, certificate is capable to perform welding depending on the qualified classification.

Table- 16: Correspondence of welders' skill classification

Hand welder's skill to be confirmed			Approval testing of welder passed under other laws and regulations	
AW-1	fvho	F-0	Rules for steel ship structure	M2-type O-class-A
AW-2	fvho	F-0		M3-type O-class-A
AW-1	fv	F-0		M2-type V-class-A
AW-2	fv	F-0		M3-type V-class-A
AW-2	fvho	F-0	Rules for safety of boiler & pressure vessel	Special boiler welder
AW-1	fvho	F-0		Ordinary boiler welder

Note: If welding rods used for test is clear that the appropriate to F-1 to F-4 in the Table-18, F-0 must be read such classification.

Reference: Appendix-15 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 17: Correspondence of qualification classification between interpretations of technical regulation and JIS Z3801

《JIS Z3801》

JIS Qualification classification	A			N			G		
	Classification of qualification in interpretation of technical regulation								
1F	—	—	—	Ao	W-0	f	G	W-0	f
2F	A	W-1	f	Ao	W-1	f	G	W-1	f
3F	A	W-2	f	Ao	W-2	f	—	—	—
1V	—	—	—	Ao	W-0	v	G	W-0	v
2V	A	W-1	v	Ao	W-1	v	G	W-1	v
3V	A	W-2	v	Ao	W-2	v	—	—	—
1H	—	—	—	Ao	W-0	h	G	W-0	h
2H	A	W-1	h	Ao	W-1	h	G	W-1	h
3H	A	W-2	h	Ao	W-2	h	—	—	—
1O	—	—	—	Ao	W-0	o	G	W-0	o
2O	A	W-1	o	Ao	W-1	o	G	W-1	o
3O	A	W-2	o	Ao	W-2	o	—	—	—
1P	—	—	—	Ao	W-3-0	e	G	W-0	e
2P	A	W-3	e	Ao	W-3	e	G	W-1	e
3P	A	W-4	e	Ao	W-4	e	—	—	—

Note:

(1) Classification of welding rod must be those which used for examination in the Table-25.

(2) "—" means that there is no equivalent examination in JIS.

(3) In case of welding method "G", thickness of base metal corresponding workable range must be less than the thickness of test piece.

Reference: Appendix-16 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 18: Correspondence of qualification classification between interpretations of technical regulation and JIS Z3811

《JIS Z3811》

JIS Qualification classification	TN	MN	MA
	Classification of qualification in interpretation of technical regulation		
1F	T W-10 f	Mo W-10 f	M W-10 f
2F	T W-11 f	Mo W-11 f	M W-11 f
3F	T W-12 f	Mo W-12 f	M W-12 f
1V	T W-10 v	Mo W-10 v	M W-10 v
2V	T W-11 v	Mo W-11 v	M W-11 v
3V	T W-12 v	Mo W-12 v	M W-12 v
1H	T W-10 h	Mo W-10 h	M W-10 h
2H	T W-11 h	Mo W-11 h	M W-11 h
3H	T W-12 h	Mo W-12 h	M W-12 h
1O	T W-10 o	Mo W-10 o	M W-10 o
2O	T W-11 o	Mo W-11 o	M W-11 o
3O	T W-12 o	Mo W-12 o	M W-12 o
1P	T W-10 e	— — —	M W-13 e
2P	T W-11 e	Mo W-14 e	M W-14 e
3P	T W-12 e	Mo W-15 e	— — —

Note:

(1) The classification of filler metal of welding method M_O and M must be pursuant to the welding rod, filler metal and core wire as shown in Table-27.

(2) The Tig welding of first layer under JIS MN-2P and MN-3P does not correspond to classification of qualification in interpretation of technical regulation

(3) "—" shows no application of testing in JIS

Reference: Appendix-16 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 19: Correspondence of qualification classification between interpretations of technical regulation and JIS Z3821

《JIS Z3821》

JIS Qualification classification	CN	CA	TN	MN	MA
	Classification of qualification in interpretation of technical regulation				
F	Ao W-1 f	— — —	T W-0 f	Mo W-1 f	M W-1 f
V	Ao W-1 v	— — —	T W-0 v	Mo W-1 v	M W-1 v
H	Ao W-1 h	— — —	T W-0 h	Mo W-1 h	M W-1 h
O	Ao W-1 o	A W-1 o	T W-0 o	— — —	— — —
P	Ao W-3 e	— — —	T W-3-0 e	— — —	— — —

Note:

(1) The classification of welding rod of welding method A_O and A, the classification of filler metal of welding method T and the classification of core wire of welding method M_O and M must be pursuant to the welding rod, filler metal and core wire as shown in Table-25 or 27.

(2) "—" shows no application of testing in JIS

Reference: Appendix-16 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 20: Correspondence of qualification classification between interpretations of technical regulation and JIS Z3841

《JIS Z3841》

JIS Qualification classification	SN			SA		
	Classification of qualification in interpretation of technical regulation					
1F	Mo	W-0	f	—	—	—
2F	Mo	W-1	f	M	W-1	f
3F	Mo	W-2	f	M	W-2	f
1V	Mo	W-0	v	—	—	—
2V	Mo	W-1	v	M	W-1	v
3V	Mo	W-2	v	M	W-2	v
1H	Mo	W-0	h	—	—	—
2H	Mo	W-1	h	M	W-1	h
3H	Mo	W-2	h	M	W-2	h
1O	Mo	W-0	o	—	—	—
2O	Mo	W-1	o	M	W-1	o
3O	Mo	W-2	o	M	W-2	o
1P	Mo	W-3-0	e	—	—	—
2P	Mo	W-3	e	M	W-3	e
3P	Mo	W-4	e	M	W-4	e

Note:

(1) The classification of core wire of welding method M_O and M must pursuant to the classification of filler metal as shown in Table-27.

(2) "—" shows no application of testing in JIS

Reference: Appendix-16 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

2) In the following cases of welder who use automatic welding machine and conform to followings;

a. It was confirmed that the welder has a certain level of skill when performing test by automatic welding.
b. It was confirmed that the welder has skill according to the classification as shown in Table-3 in the method as shown pursuant to Table-21.
c. Welding procedure specification test

3) When having 1 year experience corresponding to one welding method (limited to automatic welding in the classification of welding method as shown in Table-3 or 3 months experience after passing welding qualification test.

(3) The period that is considered to be welded by skilled welders in the preceding paragraph must be as follows;

1) 2 years from the date when passed the examination and certified of such skill in case preceding paragraph-1).
2) 10 years from the date when passed the examination of such skill in case of preceding paragraph-2).

(4) Criterion

1) When performing welding qualification test for welder, they must conform to the criterion as shown in Table-11 depending on the test items as shown in Table-21.

Table- 21: Approval testing of welder and criterion (other than aluminum or aluminum alloy)

<table>
<tr><th>Classification of test piece</th><th>Test method</th><th>Criterion</th></tr>
<tr><td>Other than aluminum or aluminum alloy</td><td>Test method must be pursuant to JIS Z3801-1997 “standard qualification procedure for manual welding technique” except following cases;
1. Welding method, test piece, welding position, welding rod, filler metal and core wire must be pursuant to the detail classification according to the classification of test items in Table-11.
2. In case of 1., classification of welding method listed in left column of the following table must conform to the method listed in the right column.
<table>
<tr><th>Classification of welding method</th><th>Welding method</th></tr>
<tr><td>A_o and A</td><td>A_o</td></tr>
<tr><td>T, T_B, T_F and T_{FB}</td><td>T</td></tr>
<tr><td>T_B and $_{TFB}$</td><td>T_B</td></tr>
<tr><td>T_F and $_{TFB}$</td><td>T_F</td></tr>
<tr><td>M_o and M</td><td>M_o</td></tr>
</table>
3. In case of 1., classification of welding rod listed in left column of the following table must conform according to the method listed in the right column.
<table>
<tr><th>Classification of welding rod</th><th>Welding rod</th></tr>
<tr><td>F-0</td><td>F-0</td></tr>
<tr><td>F- 0 and F-1</td><td>F-1</td></tr>
<tr><td>F-0 ~ F-2</td><td>F-2</td></tr>
<tr><td>F-0 ~ F-3</td><td>F-3</td></tr>
<tr><td>F-0 ~ F-4</td><td>F-4</td></tr>
<tr><td>F-5</td><td>F-5</td></tr>
<tr><td>F-6-1</td><td>F-6-1</td></tr>
<tr><td>F-6-2</td><td>F-6-2</td></tr>
<tr><td>F-41 ~ F-45</td><td>any of F-41 ~ F-45</td></tr>
</table>
4. In case of 1., classification of filler metal listed in left column of the following table must conform according to the method listed in the right column.
<table>
<tr><th>Classification of filler metal</th><th>Filler metal</th></tr>
<tr><td>R-1 ~ R-4-2 and R-10</td><td>any of R-1 ~ R-4-2 and R-10</td></tr>
<tr><td>R-5 ~ R-8</td><td>any of R-5 ~ R-8</td></tr>
<tr><td>R-21 ~ R-23</td><td>any of R-21 ~ R-23</td></tr>
<tr><td>R-31 ~ R-34, R-36 and R-37</td><td>any of R-31 ~ R-34, R-36 and R-37</td></tr>
<tr><td>R-41 ~ R-45</td><td>any of R-41 ~ R-45</td></tr>
<tr><td>R-51</td><td>R-51</td></tr>
</table>
5. In case of 1., classification of core wire listed in left column of the following table must conform according to the method listed in the right column.</td><td>According to JIS Z3801 Cracks occur on the corner edge must be excluded from the criterion in the bend test (no more than 3.0mm length crack).</td></tr>
</table>

Classification of test piece	Test method	Criterion

Classification of core wire	Core wire
E-1 ~ E-4-2 and E-10	any of E-1 ~ E-4-2 and E-10
E-3 ~ E-8	any of E-3 ~ E-8
E-21 ~ E-23	any of E-21 ~ E-23
E-31 ~ E-34, E-36 and E-37	any of E-31 ~ E-34, E-36 and E-37
E-41 ~ E-45	any of E-41 ~ E-45
E-51	E-51

6. Type of test piece must be appropriate for the welding.
7. If the classification of combination of test piece and welding position is W-3-0r, W-3r and W-4r, the dimension, location to install and specimen collection position must be pursuant to Fig-4.
8. If the classification of welding method is other than A, (A_o+A) and G as shown in Table-11, shape and dimension of joint must be appropriate for such welding method, and (T_B+T_{FB}), T_{FB}, M or PA must be one side welding.
9. If the classification of welding method is (T_F +T_{FB}) and T_{FB} as shown in Table-11, must be pursuant as follows;

(1) The name of welder, welding method and welding position of other than first layer does not matter. The welding other than first layer must be performed by welders who have reliable workmanship and the weld metal must be comparable to that of the first layer in this case.

(2) The number of specimens must be the sum of specimens for face bend, side bend, root bend as shown in Fig-4 and attachment drawing-3, 4, 5, 6, 7 or 8 of JIS Z3802. All specimens must be tested by root bend test.

Reference: Appendix-14 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 22: Approval testing of welder and criterion (aluminum or aluminum alloy)

Classification of test piece	Test method	Criterion
Aluminum or aluminum alloy	Test method must be pursuant to JIS Z3811-2000 "standard qualification procedure for manual welding technique" except following cases; 1. Welding method, test piece, welding position, filler metal or core wire must be pursuant to the detail classification as shown in Table-11. 2. If the classification of test piece is W-13r, W-14r and W-15r as shown in Table-23, the dimension, location to install method and specimen collection position must be pursuant to Fig-4. 3. If the classification of test piece is other than aluminum or aluminum alloy, item-5 and -6 of above table must be applied mutatis mutandis.	According to JIS Z3811 Cracks occur on the corner edge must be excluded from the criterion in the bend test (no more than 3.0mm length crack).

Reference: Appendix-13 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

(5) Accreditation of skills

1) The welder who passed the welding qualification test can weld according to qualified skill 2 years from the date when conforming or passing to the latest inspection before the day on which expires 2 years.

2) When conforming to the inspection of Electric Utility Law.

3) When passing to either following inspection;

a. Inspection according to ship safety law; or
b. Inspection according to rules for safety of boiler & pressure vessel; or
c. Inspection according to high pressure gas safety law; or
d. Inspection according to Japan Welding Engineering Society or;
e. Inspection according to Japan Petroleum Institute; or
f. Equivalent inspection according to TCVN, ASME, AWS, API, ABS, EN, ISO and the like.

