



Education and Culture

Leonardo da Vinci

Course: 141 - TIG WELDING OF STAINLESS STEEL

Module 8

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MODULE 8

Introduction to ISO 14731 Welding Coordination (B9)

The tasks and responsibilities of personnel involved in welding coordination activities, shall to be clearly defined because each single activity can be associated with a number of tasks and responsibilities such as:

- specification and preparation,
- coordination,
- control,
- inspection, check or witnessing.

Where welding coordination is carried out by more than one person, the tasks and responsibilities shall be clearly allocated.

Welding coordination is the sole responsibility of the manufacturer.

The manufacturer shall appoint at least one responsible welding coordinator. The responsible welding coordinator may delegate specific welding coordination tasks.

Welding coordination may be subcontracted.

A clear identification of the assigned welding coordinator shall exist in respect to:

- position in the manufacturing organization and responsibilities.
- the extent of authorization to accept by signing on behalf of the manufacturing organization for e.g. procedure specification, supervision reports, as needed in order to fulfill the assigned tasks.
- the extent of authorization to carry out the assigned tasks.

For all tasks assigned the welding coordinators shall be able to demonstrate adequate technical knowledge to enable such tasks to be performed satisfactorily.

The following factors should be considered:

- general technical knowledge;
- specialized technical knowledge in welding and related processes relevant to the assigned tasks.

Responsible welding coordination personnel should usually have:

Comprehensive technical knowledge

Welding coordination personnel with full technical knowledge for planning, executing, supervisory and testing of all tasks and responsibilities in welding fabrication.

Specific technical knowledge

Welding coordination personnel where technical knowledge is sufficient for planning, executing, supervisory and testing of the tasks and responsibilities in welding fabrication within a selective or limited technical field.

Basic technical knowledge

Welding coordination personnel where technical knowledge is sufficient for planning, executing, supervisory and testing of the tasks and responsibilities within a limited technical field involving

only simple welded constructions.

Welding related tasks of the welding coordinator

Requirements review

- a) The product standard to be used, together with any supplementary requirements;
- b) the capability of the manufacturer to meet the prescribed requirements.

Technical review

- a) Parent material(s) specification and welded joint properties;
- b) joint location with relation to the design requirements;
- c) quality and acceptance requirements for welds;
- d) location, accessibility and sequence of welds including accessibility for inspection and NDT;
- e) other welding requirements, e.g. batch testing of consumables, ferrite content of weld metal, ageing, hydrogen content, weld profile;
- f) dimensions and details of joint preparation and completed weld.

Sub-contracting

Suitability of any sub-contractor for welding fabrication.

Welding personnel

Qualification of welders and welding operators, brazers and brazing operators.

Equipment

- a) suitability of welding and associated equipment;
- b) auxiliaries and equipment supply, identification and handling;
- c) personal protective equipment and other safety equipment, directly associated with the applicable manufacturing process
- d) equipment maintenance.

Production planning

- a) reference to the appropriate procedure specifications for welding and allied processes;
- b) sequence in which the welds are to be made;
- c) environment conditions (e.g. protection from wind, temperature and rain);
- d) allocation of qualified personnel;
- e) equipment for preheating and post-heat treatment including temperature indicator.

Qualification of the welding procedures

Method and range of qualification.

Welding procedure specifications

Range of qualification.

Work instructions

Issue and use of work instruction.

Welding consumables

- a) compatibility;
- b) delivery conditions;
- c) any supplementary requirements in welding consumable purchasing specifications including the

type of welding consumables certificate;
d) storage and handling of welding consumables.

Materials

- a) any supplementary requirements in the material purchasing specifications including the type of material certificate;
- b) storage and handling of parent material;
- c) traceability.

Inspection and testing before welding

- a) suitability and validity of welders qualification certificates;
- b) suitability of welding procedure specification;
- c) identity of parent material;
- d) identity of welding consumables;
- e) joint preparation (e.g. shape and dimensions);
- f) fit-up, jiggling and tacking;
- g) any special requirements in the welding procedure specification (e.g. prevention of distortion);
- h) arrangement for any production test;
- i) suitability of working conditions for welding, including environment.

