Base Load Power Hub (BLPH)

NDE PROCEDURES

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Revision / Change Log

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IOP-VT-2023263-01
VISUAL EXAMINATION INSTRUCTION

Project: **123A90A - Base Load Power Hub Platform**

Client: **Rosetti Marino SpA**

Revision matrix (revised where underlined)

0	11/12/2023	Gianessi A.	Macor M.	Nali M.
Rev.	**Date**	**Issued**	**Checked**	**Approved**

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1. SCOPE

This procedure is intended for the visual examination of welds and HAZ on longitudinal welds of pipes in ferromagnetic steel and for the dimensioning of indications by means of comparison with Acceptance Standards .

Visual examination shall be used to evaluate an item by observation, such as: the correct assembly, evidence of leaking, surface conditions, shape, or cleanliness of materials, parts, and components used in the fabrication and construction of structure.

This procedure shall be applied solely by the qualified Quality Control Personnel for the visual inspection of the welds and materials

The visual inspection shall be executed during the following fabrication stages:

a) on completion of the cutting of the pieces to be welded;
b) on completion of the fit-up before start of welding;
c) during welding and after back-gouging;
d) on completion of the welding;
e) before start of welding repairs;
f) on completion of the repair of welds and base material;
g) on completion of the whole fabrication process.

- Quality level in accordance to EEMUA 158 table 14 and ISO 5817: Level C

2. REFERENCE DOCUMENTS

- EN ISO 17637: Non destructive testing of welds. Visual testing of fusion-welded joints
- EN ISO 5817: Fusion welded joints in steel, ... – Quality levels for imperfections
- EN 473: Qualification and Certification of NDT Personnel.
- ISO 9712: Qualification and Certification of NDT Personnel.
- EEMUA 158: Construction Specification for fixed offshore structures

3. PERSONNEL QUALIFICATION

Examination shall be carried out by NDE examiners holding a level II or III qualification in accordance with the following document or other equivalent standard:

- EN 473
- ISO 9712

The personnel employed for the execution of NDE Examination shall have an annual vision test to assure:

- Near vision acuity: the examination should ensure natural or corrected near distance acuity such that they are capable of reading standard J-1 letters on standard Jaeger test type charts or Times Roman No.4,5 (having a height of 1,6mm) or equivalent characters to a distance of not less than 30 cm with one or both eyes. Equivalent near vision tests are acceptable

- Color contrast differentiation: the examination should demonstrate the capability of distinguishing and differentiating contrast among colors or shades of gray (reading of Ishiara test or equivalent)

4. EXTENT OF EXAMINATION

Extent of Examination shall be as follow:

- From outside: 100% on longitudinal welds after weld completion
- From inside:
  - For diameter equal to or greater than 800 mm, 100% on longitudinal welds after weld completion
  - For diameter less than 800 mm, the welds shall be inspected for a length equal to the outer diameter at both pipe ends.

The width of the surface shall include the weld metal and the adjacent parent metal up to a distance of 20 mm on each side of the weld.

5. TIME OF EXAMINATION

Visual Examination shall be carried out at least 24 hours following completing of welding. When PWHT is performed, final Visual Examination shall be carried out when all heat treatments have been completed.

6. SURFACE CONDITIONS

The surface to be inspected shall be cleaned from any dirt, oil, grease, scales, slag and any other contaminations which may interfere with the scanning or interpretation of the results: when the base material or weld surface interferes with the examination, the base material or weld shall be prepared as needed to permit the examination.

Base material surface adjacent to the weld, shall be prepared to a distance at least 25 mm on either side of the weld: shall be free of weld spatter, rust or other foreign particles which could interfere with examination and this could be obtained by sandblasting or light grinding

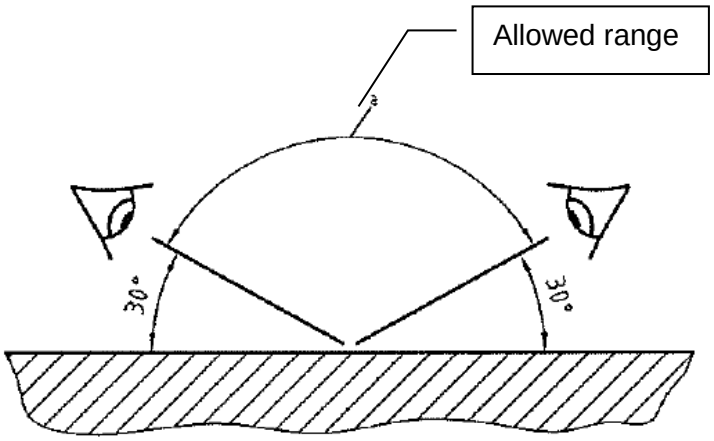
The weld surface should be free of irregularities that could impede examination, offer reasonably smooth surface with minimal undercut, rippling and spatter and should merge smoothly into the adjacent base materials. “As welded” weld surface condition is acceptable to perform correctly the examination. If undercuts, imperfect shape, incorrect weld toe or other surface discontinuities are clearly visible before examination start, these shall be removed with adequate operations (grinding, welding etc.).