4) 3) must be applied mutatis mutandis to the automatic welding. In this case, "2 years" must be read "10 years".

(6) Workable range

The workable range such as position, thickness of base metal of welding that is performed by the qualified welder must be the range as shown in Table-23 depending on the test piece or position in

that Table.

Table- 23: Classification of test material, position and workable range

(other than aluminum or aluminum alloy)

Classification base metal		Classification of position		Workable range
Other than aluminum and aluminum alloy	W-0 (plate with thickness 3~3.2mm)	f	downward	In downward position, in base metal thickness less than 7mm
		v	vertical	In vertical position of plate, in base metal thickness less than 7mm
		h	horizontal	In horizontal position of plate, in base metal thickness less than 7mm
		o	upward	In upward position of plate, in base metal thickness less than 7mm
	W-1 (plate with thickness 9mm)	f	downward	In downward position, in base metal thickness less than 19mm
		v	vertical	In vertical position of plate, in base metal thickness less than 19mm
		h	horizontal	In horizontal position of plate, in base metal thickness less than 19mm
		o	upward	In upward position of plate, in base metal thickness less than 19mm
	W-2 (plate with thickness at least 25mm)	f	downward	In downward position, no limitation of thickness for base metal
		v	vertical	In vertical position of plate, no limitation of thickness for base metal
		h	horizontal	In horizontal position of plate, no limitation of thickness for base metal
		o	upward	In upward position of plate, no limitation of thickness for base metal
	W-3-0	r	Horizontal fixing with wall and	No restrictions of position and thickness of base

Classification base metal		Classification of position		Workable range
	(pipe with diameter at least 100~120mm and thickness 4~5.3mm)		vertical fixing with wall	metal is less than 11mm
		e	Horizontal fixing and vertical fixing	No restrictions of position and thickness of base metal is less than 11mm (except in the case that there is restriction)
	W-3 (pipe with diameter at least 150~170mm and thickness 9~11mm)	r	Horizontal fixing with wall and vertical fixing with wall	No restrictions of position and thickness of base metal is less than 19mm
		e	Horizontal fixing and vertical fixing	No restrictions of position and thickness of base metal is less than 19mm (except in the case that there is restriction)
	W-4 (pipe with diameter at least 200~300mm and thickness at least 20mm)	r	Horizontal fixing with wall and vertical fixing with wall	No restrictions of position and base metal thickness
		e	Horizontal fixing and vertical fixing	No restrictions of position and base metal thickness (except in the case that there is restriction)

Reference: Appendix-17 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 24: Classification of test material, position and workable range

(aluminum or aluminum alloy)

Classification base metal		Classification of position		Workable range
Aluminum and aluminum alloy	W-10 (plate with 3mm thickness)	f	downward	In downward position, in base metal thickness less than 7mm
		v	vertical	In vertical position of plate, in base metal thickness less than 7mm
		h	horizontal	In horizontal position of plate, in base metal thickness less than 7mm
		o	upward	In upward position of plate, in base metal thickness less than 7mm
	W-11 (plate with 8mm thickness)	f	downward	In downward position, in base metal thickness less than 17mm
		v	vertical	In vertical position of plate, in base metal thickness less than 17mm
		h	horizontal	In horizontal position of plate, in base metal thickness less than 17mm
		o	upward	In upward position of plate, in base metal thickness less than 17mm
	W-12 (plate with thickness at least 20mm)	f	downward	In downward position, no limitation of thickness for base metal
		v	vertical	In vertical position of plate, no limitation of thickness for base metal
		h	horizontal	In horizontal position of plate, no limitation of thickness for base metal
		o	upward	In upward position of plate, no limitation of thickness for base metal
	W-13 (pipe with diameter at least 100~150mm and thickness 4mm)	r	Horizontal fixing with wall and vertical fixing with wall	No restrictions of position and thickness of base metal is less than 9mm
		e	Horizontal fixing and vertical fixing	No restrictions of position and thickness of base metal is less than 9mm (except in the case that there is restriction)
	W-14 (pipe with diameter at least 150~200mm and thickness 12~15mm)	r	Horizontal fixing with wall and vertical fixing with wall	No restrictions of position and thickness of base metal is less than 25mm
		e	Horizontal fixing and vertical fixing	No restrictions of position and thickness of base metal is less than 25mm (except in the case that there is restriction)
	W-15 (pipe with diameter at least 200~300mm and thickness at least 20mm)	r	Horizontal fixing with wall and vertical fixing with wall	No restrictions of position and base metal thickness
		e	Horizontal fixing and vertical fixing	No restrictions of position and base metal thickness (except in the case that there is restriction)

Note:

(1) "Restriction" means the variety of limitations of the work in high place, narrow place and where it is difficult work.

(2) In case of TTF + TFB) as shown in Table-13, the workable scope W-0, W-1, W-3-0, W-3, W-10, W-11, W-13 and W-14 as shown in above table must be considered as no limitation for the thickness 0f base metal.

(3) In case of gas welding, "base metal thickness less than 19mm" as shown above or "no limitation of thickness" must be red "thickness of base metal is less than thickness of test piece".

*(4) The workable scope in case of test classification W-0 or W-10 in the above Table-**, if 4 position such as f, v, h and o, the workable scope must be red "no limitation".*

Table- 25: Classification of welding rod

Classification of welding rod		Type
Covered metal rod	F-0	Ilmenite type welding rod
	F-1	High oxidation iron lime type rod
		Iron powder oxide-titanium welding rod (for mild steel and high tension steel (downward, horizontal fillet))
		Iron powder low hydrogen type welding rod (except for molybdenum and chromium-molybdenum steel)
		Iron powder iron-oxide welding rod
	F-2	Limetitania type welding rod
		High oxide-titanium welding rod
		Iron powder oxide-titanium welding rod (for high tension steel (all position))
	F-3	High cellulose type welding rod
	F-4	Low hydrogen type welding rod
		Iron powder low hydrogen type welding rod (for molybdenum and chromium-molybdenum alloy)
	F-5	Welding rod for stainless steel
Gas welding rod	F-6-1	High ductility gas welding rod
	F-6-2	Low ductility gas welding rod
Covered metal rod	F-41	Welding rod for nickel
	F-42	Welding rod for nickel-copper alloy
	F-43	Welding rod for nickel-chromium-iron alloy
	F-44	Welding rod for nickel ‐molybdenum-iron alloy
	F-45	Welding rod for nickel ‐chromium-molybdenum-iron alloy

Reference: Appendix-18 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 26: Classification of welding metal

Classif ication	Weld metal	Major component of weld metal (%)					
		C	Cr	Mo	Ni	Mn	Si
A-1	Carbon steel	≤ 0.15	—	—	—	≤ 1.60	≤ 1.00
A-2	Molybdenum steel	≤ 0.15	≤ 0.5	0.40~0.65	—	≤ 1.60	≤ 1.00
A-3	Cr-molybdenum steel	≤ 0.15	0.40~2.00	0.40~0.65	—	≤ 1.60	≤ 1.00
A-4-1	Cr-molybdenum steel	≤ 0.15	2.00~5.00	0.40~1.50	—	≤ 1.60	≤ 2.00
A-4-2	Cr-molybdenum steel	≤ 0.15	5.00~10.50	0.40~1.50	—	≤ 1.20	≤ 2.00
A-5	Martensitic stainless steel	≤ 0.15	11.00~15.00	≤ 0.70	—	≤ 2.00	≤ 1.00
A-6	Frrritic stainless steel	≤ 0.15	11.00~30.00	≤ 1.00	—	≤ 1.00	≤ 3.00
A-7	Austenitic stainless steel	≤ 0.15	14.50~30.00	≤ 4.00	7.50~15.00	≤ 2.50	≤ 1.00
A-8	Austenitic stainless steel	≤ 0.30	25.00~30.00	≤ 4.00	15.00~37.00	≤ 2.50	≤ 1.00
A-10	Nickel steel	≤ 0.15	—	≤ 0.55	0.80~4.00	≤ 1.70	≤ 1.00

Reference: Appendix-19 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 27: Classification of filler metal or weld inserts

Classification of filler metal or weld insert	Type of core wire	Type
R-1	E-1	Carbon steel (component of weld metal is equivalent to A-1 listed in Table-26)
R-2	E-2	Molybdenum steel (component of weld metal is equivalent to A-2 listed in Table-26)
R-3	E-3	Cr-molybdenum steel (component of weld metal is equivalent to A-3 listed in Table-26)
R-4-1	E-4-1	Cr-molybdenum steel (component of weld metal is equivalent to A-4-1 listed in Table-26)
R-4-2	E-4-2	Cr-molybdenum steel (component of weld metal is equivalent to A-4-2 listed in Table-26)
R-5	E-5	Martensitic stainless steel (component of weld metal is equivalent to A-5 listed in Table-26)
R-6	E-6	Frrritic stainless steel (component of weld metal is equivalent to A-6 listed in Table-26)
R-7	E-7	Austenitic stainless steel (component of weld metal is equivalent to A-7 listed in Table-26)
R-8	E-8	Austenitic stainless steel (component of weld metal is equivalent to A-8 listed in Table-26)
R-10	E-10	Nickel copper (component of weld metal is equivalent to A-10 listed in Table-26)
R-21	E-21	Aluminum
R-22	E-22	Aluminum magnesium alloy
R-23	E-23	Aluminum silicate alloy
R-31	E-31	Copper
R-32	E-32	Silicon bronze
R-33	E-33	Phosphor bronze
R-34	E-34	Cupronickel
R-36	E-36	Aluminum bronze
R-37	E-37	Special aluminum bronze
R-41	E-41	Nickel
R-42	E-42	Nickel-copper alloy
R-43	E-43	Nickel-Cr-iron alloy
R-44	E-44	Nickel-Mo-iron alloy
R-45	E-45	Iron-nickel Cr-Mo alloy
R-51	E-51	Titanium

Reference: Appendix-20 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 28: Temperature range for post weld heat treatment and retention time depending on the thickness of weld part

Classification of base metal	Temperature (°C)	Retention time depending on the thickness of weld part (hour)			
		t ≤12.5mm	12.5mm< t ≤50mm	50mm< t ≤125mm	125mm< t
P-1	595≤ T ≤700	0.5 ≤ h	$\frac{t}{25} < h$	$2 + \frac{t-50}{100} < h$	$2 + \frac{t-50}{100} < h$
P-3	595≤ T ≤710	0.5 ≤ h	$\frac{t}{25} < h$	$2 + \frac{t-50}{100} < h$	$2 + \frac{t-50}{100} < h$
P-4	595≤ T ≤740	0.5 ≤ h	$\frac{t}{25} < h$	$\frac{t}{25} < h$	$2 + \frac{t-50}{100} < h$
P-5	595≤ T ≤760	0.5 ≤ h	$\frac{t}{25} < h$	$\frac{t}{25} < h$	$2 + \frac{t-50}{100} < h$
P-6	595≤T≤760	0.5 ≤ h	$\frac{t}{25} < h$	$\frac{t}{25} < h$	$2 + \frac{t-50}{100} < h$
P-7	595≤ T ≤760	0.5 ≤ h	$\frac{t}{25} < h$	$\frac{t}{25} < h$	$2 + \frac{t-50}{100} < h$
P-9A, 9B	595≤ T ≤680	0.5 ≤ h	$\frac{t}{25} < h$	$\frac{t}{25} < h$	$2 + \frac{t-50}{100} < h$
P-11A, P-11B	595≤ T ≤680	0.5 ≤ h	$\frac{t}{25} < h$	$\frac{t}{25} < h$	$\frac{t}{25} < h$

Note:

"t" must be the thickness (mm) as listed below.

(1) In case of full fusion welding, the thickness of welding part or base metal (limited to the pressure part) must be thickness of the either thinner one (thinner one, the thickness is different).