Inspection and testing during welding

- a) Essential welding parameters (e.g. welding current, arc voltage and travel speed);
- b) preheating/interpass temperature;
- c) cleaning and shape of runs and layers of weld metal;
- d) back gouging;
- e) welding sequence;
- f) correct use and handling of welding consumables;
- g) control of distortion;
- h) any intermediate examination (e.g. checking dimensions).

Inspection and testing after welding

- a) by visual inspection (completeness of welding, weld dimensions, shape);
- b) by non-destructive testing;
- c) by destructive testing;
- d) form, shape, tolerance and dimensions of the construction;
- e) results and records of post-operations (e.g. post-weld heat treatment, ageing).

Post weld heat treatment

Performance in accordance with the specification.

Non-conformance and corrective actions

Necessary measures and actions (weld repairs, re-assessment of repaired welds, corrective action).

Calibration and validation of measuring, inspection and testing equipment

Necessary methods and actions.

Identification and traceability

- a) identification of production plans;
- b) identification of routing cards;

- c) identification of weld locations in construction;
- d) identification of non-destructive testing procedures and personnel;
- e) identification of welding consumable (e.g. designation, trade name, manufacturer of consumables and batch or cast numbers);
- f) identification and/or traceability of parent material (e.g. type, cast number);
- g) identification of location of repairs;
- h) identification of location of temporary attachments;
- i) traceability for fully mechanized and automatic weld-equipment to specific welds;
- j) traceability of welder and welding operators to specific welds;
- k) traceability of welding procedure specification to specific welds.

Quality records

Preparation and maintenance of the necessary records (including subcontracted activities).

Surface inspection on cracks and other surface imperfections by visual testing (B8)

Visual examination is a simple, accessible low - cost inspection method, and it is an excellent process-control tool to help avoid subsequent fabrication problems and evaluate workmanship. Visual inspection only identifies surface discontinuities. Consequently, any conscientious quality control program should include a sequence of examinations performed during all phases of fabrication.

Visual Inspection is performed in three phases.

- I. Prior to Welding.
- II. During Welding.
- III. After Welding.

I. Prior to Welding.

Some typical action items requiring attention should include the followings:

- i. Groove angle.
- ii. Root openings.
- iii. Joint alignment.
- iv. Backing.
- v. Consumable insert.
- vi. Joint cleanliness.
- vii. Tack welds
- viii. Preheat (if required)

II. During Welding.

Some typical action items requiring attention by those responsible for weld quality should include the followings:

- a. Check preheat and interpass temperatures.

- b. Check conformance to Welding Procedure Specification or Weld Schedule.
- c. Examine weld root pass.
- d. Examine weld layers.
- e. Examine second side prior to welding

Any of these factors, if ignored could result in discontinuities that could cause serious degradation.

III. After Welding.

Following welding, some typical action items requiring attention by the visual inspector should include followings:

- a. Examination of weld surface quality.

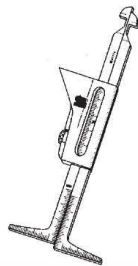
The typical discontinuities found at the surface are as:

- i. Porosity
 - ii. Lack of fusion
 - iii. Incomplete joint penetration
 - iv. Undercut
 - v. Underfill
 - vi. Overlap
 - vii. Cracks
 - viii. Metallic and non-metallic inclusions
 - ix. Excessive and negative reinforcement
 - x. Off set
 - xi. Arc Strikes
 - xii. Suck back
 - xiii. Overlay
 - xiv. Burn thru
 - xv. Discoloration
- b. Verifying weld dimensions
 - c. Verifying dimensional accuracy
 - d. Reviewing subsequent requirements

WELDING INSPECTION: Welding Gauges

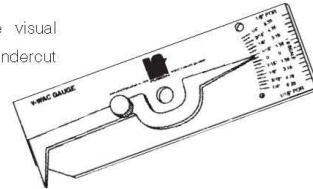
Hi-Lo weld gauges (Gal)

measure crown height of welds, fillet weld size, internal misalignment, bevel on end preparation, fit-up gap, pipe wall thickness, scribe line and socket welds.



“V-WAC”

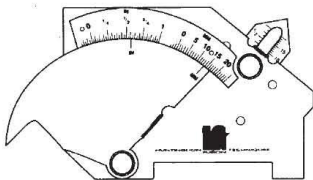
Simple to use for the visual inspection of welds for undercut depth, crown height, porosity comparison and the amount of porosity per linear inch.