If "PWHT" is required, any Welding Remedial shall be done "before PWHT" and to the correct Weld Repair Procedure.

7. EXAMINATION TECHNIQUE

7.1 Direct Visual Examination.

Direct Visual Examination technique is used when access is sufficient to place the eye at 24 in. (600 mm) or less from the surface to be examined and at an angle not less than 30 deg. Mirrors may be used to improve the angle of vision, and aids such as a magnifying lens may be used to assist examination for small defects and where a greater sensitivity is required. Illumination (natural or supplemental white light) for the specific part, component, or section thereof being examined is required. The minimum light intensity at the examination surface shall be 500 lux.



8. DEMONSTRATION

A fine line or wire 1/32 in (0.8 mm) or less in width, located on the surface or a similar surface to that to be examined, may be considered as a method for procedure demonstration. The artificial imperfection should be in the least discernible location on the surface area to be examined to validate the procedure.

9. EXAMINATION AIMS

9.1 Examination of cut surfaces.

Surfaces and edges to be welded shall be in conformity to the construction drawings and relevant WPS: free of indentations, smooth, uniform, and free from fins, tears, cracks, and other discontinuities which would adversely affect the quality or strength of the weld. Surfaces to be welded and surfaces adjacent to a weld shall also be free from loose or thick scale, slag, rust, moisture, grease, and other foreign material that would prevent proper welding.
When possible, the examination shall be carried out on completion of the blast cleaning operation.

9.2 Examination of the assembled pieces

The tack welds shall be carried out by qualified welders, intact and free of defects.
Defective tack welds shall be totally removed prior to any subsequent operation being carried out.
The distance between the edges to be welded shall comply with the construction drawings and the relevant welding procedure.
The edge misalignment for butt welds shall be less than 10% of the lower thickness but not greater than 3 mm.

9.3 Weld and surrounding area examination

The examination shall be carried out in order to verify as follows:

a) the presence of superficial defects like cracks, worm and gas holes, weld spatter, blow holes, etc.;
b) the presence of undercuts between base material and weld;
c) the presence of undercuts between the different runs of the same weld;
d) dimensional conformity of the weld profile to the construction drawing and to the relevant welding procedure;
e) the dimension of the weld reinforcement in the butt welds;
f) the removal of temporary tack welds, extraneous material residuals electrodes arch strokes and weld spatters.
g) all surface defects (i.e. because of the use of plate clamp), should be repaired.
h) after removal, positions of former temporary pieces shall be tested by MPI

9.4 Post-repair examination

Examination after repair by means of grinding shall verify the followings:

a) the complete removal of the defect;
b) that the grinding-affected area shall be smooth with the adjacent area;
c) that the grinded area shall comply with the geometrical dimensions as specified in the construction drawings (i.e. the profile of the weld section and the minimum base material thickness).

Where the above conditions may not be achieved by grinding only, it will be necessary to restore the area by means of welding in accordance with an approved repair welding procedure.

10. ACCEPTANCE CRITERIA

Acceptance Criteria shall be in according to table 14 of EEMUA 158 reported here below. Where doubts may persist an opportune non destructive inspection shall be carried out, e.g. magnetic particle or dry penetrant inspection.

Table 14 Visual inspection acceptance criteria

Defect type	Permitted maximum
Undercut	Slight intermittent undercut permitted, depth should not exceed approximately 0·5mm.
Shrinkage grooves and root concavity	As for undercut, depth should not exceed 1·5mm.
Excess penetration (girth welds only)	3mm maximum. Occasional local slight excess is allowable.
Reinforcement shape	The reinforcement shall blend smoothly with the parent metal. Dressing is not normally required provided the shape does not interfere with the specified NDT techniques.
Overlap	Not permitted.
Linear misalignment	See 4.5.2. (k) and (l)

11. REPAIR

In the event that unacceptable indications have been detected, the relevant removal of the defects shall be carry out by machining, grinding, chipping or gouging. Oxygen gouging shall not be used in quenched and tempered steel. Where arc-air gouging may be carried out, it will be necessary to grind the area in order to remove the decarburized material and to smooth the relevant surfaces.