Reference: Appendix-16 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Table- 29: Welder and welding operator performance qualification record

WELDER and WELDING OPERATOR PERFORMANCE QUALIFICATION RECORD

Welder's Name:		**ATF No:** **Test No.**
Welder's SS No. XXX-XX-	**Date:**	**Reference WPS No:**

VARIABLE	QUALIFICATION TEST DETAIL	QUALIFICATION RANGE*
Code or Specification Used:		
Welding Process and Type:	☐ Manual ☐ Semiautomatic ☐ Mechanized ☐ Automatic	☐ Manual ☐ Semiautomatic ☐ Mechanized ☐ Automatic
Backing:	☐ Used ☐ Not Used	Required if used
Base Metal **Spec/P or M-Number**		
Plate/Pipe Thickness – Groove	Plate ☐ Pipe ☐ Thick.	
Plate/Pipe Thickness – Fillet	Plate ☐ Pipe ☐ Thick.	
Pipe/Tubular Outside Diameter – Groove		
Pipe/Tubular Outside Diameter – Fillet		
Filler Metal **Specification No.**		
Classification No.		
F No.		
Diameter		
Consumable Insert	☐ Yes ☐ No	
Penetration Enhancing Flux	☐ Yes ☐ No	
Deposited Weld Metal Thickness		
Current/Polarity & Current Range	Type/Polarity: Range: Amperes	
Metal Transfer Mode (GMAW or FCAW)		
Torch Shielding Gas	Type: Flow:	
Root Shielding Gas	☐ NA Type: Flow:	
Position(s)	Test Position(s) (1G, 2G, etc.):	Qualified Position(s) (F, H, V, O, or All)
Vertical Progression	☐ Uphill ☐ Downhill	☐ Uphill ☐ Downhill

* NOTE: Insert NA for Variables that are identified as Non-essential in the Code or Specification used for the Performance Qualification Test

MECHANICAL TEST RESULTS			
Type And Figure No.	**Results**	**Type And Figure No.**	**Results**

Guided mechanical Testing Conducted By: **Date:**

NONDESTRUCTIVE EXAMINATION RESULTS

Radiographic Results:	**Report No.**
Radiographic Testing Conducted By:	
Welding Witnessed By:	**Visual Inspection:** ☐ Pass ☐ Fail (reason)

We certify that the statements in this record are correct and the test welds were prepared, welded and tested in accordance with the requirements of: AWS D1.1- , AWS B2.1- Other:

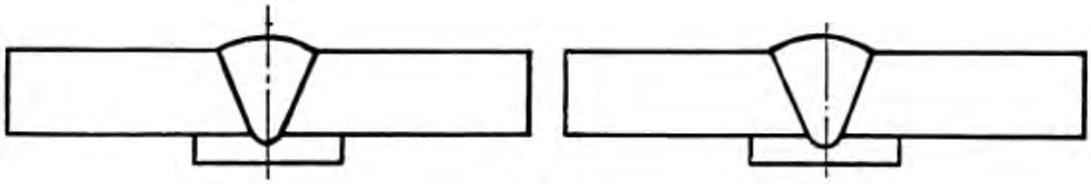
Date Qualified:	**ATF Name and Number:** **Signed By:** **CWI No.**

A: thickness of the test material less than 19mm

Truncation
(1) Joint tensile test specimen
(2) Root bend test specimen
(3) Face bend test specimen
(4) Root bend test specimen
(5) Face bend test specimen
(6) Joint tensile test specimen
(7) Impact test specimen
Truncation

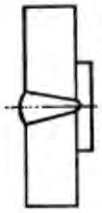
B: thickness of the test material 19mm and more

Truncation
(1) Side bend test specimen
(2) Joint tensile test specimen
(3) Root bend test specimen
(4) Side bend test specimen
(5) Joint tensile test specimen
(6) Root bend test specimen
(7) Impact test specimen
Truncation



C: when performing longitudinal bending test

Truncation	(1) Longitudinal face bend	(2) Joint tensile test specimen	(3) Longitudinal root bend	(4) Longitudinal face bend	(5) Joint tensile test specimen	(6) Longitudinal root bend	(7) Impact test specimen	Truncation

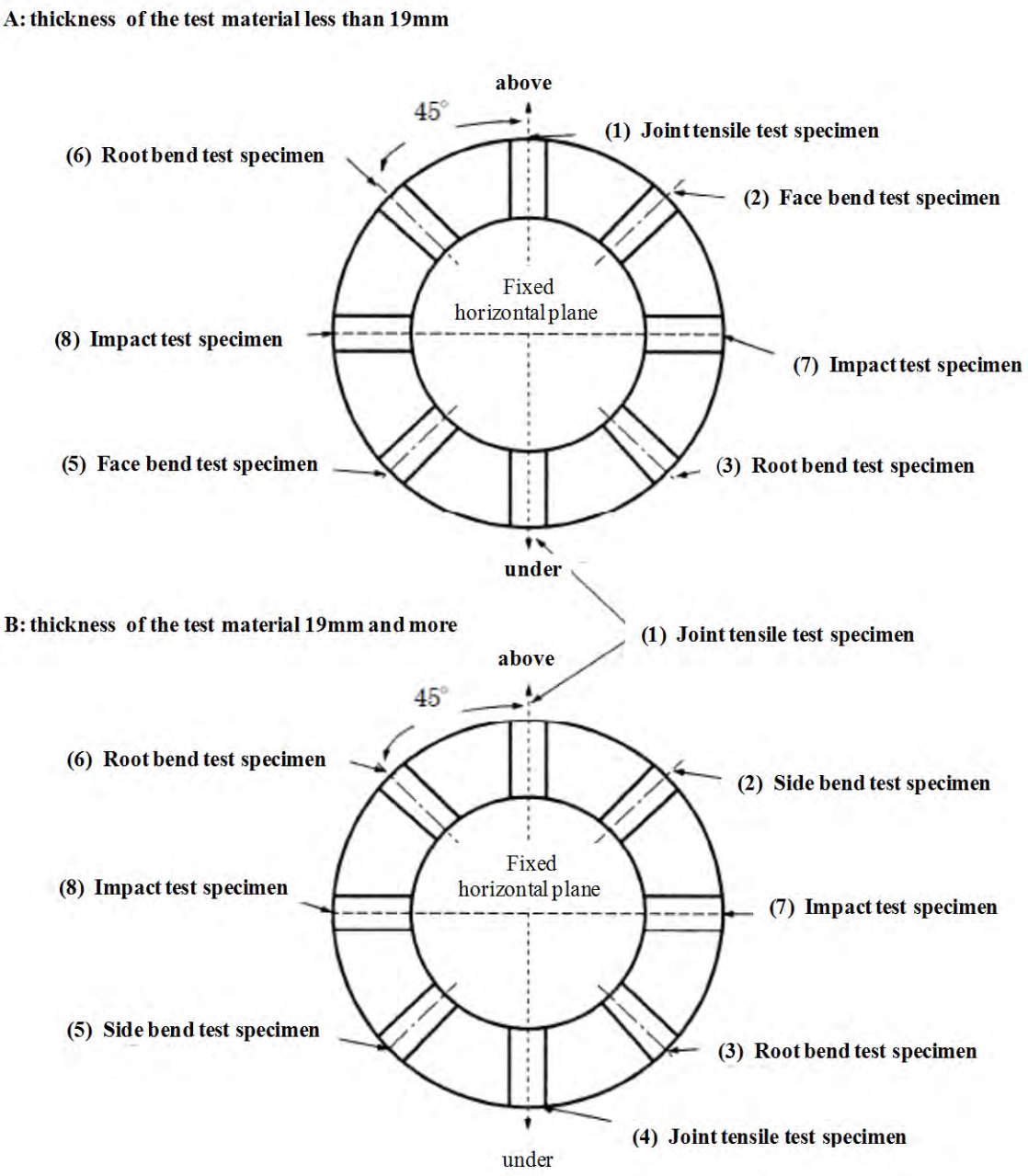


Note:

1. *When performing Tig welding of the first layer for the test piece with thickness less than 19mm, "test specimen for face bend" must be read "test specimen for root bend".*
2. *The number of the impact test specimen must be 3 taken from heat affected zone and weld metal part. However, when using different base metals, 3 specimens from heat affected zone and weld metal part of each base metal. In addition, when different welding method is applied (in case of welding methods used in only the first layer, it is not necessary to collect specimen), 3 specimens from heat affected zone and weld metal part of intersection of each welding methods.*

Reference: Appendix-Fig-1 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Fig- 4: Test piece and specimen for plate



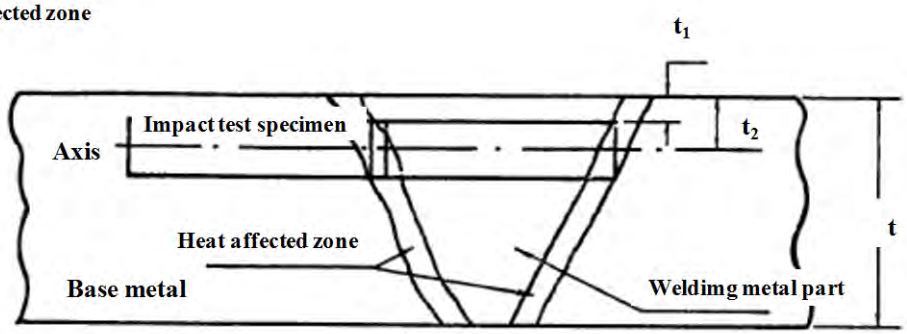
Note:

1. *When performing Tig welding of the first layer for the test piece with thickness less than 19mm, "test specimen for face bend of (2) and (5)" must be read "test specimen for root bend".*
2. *The number of impact test specimen may be same as plate as shown in Fig-4.*
3. *The position to collect impact test specimen may be either (7) or (8).*
4. *The position to collect test specimen in case performing welding in the horizontal rotation, the absolute position of specimen does not matter as shown the relative position in the figure.*
5. *A fixed horizontal plane in case performing the welding in the horizontal mounting must be as shown in figure.*

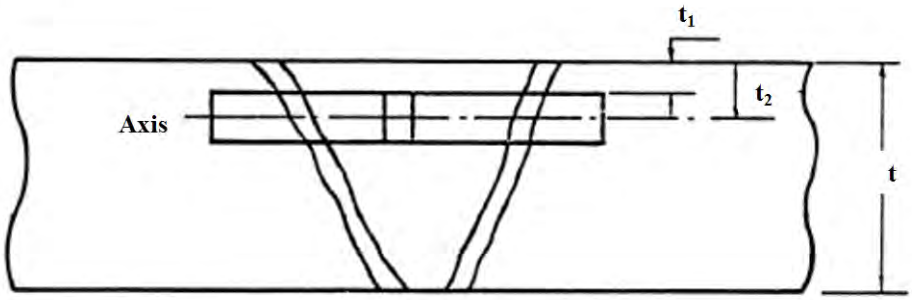
Reference: Appendix-Fig-2 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Fig- 5: Test piece and specimen for pipe

(1) Heat affected zone



(2) Weldimg metal part



Note:

1. "t" must be thickness of test specimen.

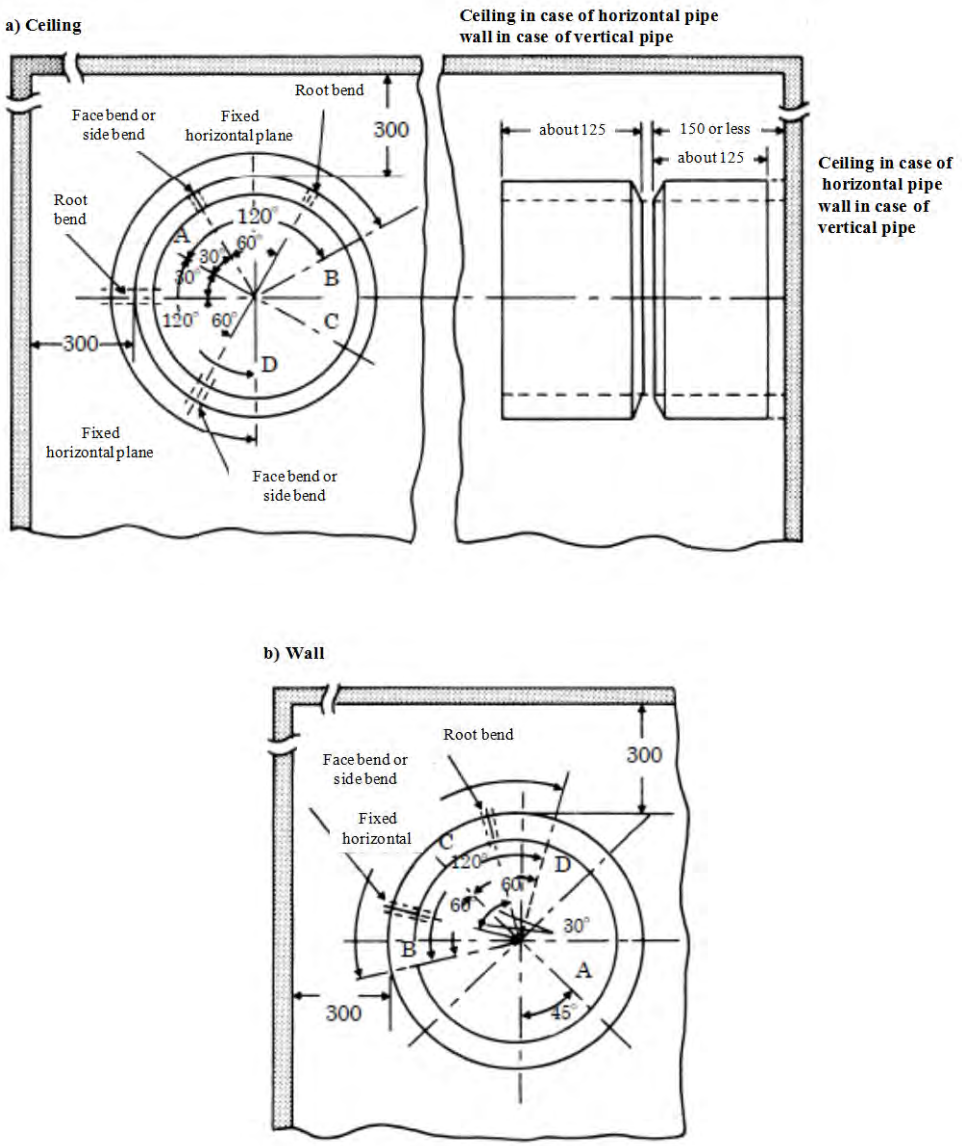
"t_1" must be at least 1mm from surface of test specimen.