“Pearson Mastergag”

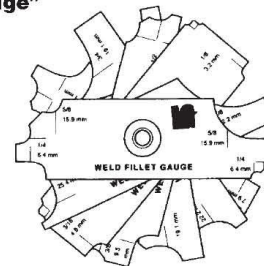
formerly known as Cambridge type or Welding Institute gauge.

Measures fillet leg length and weld throat size, undercut and pitting depth, excess weld metal, root and face gap, angle of preparation and misalignment.



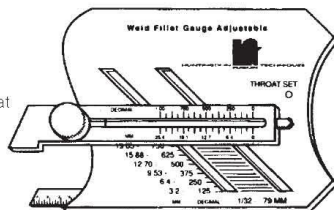
“Fillet Welding Gauge”

Measures 11 fillet weld sizes for concave or convex welds.



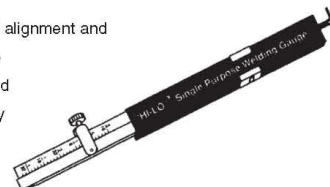
“Adjustable Fillet Weld Gauge” (Gal)

measures fillet welds, unequal weld leg lengths and weld throat thicknesses.



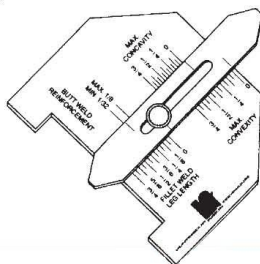
“Simple Purpose HI-LO”

Checks the internal alignment and rootweld spacing to eliminate rejects and improve productivity



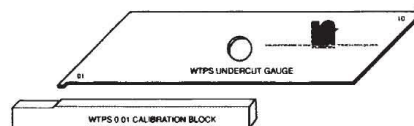
“AWS Weld Gauge”

determines the size of a fillet weld and checks the permissible tolerances of convexity, concavity and reinforcement.



“Simple Purpose HI-LO”

Measures undercuts 0.25 mm deep. The calibration block has been surface ground to 0.0005” tolerance for exceptional accuracy.



Non destructive evaluation of welded joints

The application of non-destructive testing is highly dependent on the geometrical conditions of the component, the configuration and accessibility of the joint. This is particularly true for volumetric methods, radiographic and ultrasonic testing.

The methods for surface testing visual, magnetic particle, penetrant and eddy current are primarily dependent on the surface conditions and accessibility.

This document shows examples for general non destructive evaluation of welded joints in table 1. More specific examples for the evaluation of different weld types representing various applications are shown in table.







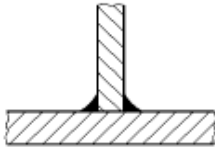
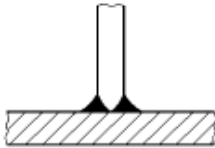
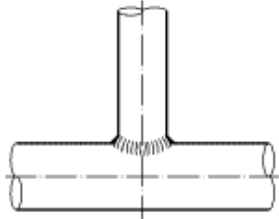
The examples are intended to give guidance when planning for non-destructive testing during design and fabrication. Each serial number starts with a joint configuration,

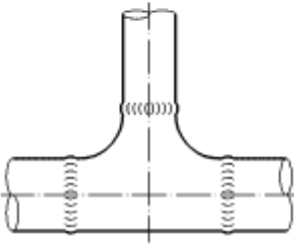
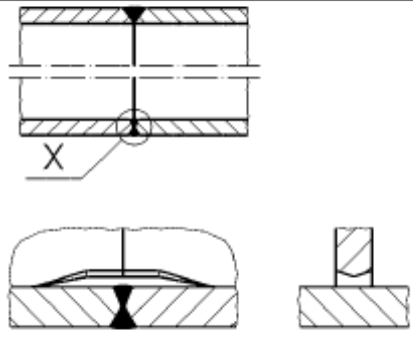
- a) showing the least acceptable configuration for testing, and
- b) a better joint configuration for testing, and
- c) the best configuration.