"t_2" must be 0.25t. In addition, in the case of using a different method of welding, it must be up to the center of intersection of each method.

2. When the axis is 0.25t, if t1 is less than 1mm, it must be changed the position of axis and be 1mm.

Reference: Appendix-Fig-3 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Fig- 6: Test piece and specimen for impact test



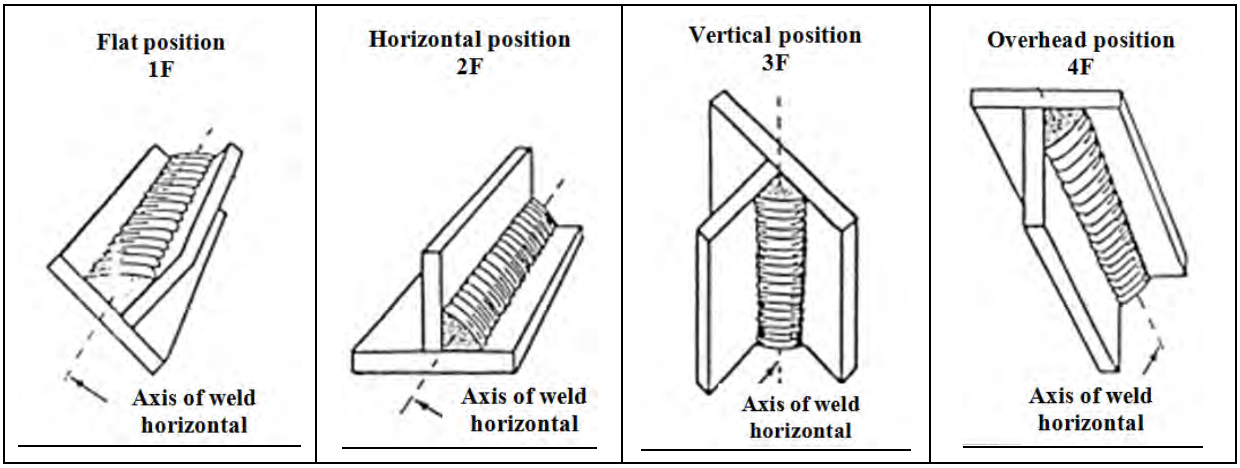
Note:

1. *Dimension must be in mm.*
2. *Test piece, in addition to the provisions in this figure, must be applied mutatis mutandis to JIS Z3801-1997 "test methods and criteria in the test of manual welding technology".*
3. *Test piece must be welded between A to B and A to D by appropriate method, fixed horizontally as shown Fig-a). D must be the lowest point of horizontal axis. Then, BCD must be welded after fixing test piece in vertical position as shown in Fig-b). C point must be located to the direction of corner of the wall. Welding may be started from any point either B or D.*
4. *If the classification of welding method is M or M+M_O as shown in Table-11, distance from ceiling and wall to test piece must be read "500" instead of "300".*
5. *In case of W-13r, W-14r and W-15r, distance from ceiling and wall "300" must be read "500 (if the classification of welding method is T or T_F as shown in Table-3, "400")", distance from wall or floor "150" must be read "350 (if the classification of welding method is T or T_F as shown in Table-3, "300")".*
6. *"Face bends or side bends" shown in the figure must be the bending for W-3-0r, W-3r, W-13r and W-14r, the side bending for W-4r and W-15r.*

Reference: Appendix-Fig-4 of Interpretation of technical regulation for thermal power facility (10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI Japan

Fig- 7: Installation of test piece for pipe (W-3-0r, W-3r, W-13r, W-14r and W-15r)

Fillet Welding



Groove Welding

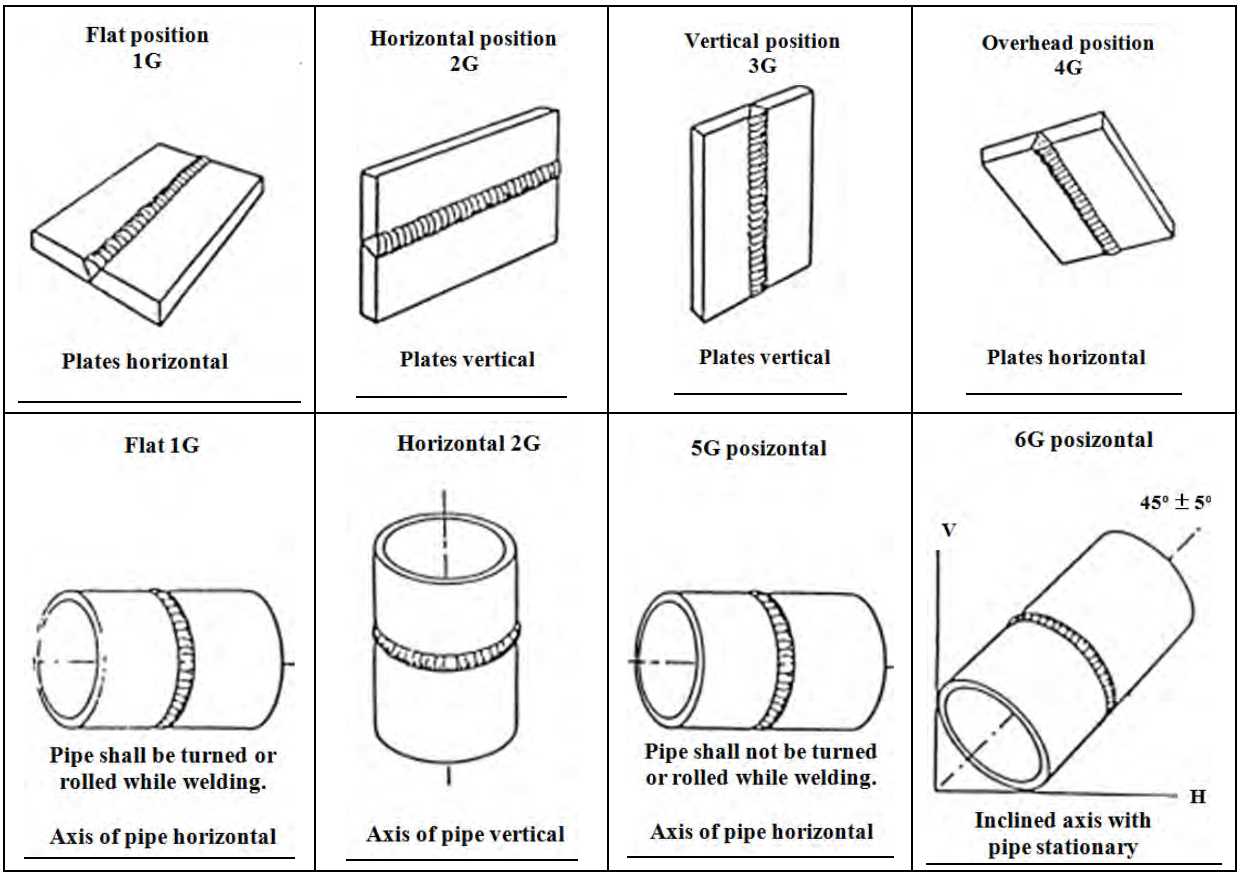


Fig- 8: Welding position according to ASME

Table- 30: Comparison of various welders' qualification system

Item \ Standard	Electric Utility Law	Labor Safety and Health Act	High Pressure Gas Safety Law	Japan Petroleum Institute (JPI)	Japan Welding Engineering Society (JWES)	Nippon Kaiji Kyokai (ClassNK) (NK)	Japanese Industrial Standards (JIS)
Regulations compliance	Interpretation of technical regulation for thermal power facility	Rules for safety of boiler & pressure vessel	High Pressure Gas Safety Law Article 12 Paragraph-2	Code of practice for welder's skill examination (JPI-7S-31-86)	JIS Standards Z3801 (steel), Z3811 (almi.) Z3821 (SUS), Z3841 (Auto.)	Rules for steel vessel Version-M: welding	JIS Standards Z3801 (steel), Z3811 (almi.) Z3821 (SUS), Z3841 (Auto.)
Object	Boiler, piping, pressure vessel, heat exchanger, liquefied gas facility for power generation	Boiler, piping, pressure vessel	Pressure vessel and piping for high pressure facility	Storage tank, vessel, oil & gas pipeline	All welding and brazing	Hull, rigging, prime mover	JIS stipulate only procedure and criterion about welding procedure, welder qualification test, non-destructive test or mechanical test as standard.
Scope of accreditation	Scope classified by factory, and welding content such as material , position, welding rod, etc.	Special boiler welder and Ordinary boiler welder **Individual qualification**	Scope according to other law and regulation **Individual qualification**	Scope by material, position, thickness **Individual qualification**	Scope by material, position, thickness **Individual qualification**	Scope by material, position, thickness **Individual qualification**	
Accreditation organization	Operator (owner of generation facility)	Director of labor standards bureau in each prefecture	Accreditation by operator (ckeck of official qualification)	Japan Petroleum Institute	Japan Welding Engineering Society	Nippon Kaiji Kyokai (ClassNK)	
Application institution							
Form of application							
Criteria	Interpretation of technical regulation for thermal power facility Practical examination	Law Article 72, rule-6 Practical examination and the written test	Confirmation of qualification (such as JWES)	JIS Standards Z3801 (steel), Z3821 (SUS) Practical examination and the written test	JIS Standards Z3801 (steel), Z3811 (almi.) Z3821 (SUS), Z3841 (Auto.) Practical examination and the written test	Rules for steel vessel Version-M: welding Practical examination	
Certifier	Operator (owner of generation facility)	Labor standard inspection office or designated agency	High pressure gas safety institute of Japan	Japan Petroleum Institute	Japan Welding Engineering Society	Nippon Kaiji Kyokai (ClassNK)	
Certification method	Witness	Audit by witness in each district	Document review and witness	JWES performs practical test of type-E, F, Ft, FC. JPI audit documents for other type.	Audit by witness in each district	Witness	
Certification result	Skill approval by every product	Individual licensing	Skill approval by every product	Issue of individual qualification certificate by each type	Issue of individual qualification certificate by each type	Issue of individual qualification certificate by each type	
Expiration date, Update procedure	2 year (with automatic renewal conditions of 2 years)	1 year (witness practical examination in once every year)	According to other standard	1 year (with approval of continuation in once every 2 years)	3 year (with approval of continuation in once every year)	3 year (with automatic renewal conditions of 3 years)	

Table- 31: Comparison of various welders' qualification system

Item \ Standard	American Welding Society (AWS)	American Mechanical Engineers (ASME)	American Petroleum Institute (API)	American Bureau of Shipping (ABS)	European Norm (EN)	International Organization for Standardization (ISO)	National Standards of Vietnam (TCVN)
Regulations compliance	Welding standard for structure—steel: Section 5 Part-C	Boiler & Pressure Vessel Code Section-9.				None	QCVN-**: Design technical regulation of thermal power facility
Object	Building, bridge, steel structure	Boiler, piping, pressure vessel	Storage tank, vessel, oil & gas pipeline	Hull, rigging, prime mover of ship	All welding and brazing	All welding and brazing	All welding and brazing?
Scope of accreditation	Scope classified by factory, and welding content such as material , position, welding rod, etc.	Scope classified by factory, and welding content such as material , position, welding rod, etc.					
Accreditation organization	Witness by the manufacturing factory director or CWI (Certified inspector by AWS)	Witness by the manufacturing factory director or AI					
Application institution	None	None					
Form of application	No application form descried necessary information	No application form descried necessary information					
Criteria	Structural welding (steel) Section-5 Part-C Practical examination	Boiler & Pressure Vessel Code Section-9. Practical examination	API 1104 Section 6.1	ABS rules for materials and welding Part-2 2012	EN 287-1, 6 EN 1418	ISO 9606-1 to 9606-5	TCVN 6700-1 TCVN 6700-2
Certifier	Director of manufacturing factory or CWI (Certified Welding Inspector)	Director of manufacturing factory or AI(Authorized Inspector)					
Certification method	Witness by the manufacturing factory director or CWI (Certified Welding Inspector)	Witness by the manufacturing factory director or AI(Authorized Inspector)					
Certification result	Skill approval for every product	Skill approval for every product					
Expiration date, Update procedure	Whole life (there is requirements for obtained welding procedure engaging in more than 6 months)	3 month (with automatic renewal conditions)					

Chapter-3. Reference International Technical Standards

The reference international standards for welding are organized in Table-32.