The following conventions are also used:

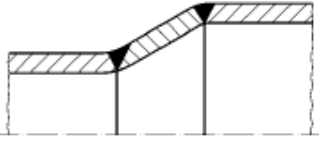

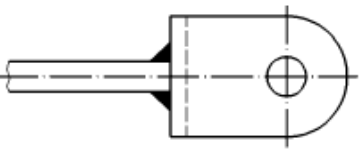
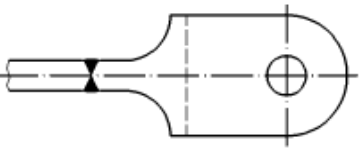
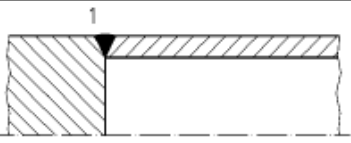
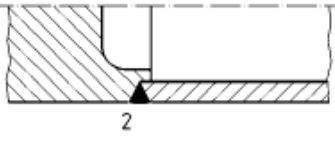
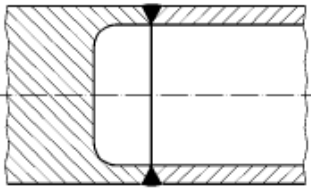
- + implies that the method is applicable and that the results will satisfy ordinary requirements;
- (+) implies that the method has a limited application. The method should be supplemented with another method;
- implies that the method cannot be used or that the results are not sufficient.

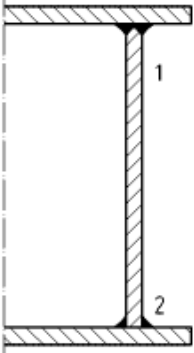
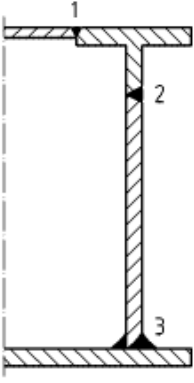
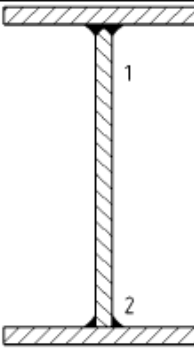
General evaluation of welded joints:

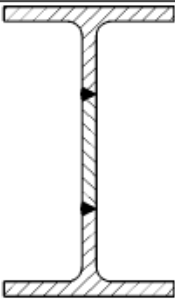
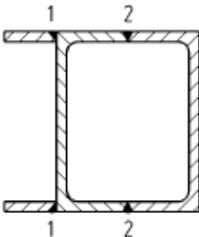
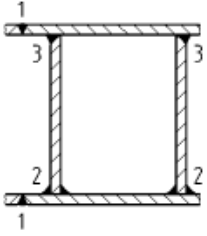
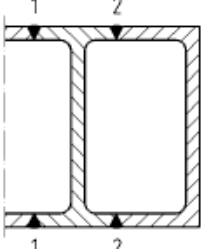
Serial no.	Example	NDT method				
		VT	UT	RT	MT	PT
1a		+	-	(+)	+	+
1b		+	(+)	+	+	+
1c		+	+	+	+	+
1d		+	+	+	+	+
2a		+	+	+	+	+
2b		+	+	+	+	+
3a		+	(+)	(+)	+	+
3b		+	+	(+)	+	+
4a		+	(+)	(+)	+	+

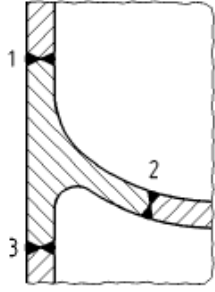
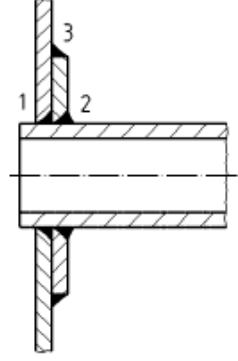
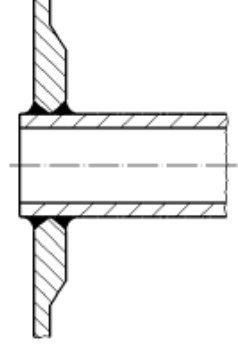
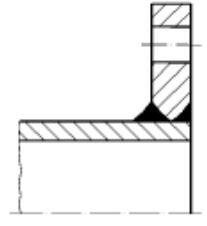
Serial no.	Example	NDT method				
		VT	UT	RT	MT	PT
4b		+	+	+	+	+
5a		+	+	+	+	+

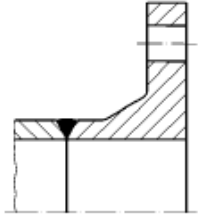
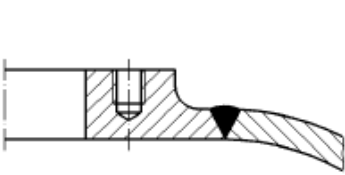

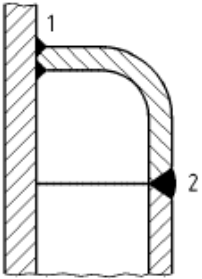
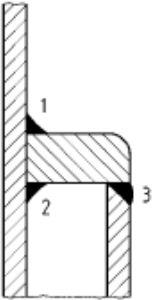
Evaluation of specific examples of welded joints

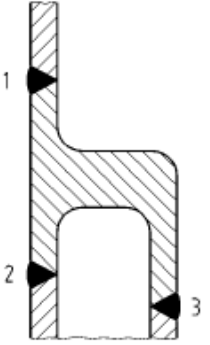
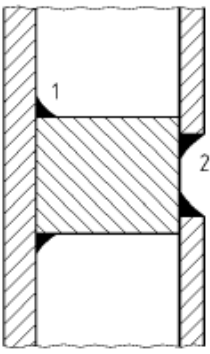
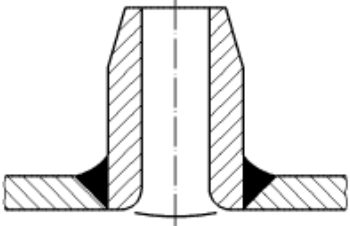
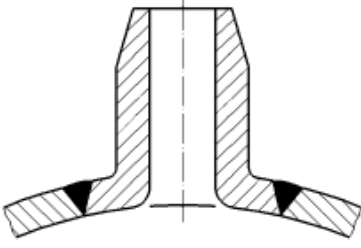
Serial no.	Example		NDT method					Remarks
			VT	UT	RT	MT	PT	
1a			+	+	(+)	+	+	
1b			+	+	+	+	+	More suitable for examination than 1a
2a			+	-	-	+	+	
2b			+	+	+	+	+	
3a		1	+	+	-	+	+	
3b		2	+	+	+	+	+	
3c			+	+	+	+	+	More suitable for examination than 3b

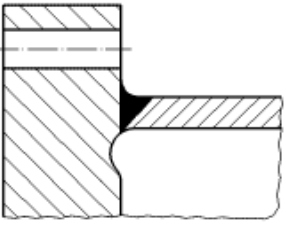
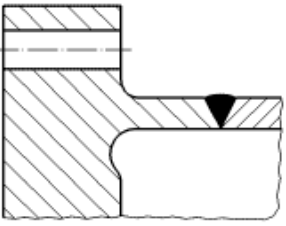
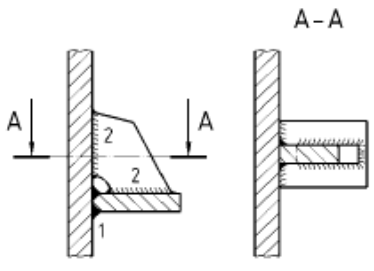
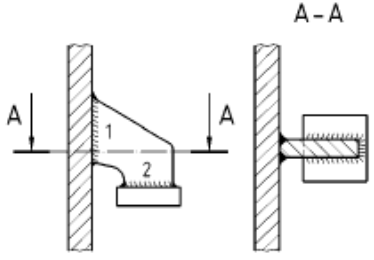
Serial no.	Example	Welded joint	NDT method					Remarks
			VT	UT	RT	MT	PT	
4a		1	-	+	-	+	(+)	Accessibility is restricted to one side
		2	-	+	-	+	(+)	
4b		1	-	+	-	+	(+)	Accessibility is restricted to one side
		2	-	+	-	+	(+)	
		3	-	+	-	+	(+)	
5a		1	-	+	(+)	+	+	
		2	+	(+)	(+)	+	+	