Table- 32: Reference International Technical Standards

Number	Rev.	Title
ISO 3677	1992	Filler metal for soft soldering, brazing and braze welding -- Designation
ISO 5187	1985	Welding and allied processes -- Assemblies made with soft solders and brazing filler metals -- Mechanical test methods
ISO 10564	1993	Soldering and brazing materials -- Methods for the sampling of soft solders for analysis
ISO 15614-10	2005	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 10: Hyperbaric dry welding
ISO 18279	2003	Brazing -- Imperfections in brazed joints
ISO 544	2003	Welding consumables -- Technical delivery conditions for welding filler materials -- Type of product, dimensions, tolerances and markings
ISO 636	2004	Welding consumables -- Rods, wires and deposits for tungsten inert gas welding of non-alloy and fine-grain steels -- Classification
ISO 1071	2003	Welding consumables - Covered electrodes, wires, rods and tubular cored electrodes for fusion welding of cast iron - Classification
ISO 2401	1972	Covered electrodes -- Determination of the efficiency, metal recovery and deposition coefficient
ISO 2560	2002	Welding consumables -- Covered electrodes for manual metal arc welding of non-alloy and fine grain steels -- Classification
ISO 3581	2003	Welding consumables -- Covered electrodes for manual metal arc welding of stainless and heat-resisting steels -- Classification
ISO 6848	2004	Arc welding and cutting -- Nonconsumable tungsten electrodes -- Classification
ISO 14171	2002	Welding consumables -- Wire electrodes and wire-flux combinations for submerged arc welding of non alloy and fine grain steels – Classification
ISO 14172	2003	Welding consumables -- Covered electrodes for manual metal arc welding of nickel and nickel alloys – Classification
ISO 14172	2004	Welding consumables -- Fluxes for submerged arc welding -- Classification
ISO 14175	2008	Welding consumables -- Gases and gas mixtures for fusion welding and allied processes
ISO 14341	2002	Welding consumables -- Wire electrodes and deposits for gas shielded metal arc welding of non alloy and fine grain steels – Classification
ISO 15792-1	2000	Welding consumables -- Test methods -- Part 1: Test methods for all-weld metal test specimens in steel, nickel and nickel alloys
ISO 15792-2	2000	Welding consumables -- Test methods -- Part 2: Preparation of single-run and two-run technique test specimens in steel
ISO 15792-3	2000	Welding consumables -- Test methods -- Part 3: Classification testing of positional capacity and root penetration of welding consumables in a fillet weld
ISO 16834	2006	Welding consumables -- Wire electrodes, wires, rods and deposits for gas-shielded arc welding of high strength steels -- Classification
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 17633	2004	Welding consumables -- Tubular cored electrodes and rods for gas shielded and non-gas shielded metal arc welding of stainless and heat-resisting steels --

Number	Rev.	Title
		Classification
ISO 17634	2004	Welding consumables -- Tubular cored electrodes for gas shielded metal arc welding of creep resisting steels -- Classification
ISO 18273	2004	Welding consumables -- Wire electrodes, wires and rods for welding of aluminum and aluminum alloys -- Classification
ISO 18274	2004	Welding consumables -- Wire and strip electrodes, wires and rods for fusion welding of nickel and nickel alloys -- Classification
ISO 18275	2005	Welding consumables -- Covered electrodes for manual metal arc welding of high-strength 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
ISO 21952	2007	Welding consumables -- Wire electrodes, wires, rods and deposits for gas-shielded arc welding of creep-resisting steels -- Classification
ISO 24034	2005	Welding consumables -- Solid wires and rods for fusion welding of titanium and titanium alloys-- Classification
ISO 24373	2008	Welding consumables -- Solid wires and rods for fusion welding of copper and copper alloys -- Classification
ISO 24598	2007	Welding consumables -- Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of creep-resisting steels -- Classification
ISO 4136	2001	Destructive tests on welds in metallic materials -- Transverse tensile test
ISO 5173	2000	Destructive tests on welds in metallic materials -- Bend tests
ISO 5178	2001	Destructive tests on welds in metallic materials -- Longitudinal tensile test on weld metal in fusion welded joints
ISO 9015-1	2001	Destructive tests on welds in metallic materials -- Hardness testing -- Part 1: Hardness test on arc welded joints
ISO 9015-2	2003	Destructive tests on welds in metallic materials -- Hardness testing -- Part 2: Micro hardness testing of welded joints
ISO 9016	2001	Destructive tests on welds in metallic materials -- Impact tests -- Test specimen location, notch orientation and examination
ISO 9017	2001	Destructive tests on welds in metallic materials -- Fracture test
ISO 9018	2003	Destructive tests on welds in metallic materials -- Tensile test on cruciform and lapped joints
ISO 10675	2008	Non-destructive testing of welds -- Acceptance levels for radiographic testing -- Part 1: Steel, nickel, titanium and their alloys
ISO/TR 16060	2003	Destructive tests on welds in metallic materials -- Etchants for macroscopic and microscopic examination
ISO 17635	2003	Non-destructive testing of welds -- General rules for fusion welds in metallic materials
ISO 17636	2003	Non-destructive testing of welds -- Radiographic testing of fusion-welded joints
ISO 17637	2003	Non-destructive testing of welds -- Visual testing of fusion-welded joints
ISO 17638	2003	Non-destructive testing of welds -- Magnetic particle testing
ISO 17639	2003	Destructive tests on welds in metallic materials -- Macroscopic and microscopic examination of welds
ISO 17640	2005	Non-destructive testing of welds -- Ultrasonic testing of welded joints
ISO 17641-1	2004	Destructive tests on welds in metallic materials -- Hot cracking tests for weldments -- Arc welding processes -- Part 1: General

Number	Rev.	Title
ISO 17641-2	2005	Destructive tests on welds in metallic materials -- Hot cracking tests for weldments -- Arc welding processes -- Part 2: Self-restraint tests
ISO/TR 1764-1	2005	Destructive tests on welds in metallic materials -- Hot cracking tests for weldments -- Arc welding processes -- Part 3: Externally loaded tests
ISO 17642-1	2004	Destructive tests on welds in metallic materials -- Cold cracking tests for weldments -- Arc welding processes -- Part 1: General
ISO 17642-2	2005	Destructive tests on welds in metallic materials -- Cold cracking tests for weldments -- Arc welding processes -- Part 2: Self-restraint tests
ISO 17642-3	2005	Destructive tests on welds in metallic materials -- Cold cracking tests for weldments -- Arc welding processes -- Part 3: Externally loaded tests
ISO 17643	2005	Non-destructive testing of welds -- Eddy current testing of welds by complex-plane analysis
ISO 17655	2003	Destructive tests on welds in metallic materials -- Method for taking samples for delta ferrite measurement
ISO 22825	2006	Non-destructive testing of welds -- Ultrasonic testing -- Testing of welds in austenitic steels and nickel-based alloys
ISO 22826	2005	Destructive tests on welds in metallic materials -- Hardness testing of narrow joints welded by laser and electron beam (Vickers and Knoop hardness tests)
ISO 23277	2006	Non-destructive testing of welds -- Penetrant testing of welds -- Acceptance levels
ISO 23278	2006	Non-destructive testing of welds -- Magnetic particle testing of welds -- Acceptance levels
ISO 23279	2007	Non-destructive testing of welds -- Ultrasonic testing -- Characterization of indications in welds
ISO 669	2000	Resistance welding -- Resistance welding equipment -- Mechanical and electrical requirements
ISO 693	1982	Dimensions of seam welding wheel blanks
ISO 865	1981	Slots in platens for projection welding machines
ISO 1089	1980	Electrode taper fits for spot welding equipment -- Dimensions
ISO 5182	2008	Resistance welding -- Materials for electrodes and ancillary equipment
ISO 5183-1	1998	Resistance welding equipment -- Electrode adaptors, male taper 1:10 -- Part 1: Conical fixing, taper 1:10
ISO 5183-2	2000	Resistance spot welding -- Electrode adaptors, male taper 1:10 -- Part 2: Parallel shank fixing for end-thrust electrodes
ISO 5184	1979	Straight resistance spot welding electrodes
ISO 5821	1979	Resistance spot welding electrode caps
ISO 5822	1988	Spot welding equipment -- Taper plug gauges and taper ring gauges
ISO 5826	1999	Resistance welding equipment -- Transformers -- General specifications applicable to all transformers
ISO 5827	1983	Spot welding -- Electrode back-ups and clamps
ISO 5828	2001	Resistance welding equipment -- Secondary connecting cables with terminals connected to water-cooled lugs -- Dimensions and characteristics
ISO 5829	1984	Resistance spot welding -- Electrode adaptors, female taper 1 : 10
ISO 5830	1984	Resistance spot welding -- Male electrode caps
ISO 6210-1	1991	Cylinders for robot resistance welding guns -- Part 1: General requirements
ISO 7284	1993	Resistance welding equipment -- Particular specifications applicable to transformers with two separate secondary windings for multi-spot welding, as used in the automobile industry

Number	Rev.	Title
ISO 7285	1995	Pneumatic cylinders for mechanized multiple spot welding
ISO 7286	1986	Graphical symbols for resistance welding equipment
ISO 7931	1985	Insulation caps and bushes for resistance welding equipment
ISO 8166	2003	Resistance welding -- Procedure for the evaluation of the life of spot welding electrodes using constant machine settings
ISO 8167	1999	Projections for resistance welding
ISO 8205-1	2002	Water-cooled secondary connection cables for resistance welding -- Part 1: Dimensions and requirements for double-conductor connection cables
ISO 8205-2	2002	Water-cooled secondary connection cables for resistance welding -- Part 2: Dimensions and requirements for single-conductor connection cables
ISO 8205-3	1993	Water-cooled secondary connection cables for resistance welding -- Part 3: Test requirements
ISO 8430-1	1988	Resistance spot welding -- Electrode holders -- Part 1: Taper fixing 1:10
ISO 8430-2	1988	Resistance spot welding -- Electrode holders -- Part 2: Morse taper fixing
ISO 8430-3	1988	Resistance spot welding -- Electrode holders -- Part 3: Parallel shank fixing for end thrust
ISO 9312	1990	Resistance welding equipment -- Insulated pins for use in electrode back-ups
ISO 9313	1989	Resistance spot welding equipment -- Cooling tubes
ISO 10656	1996	Electric resistance welding -- Integrated transformers for welding guns
ISO 12145	1998	Resistance welding equipment -- Angles for mounting spot welding electrodes
ISO 12166	1997	Resistance welding equipment -- Particular specifications applicable to transformers with one secondary winding for multi-spot welding, as used in the automobile industry
ISO 14327	2004	Resistance welding -- Procedures for determining the weldability lobe for resistance spot, projection and seam welding
ISO 14554-1	2000	Quality requirements for welding -- Resistance welding of metallic materials -- Part 1: Comprehensive quality requirements
ISO 14554-2	2000	Quality requirements for welding -- Resistance welding of metallic materials -- Part 2: Elementary quality requirements
ISO 15609-5	2004	Specification and qualification of welding procedures for metallic materials -- Welding procedure specification -- Part 5: Resistance welding
ISO 15614-12	2004	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 12: Spot, seam and projection welding
ISO 15614-13	2005	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 13: Resistance butt and flash welding
ISO 17653	2003	Destructive tests on welds in metallic materials -- Torsion test of resistance spot welds
ISO 17654	2003	Destructive tests on welds in metallic materials -- Resistance welding -- Pressure test on resistance seam welds
ISO 17657-1	2005	Resistance welding -- Welding current measurement for resistance welding -- Part 1: Guidelines for measurement
ISO 17657-2	2005	Resistance welding -- Welding current measurement for resistance welding -- Part 2: Welding current meter with current sensing coil
ISO 17657-3	2005	Resistance welding -- Welding current measurement for resistance welding -- Part 3: Current sensing coil
ISO 17657-4	2005	Resistance welding --Welding current measurement for resistance welding --Part 4: calibration
ISO 17657-5	2005	Resistance welding -- Welding current measurement for resistance welding -- Part 5: Verification of welding current measuring system