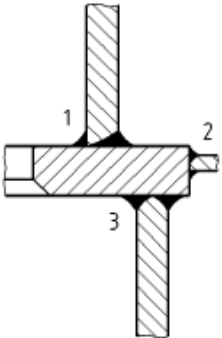
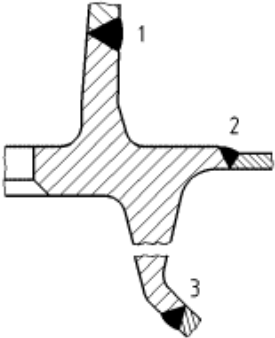
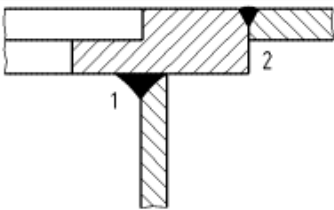
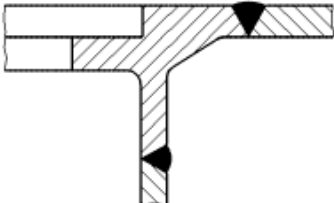
Serial no.	Example	Welded joint	NDT method					Remarks
			VT	UT	RT	MT	PT	
5b			+	+	+	+	+	
6a		1	+	+	(+)	+	+	Variant 2a: accessible from all surfaces Variant 2b: not accessible from internal surfaces * if double wall radiography taking the thicknesses into consideration
		2a	+	+	+	+	+	
		2b	(+)	+	+*)	(+)	(+)	
6b		1	+	+	+	+	+	To be carried out prior to weld n° 3
		2	+	(+)	(+)	+	+	
		3	+	+	(+)	+	+	
6c		1	+	+	+	+	+	Variant a: accessible from all surfaces Variant b: not accessible from internal surfaces * if double wall radiography taking the thicknesses into consideration
		2a	+	+	+	+	+	
		2b	+	+	+*)	+	+	

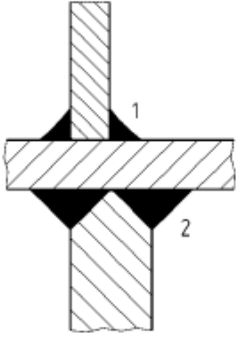
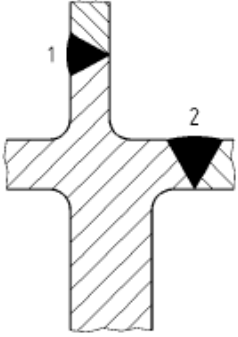
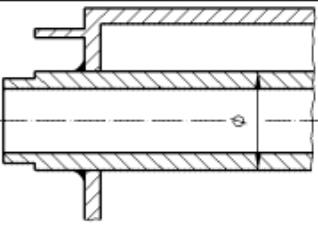
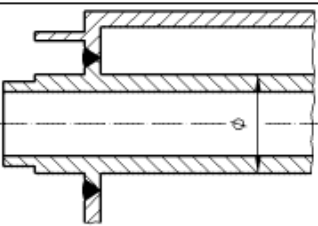
Serial no.	Example	Welded joint	NDT method					Remarks
			VT	UT	RT	MT	PT	
9b		1 2 3	+	+	+	+	+	
10a		1 2 3	+	-*)	(+)	+	+	Prior to welding of reinforcement ring *) accessible from internal surface
10b			+	-*)	(+)	+	+	*) accessible from internal surface
11a			+	+)*)	(+)*)	+	+	*) accessible from internal surface

Serial no.	Example	Welded joint	NDT method					Remarks
			VT	UT	RT	MT	PT	
11b			+	+	+	+	+	
12			+	+	+	+	+	
13a			+	+	-	+	+	
13b		1a	+	+	(+)	+	+	prior to welding weld 2
		1b	+	+	-	(+)	(+)	after welding weld 2
		2	+	+	*)	+	(+)	* if double wall radiography taking the thicknesses into consideration
14a		1	+	(+)	(+)	+	+	
		2a	+	(+)	(+)	+	+	2a: prior to welding weld n°3
		2b	-	(+)	-	-	-	2b: after welding weld n°3
		3	+	+	-	+	+	

Serial no.	Example	Welded joint	NDT method					Remarks
			VT	UT	RT	MT	PT	
14b		1	+	+	+	+	+	2a: prior to welding weld n°3 2b: after welding weld n°3 *) double wall radiography
		2a	+	+	+	+	+	
		2b	(+)	+	*)	(+)	(+)	
		3	+	+	*)	+	+	
15		1	+	(+)	(+)	+	+	1: prior to welding weld n°2
		2	+	-	-	+	+	
16a			+	+	(+)	+	(+)	
16b			+	+	+	+	+	

Serial no.	Example	Welded joint	NDT method					Remarks
			VT	UT	RT	MT	PT	
17a			+	+*)	(+)	+	+	*) more favourable prior to drilling
17b			+	+	+	+	+	
18a		1a	+	+	(+)	+	+	1a: prior to welding of support plate
		1b	+	+*)	(+)*	+	+	1b: after to welding of support plate
		2	+	-	(+)	+	+	*) restricted in the area of support plate
18b		1	+	+	(+)	+	+	
		2	+	-	(+)	+	+	

Serial no.	Example	Weld joint	NDT method					Remarks
			VT	UT	RT	MT	PT	
19a		1	+	+	(+)	+	+	
		2	+	-		+	+	
		3	+	+	(+)	+	+	
19b		1	+	+	+	+	+	
		2	+	+	(+)	+	+	
		3	+	+	+	+	+	
20a		1	+	(+)	(+)	+	+	
		2	+	-	-	+	+	
20b			+	+	+	+	+	

Serial no.	Example	Weld joint.	NDT method					Remarks
			VT	UT	RT	MT	PT	
21a		1	+	-	-	+	+	
		2	+	(+)	-	+	+	
21b		1	+	+	+	+	+	
		2	+	+	+	+	+	
22a			+	-	-	+	+	
22b			+	(+)	+	+	+	

Welders qualification and qualification standards

The testing of a welder's skill in accordance with EN 287-1 standard depends on welding techniques and conditions used in which uniform rules are complied with, and standard test pieces are used.

The principle of EN 287-1 standard is that a qualification test qualifies the welder not only for the conditions used in the test, but also for all joints which are considered to weld easier on the presumption that the welder has received a particular training and/or has industrial practice within the range of qualification.

The qualification test can be used to qualify a welding procedure and a welder provided that all the relevant requirements, e.g. test piece dimensions, are satisfied.

Accredited and none-accredited certification

Within the European system, there are a number of standards (EN 45000 series) that include regulations for testing the ability of inspection organs to act as third party Body. Its aim is to ensure that the inspection organs acting in Europe carry out equivalent assessments so that the results can be approved by all the member countries. The inspection organs that are approved according to these requirements become accredited for a certain certification task.

A Manufacturer may be certified by a Accredited or a non-accredited Certification Body (national or international). Both accreditations are valid but the certification realized by an Accredited Certification Body has a much larger recognition.

Maintenance and prolongation of certificates

The welder's qualification test certificate issued is valid for a period of two years. This is providing that the welding coordinator or the responsible personnel of the employer can confirm that the welder has been working within the initial range of qualification. This shall be confirmed every six months.

Welder's qualification test certificates according to EN 287-1 standard can be prolonged every two years by an examiner/examining body.

Before prolongation of the certification takes place, 9.2 needs to be satisfied and also the following conditions need to be confirmed:

- a) All records and evidence used to support prolongation are traceable to the welder and identifies the WPS that have been used in production;
- b) Evidence used to support prolongation shall be of a volumetric nature (radiographic testing or ultrasonic testing) or for destructive testing (fracture or bends) made on two welds during the previous six months.

Evidence relating to prolongation needs to be retained for a minimum of two years;

- c) The welds satisfy the acceptance levels for imperfections as specified in clause 7;
- d) The test results shall demonstrate that the welder has reproduced the original test conditions, except for thickness and outside pipe diameter.

Essential variables for the certificates

The qualification of welders is based on essential variables. For each essential variable a range of qualification is defined. All test pieces shall be welded using the essential variables independently.

If the welder has to weld outside the range of qualification a new qualification test is required.

The essential variables are:

- welding process,
- product type (plate and pipe),
- type of weld (butt and fillet),
- material group,
- welding consumable,
- dimension (material thickness and outside pipe diameter),
- welding position,
- weld detail (backing, single side welding, both side welding, single layer, multi layer, leftward welding, rightward welding).