Number	Rev.	Title
ISO 18278-1	2004	Resistance welding -- Weldability -- Part 1: Assessment of weldability for resistance spot, seam and projection welding of metallic materials
ISO 18278-2	2004	Resistance welding -- Weldability -- Part 2: Alternative procedures for the assessment of sheet steels for spot welding
ISO 18594	2007	Resistance spot-, projection- and seam-welding -- Method for determining the transition resistance on aluminum and steel material
ISO 18595	2007	Resistance welding -- Spot welding of aluminum and aluminum alloys -- Weldability, welding and testing
ISO 22829	2007	Resistance welding -- Transformer-rectifier for welding guns with integrated transformers -- Transformer-rectifier units operating at 1000 Hz frequency
ISO/TR 581	2005	Weldability -- Metallic materials -- General principles
ISO 857-1	1998	Welding and allied processes -- Vocabulary -- Part 1: Metal welding processes
ISO 857-2	2005	Welding and allied processes -- Vocabulary -- Part 2: Soldering and brazing processes and related terms
ISO 2553	1992	Welded, brazed and soldered joints -- Symbolic representation on drawings
ISO 4063	1998	Welding and allied processes -- Nomenclature of processes and reference numbers
ISO 6520-1	2007	Welding and allied processes -- Classification of geometric imperfections in metallic materials -- Part 1: Fusion welding
ISO 6520-2	2001	Welding and allied processes -- Classification of geometric imperfections in metallic materials -- Part 2: Welding with pressure
ISO 6947	1990	Welds -- Working positions -- Definitions of angles of slope and rotation
ISO 9692-1	2003	Welding and allied processes -- Recommendations for joint preparation -- Part 1: Manual metal-arc welding, gas-shielded metal-arc welding, gas welding, TIG welding and beam welding of steels
ISO 9692-2	1998	Welding and allied processes -- Joint preparation -- Part 2: Submerged arc welding of steels
ISO 9692-3	2000	Welding and allied processes -- Recommendations for joint preparation -- Part 3: Metal inert gas welding and tungsten inert gas welding of aluminum and its alloys
ISO 9692-4	2003	Welding and allied processes -- Recommendations for joint preparation -- Part 4: Clad steels
ISO 17658	2002	Welding -- Imperfections in oxyfuel flame cuts, laser beam cuts and plasma cuts -- Terminology
ISO 17659	2002	Welding -- Multilingual terms for welded joints with illustrations
ISO/TS 17845	2004	Welding and allied processes -- Designation system for imperfections
ISO/TR 25901	2007	Welding and related processes -- Vocabulary
ISO 3834-1	2005	Quality requirements for fusion welding of metallic materials -- Part 1: Criteria for the selection of the appropriate level of quality requirements
ISO 3834-2	2005	Quality requirements for fusion welding of metallic materials -- Part 2: Comprehensive quality requirements
ISO 3834-3	2005	Quality requirements for fusion welding of metallic materials -- Part 3: Standard quality requirements
ISO 3834-4	2005	Quality requirements for fusion welding of metallic materials -- Part 4: Elementary quality requirements
ISO 3834-5	2005	Quality requirements for fusion welding of metallic materials -- Part 5: Documents with which it is necessary to conform to claim conformity to the quality requirements of ISO 3834-2, ISO3834-3 or ISO 3834-4
ISO/TR 3834-6	2007	Quality requirements for fusion welding of metallic materials -- Part 6: Guidelines on implementing ISO 3834

Number	Rev.	Title
ISO 5817	2003	Welding -- Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) -- Quality levels for imperfections
ISO 10042	2005	Welding -- Arc-welded joints in aluminum and its alloys -- Quality levels for imperfections
ISO 13916	1996	Welding -- Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature
ISO 13918	2008	Welding -- Studs and ceramic ferrules for arc stud welding
ISO 13919-1	1996	Welding -- Electron and laser-beam welded joints -- Guidance on quality levels for imperfections -- Part 1: Steel
ISO 13919-2	2001	Welding -- Electron and laser beam welded joints -- Guidance on quality levels for imperfections -- Part 2: Aluminum and its weldable alloys
ISO 13920	1996	Welding -- General tolerances for welded constructions -- Dimensions for lengths and angles-- Shape and position
ISO 14555	2006	Welding -- Arc stud welding of metallic materials
ISO 14744-1	2008	Welding -- Acceptance inspection of electron beam welding machines -- Part 1: Principles and acceptance conditions
ISO 14744-2	2000	Welding -- Acceptance inspection of electron beam welding machines -- Part 2: Measurement of accelerating voltage characteristics
ISO 14744-3	2000	Welding -- Acceptance inspection of electron beam welding machines -- Part 3: Measurement of beam current characteristics
ISO 14744-4	2000	Welding -- Acceptance inspection of electron beam welding machines -- Part 4: Measurement of welding speed
ISO 14744-5	2000	Welding -- Acceptance inspection of electron beam welding machines -- Part 5: Measurement of run-out accuracy
ISO 14744-6	2000	Welding -- Acceptance inspection of electron beam welding machines -- Part 6: Measurement of stability of spot position
ISO 15607	2003	Specification and qualification of welding procedures for metallic materials -- General rules
ISO/TR 15608	2005	Welding -- Guidelines for a metallic materials grouping system
ISO 15609-1	2004	Specification and qualification of welding procedures for metallic materials -- Welding procedure specification -- Part 1: Arc welding
ISO 15609-3	2004	Specification and qualification of welding procedures for metallic materials -- Welding procedure specification -- Part 3: Electron beam welding
ISO 15609-4	2004	Specification and qualification of welding procedures for metallic materials -- Welding procedure specification -- Part 4: Laser beam welding
ISO 15610	2003	Specification and qualification of welding procedures for metallic materials -- Qualification based on tested welding consumables
ISO 15611	2003	Specification and qualification of welding procedures for metallic materials -- Qualification based on previous welding experience
ISO 15612	2004	Specification and qualification of welding procedures for metallic materials -- Qualification by adoption of a standard welding procedure
ISO 15613	2004	Specification and qualification of welding procedures for metallic materials -- Qualification based on pre-production welding test
ISO 15614-1	2004	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys
ISO 15614-2	2005	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 2: Arc welding of aluminum and its alloys

Number	Rev.	Title
ISO 15614-3	2008	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 3: Fusion welding of non-alloyed and low-alloyed cast irons
ISO 15614-4	2005	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 4: Finishing welding of aluminum castings
ISO 15614-5		Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 5: Arc welding of titanium, zirconium and their alloys
ISO 15614-6	2006	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 6: Arc and gas welding of copper and its alloys
ISO 15614-7	2007	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 7: Overlay welding
ISO 15614-8	2002	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 8: Welding of tubes to tube-plate joints
ISO 15614-11	2002	Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 11: Electron and laser beam welding
ISO 15616-1	2003	Acceptance tests for CO^2-laser beam machines for high quality welding and cutting -- Part 1: General principles, acceptance conditions
ISO 15616-2	2003	Acceptance tests for CO^2-laser beam machines for high quality welding and cutting -- Part 2: Measurement of static and dynamic accuracy
ISO 15616-3	2003	Acceptance tests for CO^2-laser beam machines for high quality welding and cutting -- Part 3: Calibration of instruments for measurement of gas flow and pressure
ISO 15620	2000	Welding -- Friction welding of metallic materials
ISO/TS 17477	2003	Acceptance tests for CO^2-laser beam machines for welding and cutting using 2D moving optics type
ISO 17652-1	2003	Welding -- Test for shop primers in relation to welding and allied processes -- Part 1: General requirements
ISO17652-2	2003	Welding -- Test for shop primers in relation to welding and allied processes -- Part 2: Welding properties of shop primers
ISO 17652-3	2003	Welding -- Test for shop primers in relation to welding and allied processes -- Part 3: Thermal cutting
ISO 17652-4	2003	Welding -- Test for shop primers in relation to welding and allied processes -- Part 4: Emission of fumes and gases
ISO 17660-1	2006	Welding -- Welding of reinforcing steel -- Part 1: Load-bearing welded joints
ISO 17660-2	2006	Welding -- Welding of reinforcing steel -- Part 2: Non load-bearing welded joints
ISO 17662	2005	Welding -- Calibration, verification and validation of equipment used for welding, including ancillary activities
ISO/TR 17663	2001	Welding -- Guidelines for quality requirements for heat treatment in connection with welding and allied processes
ISO/TR 17671-1	2002	Welding -- Recommendations for welding of metallic materials -- Part 1: General guidance for arc welding
ISO/TR 17671-2	2002	Welding -- Recommendations for welding of metallic materials -- Part 2: Arc welding of ferritic steels
ISO/TR 17671-3	2002	Welding -- Recommendations for welding of metallic materials -- Part 3: Arc welding of stainless steels
ISO/TR 17671-4	2002	Welding -- Recommendations for welding of metallic materials -- Part 4: Arc welding of aluminum and aluminum alloys
ISO/TR 17671-5	2004	Welding -- Recommendations for welding of metallic materials -- Part 5: Welding of clad steels
ISO/TR	2005	Welding -- Recommendations for welding of metallic materials -- Part 6: Laser beam

Number	Rev.	Title
17671-6		welding
ISO/TR 17671-7	2004	Welding -- Recommendations for welding of metallic materials -- Part 7:Electron beam welding
ISO/TR 17844	2004	Welding -- Comparison of standardized methods for the avoidance of cold cracks
ISO/TR 20172	2006	Welding -- Grouping systems for materials -- European materials
ISO/TR 20173	2005	Welding -- Grouping systems for materials -- American materials
ISO/TR 20174	2005	Welding -- Grouping systems for materials -- Japanese materials
ISO 22827-1	2005	Acceptance tests for Nd:YAG laser beam welding machines -- Machines with optical fibre delivery -- Part 1: Laser assembly
ISO 22827-2	2005	Acceptance tests for Nd:YAG laser beam welding machines -- Machines with optical fibre delivery -- Part 2: Moving mechanism
ISO 9606-1	1994	Approval testing of welders -- Fusion welding -- Part 1: Steels
ISO 9606-2	2004	Qualification test of welders -- Fusion welding -- Part 2: Aluminum and aluminum alloys
ISO 9606-3	1999	Approval testing of welders -- Fusion welding -- Part 3: Copper and copper alloys
ISO 9606-4	1999	Approval testing of welders -- Fusion welding -- Part 4: Nickel and nickel alloys
ISO 9606-5	2000	Approval testing of welders -- Fusion welding -- Part 5: Titanium and titanium alloys, zirconium and zirconium alloys
ISO 14731	2006	Welding coordination -- Tasks and responsibilities
ISO 14732	1998	Welding personnel -- Approval testing of welding operators for fusion welding and of resistance weld setters for fully mechanized and automatic welding of metallic materials
ISO 15618-1	2001	Qualification testing of welders for underwater welding -- Part 1: Diver-welders for hyperbaric wet welding
ISO 15618-2	2001	Qualification testing of welders for underwater welding -- Part 2: Diver-welders and welding operators for hyperbaric dry welding
ASME BPVC Section-5	2010	Non-destructive testing
ASME BPVC Section-9	2010	Welding and brazing qualifications
ASME B16.25	1997	Butt welding ends
API RP 577	2004	Welding inspection and metallurgy
API 1104	2010	Welding of pipelines and related facilities
AS/NZS 1554.1	2004	Structural steel welding—Welding of steel structures
AS/NZS 1554.2	2003	Structural steel welding—Stud welding (steel studs to steel)
AS/NZS 1554.3	2008	Structural steel welding—Welding of reinforcing steel
AS/NZS 1554.4	2004	Structural steel welding—Welding of high strength quenched and tempered steels
AS/NZS 1554.5	2011	Structural steel welding—Welding of steel structures subject to high levels of fatigue loading
AS/NZS 1554.6	2011	Structural steel welding—Welding stainless steel structures
AS/NZS 1554.7	2006	Structural steel welding—Welding of sheet steel structures

Number	Rev.	Title
AS/NZS 3992	1998	Pressure equipment –Welding and brazing qualification
CSA W47.1	2009	Certification of companies for fusion welding of steel
CSA W47.2	2011	Certification of companies for fusion welding of aluminum
CSA W48.6	2011	Filler metals and allied materials for metal arc welding
CSA W55.3	2008	Certification of companies for resistance welding steel and aluminum
CSA W59.2	2008	Welded aluminum construction
CSA W59.3	2008	Welded steel construction (Metal arc welding)
CSA W178.1	2008	Certification of welding inspection organizations
CSA W178.2	2008	Certification of welding inspectors
BS 2633	1987	Specification of class-1 arc welding of ferritic steel pipework for carrying fluids.
BS 2971	1977	Specification for class-2 arc welding of carbon steel pipework for carrying fluids.
BS 4515-1	2009	Specification for welding of steel pipelines on land and offshore—Part-1: Carbon and carbon manganese steel pipelines.
BS 4515-2	1999	Specification for welding of steel pipelines on land and offshore. Duplex stainless steel pipelines.
PD 6705-2	2010	Structural use of steel and aluminum. Recommendations for the execution of steel bridges to BS EN 1090-3.
PD 6705-3	2009	Structural use of steel and aluminum. Recommendations for the execution of aluminum structures to BS EN 1090-3.
EN 287-1	2011	Qualification test of welders—Fusion welding—Part-1: Steels
EN 287-6	2010	Qualification test of welders - Fusion welding - Part 6: Cast iron
EN 1090-1	2012	Execution of steel structures and aluminum structures—Part-1: Requirements of conformity assessment of structural components
EN 1090-2	2011	Execution of steel structures and aluminum structures—Part-2: Technical requirements for steel structures.
EN 1090-3	2008	Execution of steel structures and aluminum structures—Part-3: Technical requirements for aluminum structures.
EN 1011-1	2009	Welding—Recommendations for welding of metallic materials—Part-1: General guidance for arc welding.
EN 1011-2	2001	Welding—Recommendations for welding of metallic materials—Part-2: Arc welding of ferritic steels.
EN 1011-3	2000	Welding—Recommendations for welding of metallic materials—Part-3: Arc welding of stainless steels.
EN 1011-4	2000	Welding—Recommendations for welding of metallic materials—Part-4: Arc welding of aluminum and aluminum alloys.
EN 1011-5	2003	Welding—Recommendations for welding of metallic materials—Part-5: Welding of clad steel.
EN 1011-6	2005	Welding—Recommendations for welding of metallic materials—Part-6: Laser beam welding.
EN 1011-7	2004	Welding—Recommendations for welding of metallic materials—Part-7: Electron beam welding.
EN 1011-8	2004	Welding—Recommendations for welding of metallic materials—Part-7: Welding of cast irons.
EN 1418	1997	Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials
EN 1993-1-8	2005	Eurocode-3: Design of steel structures—Part-1-8: General –Design of joints

Number	Rev.	Title
EN 13133	2000	Brazing—Brazer approval
DIN 1910-100	2008	Welding; terms dependent on materials for metal welding
DIN 18800-7	2008	Steel structures - Part 7: Execution and constructor's qualification
SEW 088	1993	Schweißgeeignete Feinkornbaustähle - Richtlinien für die Verarbeitung besonders für das Schmelzschweißen, Stahlinstitut VDEh
Merkblatt DVS 0916	1997	Metall-Schutzgasschwißen von Feinkornbaustählen", Deutsche Verband für Schweißtechnik e.V.
AWS A02.4		Standard symbols for welding, brazing, and non-destructive examination
AWS A03.0	2001	Standard welding terms and definitions
AWS A05.1	2004	Specification for carbon steel electrodes for shielded metal arc welding
AWS A05.18		Specification for carbon steel electrodes and rots for gas shielded arc welding
AWS B01.10		Guide for the nondestructive examination of welds
AWS D01.1	2010	Structural welding (steel)
AWS D01.2	2008	Structural welding (aluminum)
AWS D01.3	1998	Structural welding (sheet steel)
AWS D01.4	1998	Structural welding (reinforcing steel)
AWS D01.5	2010	Bridge welding
AWS D01.6	2007	Structural welding (stainless steel)
AWS D01.7		Structural welding (strengthening and repair)
AWS D01.8	2009	Structural welding seismic supplement
AWS D01.9		Structural welding (titanium)
AWS D10.11		Root pass welding for pipe
AWS D01.12		Pipe welding (mild steel)
AWS D01.18		Pipe welding (stainless steel)

Chapter-4. Reference Japanese Technical Standards

The reference Japanese industrial standards for welding are organized in Table-33.

Table- 33: Reference Japanese Technical Standards

Number	Rev.	Title
JIS B8285	2010	Welding procedure qualification test for pressure vessels
JIS B8502	2011	Construction of welded aluminum and aluminum alloy storage tanks
JIS C3404	2000	Welding cables
JIS C9300-1	2008	Arc welding equipment - Part 1: Arc welding power sources
JIS C9300-6	2006	Arc welding equipment-Part 6: Limited duty manual metal arc welding power sources
JIS C9302	2004	Welding electrode holders for arc welding ***(Abolished)***
JIS C9303	2005	Stationary type single phase AC spot welding machines ***(Abolished)***
JIS C9304	1999	Spot welding electrodes
JIS C9305	2011	Resistance welding equipment
JIS C9307	1999	Projection welding machines ***(Abolished)***
JIS C9309	1989	Graphical symbols for electrical circuit of welding machine ***(Abolished)***
JIS C9310	1989	Electrical diagram for welding machine ***(Abolished)***
JIS C9311	2011	Voltage reducing devices for AC arc welding power sources
JIS C9313	2005	Control equipments of resistance welding machines for lap joint
JIS C9317	1995	Welding transformers for portable spot welding machines
JIS C9318	1999	Water-cooled secondary cables for portable spot welding machines
JIS C9319	1991	Thyristorstacks for resistance welding machine
JIS C9320	1977	Rotary Switches for Resistance Welding machines ***(Abolished)***
JIS C9321	2009	Condenser type spot welding machine ***(Abolished)***
JIS C9323	1999	Electric resistance welding－Transformers－General specifications applicable to all transformers
JIS G0584	2004	Ultrasonic examination for arc welded steel pipes
JIS K1105	2005	Argon
JIS K1106	2008	Liquid carbon dioxide
JIS Z2201	1998	Test pieces for tensile test for metallic materials ***(Abolished)***
JIS Z2204	1996	Bend test pieces for metallic materials ***(Abolished)***
JIS Z2241	2011	Metallic materials-Tensile testing-Method of test at room temperature
JIS Z2242	2005	Method for Charpy pendulum impact test of metallic materials
JIS Z2243	2008	Brinell hardness test-Test method
JIS Z2244	2009	Vickers hardness test-Test method
JIS Z2245	2011	Rockwell hardness test – Test method
JIS Z2246	2000	Shore hardness test－Test method
JIS Z2248	2006	Metallic materials-Bend test
JIS Z2300	2008	Terms and definitions of nondestructive

Number	Rev.	Title
JIS Z2305	2001	Non-destructive testing－Qualification and certification of personnel
JIS Z2306	2009	Radiographic image quality indicators for non-destructive testing
JIS Z2343-1	2010	Non-destructive testing－Penetrant testing－Part 1 : General principles－Method for liquid penetrant testing and classification of the penetrant indication
JIS Z2343-2	2006	Non-destructive testing---Penetrant testing—Part2: Testing of penetrant materials
JIS Z2343-3	2010	Non-destructive testing---Penetrant testing—Part3: Reference test blocks
JIS Z2343-4	2010	Non-destructive testing---Penetrant testing—Part4: Equipment
JIS Z2345	2010	Standard test blocks for ultrasonic testing
JIS Z3001-1	2008	Welding and allied processes—Vocabulary—Part 1 General
JIS Z3001-2	2008	Welding and allied processes—Vocabulary—Part 2 Welding processes
JIS Z3001-3	2008	Welding and allied processes-Vocabulary-Part 3: Soldering and brazing
JIS Z3001-4	2008	Welding and allied processes - Vocabulary - Part 4: Imperfections in fusion welding
JIS Z3011	2004	Welding position defined by means of angles of slope and rotation
JIS Z3040	1995	Method of qualification test for welding procedure
JIS Z3043	1990	Method of welding procedure qualification test for stainless－Clad steel
JIS Z3044	1991	Method of welding procedure qualification test for nickel and nickel alloy clad steels
JIS Z3050	2010	Method of nondestructive examination for weld of pipeline
JIS Z3060	2011	Method for ultrasonic examination for welds of ferritic steel
JIS Z3070	1998	Methods for automatic ultrasonic testing for welds of ferritic steel
JIS Z3080	1995	Methods of ultrasonic angle beam examination for butt welds of aluminum plates
JIS Z3081	1994	Methods of ultrasonic angle beam examination for welds of aluminum pipes and tubes
JIS Z3082	1995	Methods of ultrasonic examination for T type welds of aluminum plates
JIS Z3090	2005	Visual testing method of fusion-welded joints
JIS Z3101	1990	Testing method of maximum hardness in weld heat－Affected zone
JIS Z3103	1987	Method of repeated tension fatigue testing for fusion welded joints
JIS Z3104	2010	Methods of radiographic examination for welded joints in steel
JIS Z3105	2003	Method of radiographic examination for fusion welded butt joints of aluminum plates
JIS Z3106	2001	Methods of radiographic examination for welded joints in stainless steel
JIS Z3107	1993	Methods of radiographic examination for titanium welds by X-ray
JIS Z3111	2005	Methods of tension and impact tests for deposited metal
JIS Z3114	1990	Method of hardness test for deposited metal
JIS Z3115	1973	Method of taper hardness test in weld heat－Affected zone
JIS Z3118	2007	Method for measurement of amount of hydrogen evolved from steel welds
JIS Z3119	2006	Methods of measurement for ferrite content in austenitic and austenitic-ferritic stainless steel deposited metal
JIS Z3121	1993	Methods of tensile test for butt welded joints
JIS Z3122	1990	Methods of bend test for butt welded Joint
JIS Z3128	1996	Method of Impact test for welded Joint
JIS Z3129	2005	Test method and preparation of test specimens for single-run and two-run welding technique in steel
JIS Z3131	1976	Method of tension test for front fillet welded joint

Number	Rev.	Title
JIS Z3132	1976	Method of shear test for side fillet welded joint
JIS Z3134	1965	Method of bend test for T type fillet welded joint
JIS Z3135	1971	Method of Soundness Test for Fillet welds ***(Abolished)***
JIS Z3136	1999	Specimen dimensions and procedure for shear testing resistance spot and embossed projection welded joints
JIS Z3137	1999	Specimen dimensions and procedure for cross tension testing resistance spot and embossed projection welded joints
JIS Z3138	1989	Method of fatigue testing for spot welded joint
JIS Z3139	2009	Methods of macro testing and Vickers hardness testing for section of resistance spot, projection and seam welds
JIS Z3140	1989	Method of inspection for spot weld
JIS Z3141	1996	Method of test for seam welded joints
JIS Z3143	1996	Method of test for butt pressure welded joints
JIS Z3144	1996	Routine test of resistance spot and projection welds
JIS Z3153	1993	Method of T-joint weld cracking test
JIS Z3154	1993	Method of controlled thermal severity weld cracking test
JIS Z3155	1993	Method of FISCO test
JIS Z3157	1993	Method of U-groove weld cracking test
JIS Z3158	1993	Method of y-groove weld cracking test
JIS Z3159	1993	Method of H－type restrained weld cracking test
JIS Z3181	2005	Method of fillet weld test for welding consumables
JIS Z3183	1993	Classification and testing methods for deposited metal of submerged arc welding for carbon steel and low alloy steel
JIS Z3200	2005	Welding consumables-Technical delivery conditions for welding filler materials-Type of products, dimensions, tolerances and markings
JIS Z3201	2001	Gas welding rods for mild steel
JIS Z3202	1999	Copper and copper alloy gas welding rods
JIS Z3211	2008	Covered electrodes for mild steel
JIS Z3212	2007	Covered electrodes for high tension steel ***(Abolished)***
JIS Z3214	2007	Covered electrodes for atmospheric corrosion resisting steel
JIS Z3221	2008	Stainless steel covered electrodes
JIS Z3223	2010	Covered electrodes for molybdenum steel and chromium molybdenum steel
JIS Z3224	2010	Nickel and nickel-alloy covered electrodes
JIS Z3225	2007	Covered electrodes for 9% nickel steel
JIS Z3231	2007	Copper and copper alloy covered electrodes
JIS Z3232	2009	Aluminum and aluminum alloy welding rods and wires
JIS Z3233	2001	Tungsten electrodes for inert gas shielded arc welding, and for plasma cutting and welding
JIS Z3234	1999	Copper alloys for resistance welding electrode
JIS Z3241	2007	Covered electrodes for low temperature steel ***(Abolished)***
JIS Z3251	2006	Covered electrodes for hardfacing
JIS Z3252	2008	Covered electrodes for cast iron

Number	Rev.	Title
JIS Z3253	2011	Shielding gases for fusion welding and thermal
JIS Z3312	2009	Solid wires for MAG and MIG welding of mild steel, high strength steel and low temperature service steel
JIS Z3313	2009	Flux cored wires for gas shielded and self-shielded metal arc welding of mild steel, high strength steel and low temperature service steel
JIS Z3315	2007	Solid wires for CO_2 gas shielded arc welding for atmospheric corrosion resisting steel
JIS Z3316	2011	Solid wires and rods for TIG welding of mild steel, high strength steel and low temperature service steel
JIS Z3317	2011	Solid wire electrodes, wires and rods for gas-shielded arc welding of molybdenum steel and chromium molybdenum steel
JIS Z3318	2010	Flux cored wires for MAG welding of molybdenum steel and chromium molybdenum
JIS Z3319	2007	Flux cored wires for electro gas arc welding
JIS Z3320	2007	Flux cored wires for CO_2 gas shielded arc welding of atmospheric corrosion resisting steel
JIS Z3321	2010	Stainless steel rods, wires and strip electrodes for welding
JIS Z3322	2010	Classification and testing methods for weld metal of stainless steel overlay welding with strip
JIS Z3323	2007	Stainless steel flux cored wires and rods for arc welding
JIS Z3324	2010	Classification and testing methods for deposited metal of stainless steel by submerged arc welding
JIS Z3325	2008	Solid wire for MAG welding of low temperature steel ***(Abolished)***
JIS Z3326	2007	Arc welding flux cored wires for hardfacing
JIS Z3331	2011	Welding rods and solid wires for welding of titanium and titanium alloys
JIS Z3332	2007	Filler rods and solid wires for TIG welding of 9% nickel steel
JIS Z3333	2007	Submerged arc welding solid wires and fluxes for 9% nickel steel
JIS Z3334	2011	Nickel and nickel-alloy rods, solid wires and strip electrodes for welding
JIS Z3341	2007	Copper and copper alloy rods and solid wires for inert gas shielded arc welding
JIS Z3351	2007	Submerged arc welding solid wires for carbon steel and low alloy steel
JIS Z3353	2007	Electroslag welding solid wires and fluxes for mild steel and high strength steel
JIS Z3400	1999	Quality requirements for welding－Fusion welding of metallic materials
JIS Z3410	1999	Welding coordination－Tasks and responsibilities
JIS Z3420	2003	Specification and approval of welding procedures for metallic materials – general rules
JIS Z3422-1	2003	Specification and approval of welding procedures for metallic materials - Welding procedure tests - Arc and gas welding of steels and arc welding of nickel and nickel alloys
JIS Z3422-2	2003	Specification and qualification of welding procedures for metallic materials - Welding procedure test - Arc welding of aluminum and its alloys
JIS Z3604	2002	Recommended practice for inert gas shielded arc welding of aluminum and aluminum alloys
JIS Z3607	1994	Recommended practice for friction welding of carbon steel
JIS Z3621	1992	Recommended practice for brazing
JIS Z3700	2009	Methods of post weld heat treatment
JIS Z3703	2004	Welding-Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature

Number	Rev.	Title
JIS Z3801	1997	Standard qualification procedure for manual welding technique
JIS Z3805	1997	Standard qualification procedure for welding technique of titanium
JIS Z3811	2000	Standard qualification procedure for welding technique of aluminum and aluminum alloy
JIS Z3821	2001	Standard qualification procedure for welding technique of stainless steel
JIS Z3831	2002	Standard qualification procedure for welding technique of plastics
JIS Z3841	1997	Standard qualification procedure for semi-automatic welding technique
JIS Z3861	1979	Standard qualification procedure for radiographic testing technique of welds
JIS Z3871	1987	Standard qualification procedure for ultrasonic testing technique of aluminum and aluminum alloy welds
JIS Z3881	2009	Standard qualification procedure for gas pressure welding technique of steel bars for concrete reinforcement
JIS Z3891	2003	Standard qualification procedure for silver brazing technique
JIS Z4560	2008	Industry γ-ray apparatus for radiography
JIS Z4561	2008	Viewing illuminators for industrial radiograph
JIS Z4606	2000	Industrial---X-ray apparatus for radiographic testing

JGA	2006	Guideline for high pressure gas pipeline
JGA	2008	Check point of the welding procedure
JGA	1998	Guideline for cylindrical gasholder
JGA	1982	Guideline for water seal gasholder
JGA	2011	Guideline of seismic design for gas generation facility
JGA	2006	Guideline for high pressure gas pipeline
JGA	2008	Check point of the welding procedure
JGA-102-03	2006	Guideline for equipments of LNG receiving terminal
JGA-104-03	2004	Guideline for spherical gas storage tank
JGA-105-02	2002	Guideline for equipments of small-scale LNG base
JGA-106-05	1992	Guideline for LPG storage tank
JGA-107-02	2002	Guideline for underground LNG storage tank
JGA-108-02	2002	Guideline for aboveground LNG storage tank

Chapter-5. Reference TCVN

The reference Vietnamese national standards for welding are organized in Table-34.

Table- 34: Reference TCVN

Number	Rev.	Title
TCVN 1548	1987	Non-destructive testing for welded joints. Ultrasonic methods
TCVN 1691	1975	Manual arc-welded joints. Types and basic dimensions
TCVN 3146	1986	Electric welding works. General safety requirements
TCVN 3187	1979	Arc-welding generators
TCVN 3188	1979	Arc-welding machines
TCVN 3223	2000	Covered electrodes for manual arc welding of mild steel and low alloy steel. Symbol, dimension and general technical requirement
TCVN 3734	1989	Electrodes for arc welding. Symbols
TCVN 3746	1983	System for design documentation. Symbolic designations and representations of welded joints
TCVN 3783	1983	Electrowelded and seamless steel tubes for automotive and bicycle industries
TCVN 3812	1983	Technological documentation. Rules of making documents on welding
TCVN 3909	2000	Covered electrodes for manual arc welding of mild steel and low alloy steel. Test method
TCVN 4394	1986	Non-destructive testing. Classification and evaluation of welding seam defects by means of radiogrammes
TCVN 4395	1986	Non-destructive testing. Radiographic testing of welded joints in metallic materials using X and gamma-rays
TCVN 5017-1	2010	Welding and allied processes. Vocabulary. Part 1: Metal welding processes
TCVN 5017-2	2010	Welding and allied processes. Vocabulary. Part 2: Soldering and brazing processes and related terms
TCVN 5113	1990	Non-destructive testing. Quality classification for welded joints
TCVN 5318	2001	Machine tools. Determination of perpendicularity of the directions of two displacements. Test methods
TCVN 5400	1991	Welded joints. General requirements of sampling for mechanical test
TCVN 5402	2010	Welded joints. Blow-bending test method
TCVN 5584	1991	Edges of welded joints in steel submerged arc-welding. Shapes and dimensions
TCVN 5801-6B	2005	Rules for the classification and construction of inland waterway ships. Part 6B: Welding
TCVN 5873	1995	Welds in steel. Reference block for the calibration of equipment for ultrasonic examination
TCVN 5874	1995	Recommended practice for the X - ray inspection of fusion welded built joints for aluminum and its alloys and magnesium and its alloys 5 to 50 mm thick
TCVN 5875	1995	Radiographic inspection of electric resistance spot welds for aluminum and its alloys. Recommended practice
TCVN 6008	2010	Pressure equipment. Welded. Technical requirements and testing methods
TCVN 6113	1996	Seamless and welded (except submerged arc - welded) steel tubes for pressure purposes-full peripheral ultrasonic testing for the detection of longitudinal

Number	Rev.	Title
		imperfections
TCVN 6115-1	2005	Welding and allied processes. Classification of geometric imperfection in metallic materials. Part 1: Fusion welding
TCVN 6116	1996	Electric resistance and induction welded steel tubes for pressure purposes. Ultrasonic testing of the weld seam for the detection of longitudinal imperfections
TCVN 6259-6	2003	Rules for the classification and construction of sea-going steel ships. Part 6: Welding
TCVN 6413	1998	Stationary shell boilers of welded construction (other than water tube boilers)
TCVN-6475-12	2007	Rules for Classification and Technical Supervision of Subsea Pipeline Systems. Part 12: Weldings
TCVN 6700-1	2000	Approval testing of welders. Fusion welding. Part 1: Steels
TCVN 6700-2	2000	Approval testing of welders. Fusion welding. Part 2: Aluminum and aluminum alloys
TCVN 6735	2000	Ultrasonic examination of welds. Methods for manual examination of fusion welds in ferritic steels
TCVN 6834-1	2001	Specification and approval of welding procedures for metallic materials. Part 1: General rules for fusion welding
TCVN-6834-2	2001	Specification and approval of welding procedures for metallic materials. Part 2: Welding procedure specification for arc welding
TCVN-6834-3	2001	Specification and approval of welding procedures for metallic materials. Part 3: Welding procedure tests for the arc welding of steels
TCVN 6834-4	2001	Specification and approval of welding procedures for metallic materials. Part 4: Welding procedure tests for are welding of aluminum and its alloys
TCVN 7296	2003	Welding. General tolerances for welded constructions. Dimensions for lengths and angles. Shape and position
TCVN 7472	2005	Welding. Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded). Quality levels for imperfections
TCVN-7473	2005	Welding coordination. Tasks and responsibilities
TCVN 7474	2005	Arc- welded joints in aluminum and its weldable alloys. Guidance on quality levels for imperfections
TCVN-7506-4	2005	Quality requirements for welding. Fusion welding of metallic materials. Part 4: Elementary quality requirements
TCVN 7506-1	2005	Quality requirements for welding. Fusion welding of metallic materials. Part 1: Guidelines for selection and use
TCVN 7506-2	2005	Quality requirements for welding. Fusion welding of metallic materials. Part 2: Comprehensive quality
TCVN 7506-3	2005	Quality requirements for welding. Fusion welding of metallic materials. Part 2: Standard quality requirements
TCVN 7506-4	2005	Quality requirements for welding. Fusion welding of metallic materials. Part 4: Elementary quality requirements
TCVN 7507	2005	Non-destructive examination of welds. Visual examination
TCVN 7508	2005	Non-destructive examination of welds. Radiographic examination of welded joints. Acceptance levels
TCVN 8094-1	2009	Arc welding equipment. Part 1: Welding power sources

Chapter-6. Referenced Literature and Materials

The referenced books, literatures, standards to establishing this guideline are organized as follows.

1. Interpretation of technical regulation for thermal power facility(10/Jul/1007): NISA (Nuclear and Industrial Safety Agency) of METI (Ministry of Economy, Trade and Industry Japan)
2. Interpretation of technical regulation for gas facility (25/Mar/2010): NISA (Nuclear and Industrial Safety Agency) of METI (Ministry of Economy, Trade and Industry Japan)