A visual inspection shall be carried out on the cut surfaces in order to verify that the removal of the defect has been achieved.

Once the defect have been removed, the cutting surface shall be prepared and smoothed down in order to allow the area to be repaired by means of welding in accordance with an approved procedure.

Once the repair have been completed, the affected area shall be re-inspected in accordance with this procedure.

Local grinding may be used to reduce or remove imperfections which are the cause of unacceptable indications, while all repairs, in which welding processes are foreseen, shall be carried out in accordance with established procedures.

Repair By Welding

Before repair welding, the defects shall be completely removed. Each unacceptable discontinuity shall be directly marked on the weld over the discontinuity for its entire length. The depth from the surface and indication rating shall be marked on base metal right next to the defect.
The excavated area shall have smooth transitions to the metal surface and allow good access for both NDT after excavation and subsequent repair welding. After excavation, complete removal of the defects shall be confirmed by MT or PT. PWHT shall be performed after repair if specified for the original weld. The excavated groove shall extend minimum 25 mm before and after the defect, measured at defect depth. Defects spaced less than 100 mm shall be repaired as one continuous defect.
After repair welding, the complete weld (i.e. the repaired area plus at least 100 mm on each side) shall be subjected at least to the same NDT as specified for the original weld.
Repair welding may only be carried out once in the same area: the second require customer involvement.

Re-welding
Re-welding shall be performed in accordance with the procedures and WPS utilized for the original weld, and includes complete removal of the original weld and HAZ

12. VISUAL EXAMINATION REPORT

A report which clearly identifies the work and the area of inspection shall be completed by the VT operator at the time of inspection. Examination results for each weld shall be reported on the Visual Examination Report Form. The Visual Examination Report (sample form) is enclosed as Attachment 1 to this procedure: any change or update to this form, does not invalidate this procedure as long all therein information are maintained.

The report shall be signed by the Quality Control Manager and when required by the Client's Inspector and other Authority Testing.

The report form for welds that are acceptable need only contain sufficient information to identify the weld, the operator (signature), and the acceptability of the weld.

When a defect shall be identified and repair shall be required, the relevant report issued at completion of the inspection operation will have to record both inspections prior and after the repair of the defect.

Evaluation of retested repaired weld areas shall be tabulated on a new line on the report form. If the original report form is used, an R1, R2, ...Rn shall prefix the indication number. If additional report forms are used, the R number shall prefix the report number.

All NDT shall be properly documented in such a way that the performed testing can be easily retraced at a later stage. The reports shall identify the unacceptable defects present in the tested area, and a conclusive statement as to whether the weld satisfies the acceptance criteria or not.

The report shall include a reference to the applicable standard, NDT procedure and acceptance criteria. In addition, as a minimum, the following information must be given or easily retrievable from therein included information:

- object and drawing references
- place and date of examination

- material type and dimensions
- post weld heat treatment, if required
- location of examined areas, type of joint
- welding process used
- name and certification level of the operator carrying out the testing
- surface conditions
- contract requirements e.g. order no., specifications, special agreements etc.
- sketch showing location and information regarding detected defects
- extent of testing
- test equipment used
- description and location of all recordable indications
- examination results with reference to acceptance level.
- number of repairs to be specified in the report, such as once or twice repairs in the same area.

The report shall be such that there is no doubt about what is tested, where it has been carried out and give a clear and exact description of reportable defect location.

The format of report is not a reason for rejection as long all above indicated information are included and any change induced by addition doesn't be considered a rejection of those already issued

ATTACHMENT N. 1

CIMOLAI S.p.A.
San Giorgio di Nogaro (UD)

VISUAL AND DIMENSIONAL INSPECTION OF WELDS - REPORT

RAPPORTO DI ISPEZIONE VISIVA E DIMENSIONALE SALDATURE

REPORT No.
DATE - *DATA*
PAGE - *PAGINA* 1 di 1

GENERAL DATA / DATI GENERALI

CLIENT / *CLIENTE* | CLIENT P.O. / *ORDINE CLIENTE* | JOB / COMMESSA | ITP

PLACE AND DATE OF EXAMINATION / LUOGO E DATA DELL'ESAME | TESTING EQUIPMENT USED / STRUMENTI UTILIZZATI

PRODUCT DATA / DATI DEL PRODOTTO

BASE MATERIAL / MATERIALE BASE | THICKNESS / SPESSORE | SURF. CONDITIONS / CONDIZIONI SUP. | PWHT CONDITIONS / CONDIZ. TRATT. TERMICO

REFERENCE DOCUMENTS / DOCUMENTI DI RIFERIMENTO

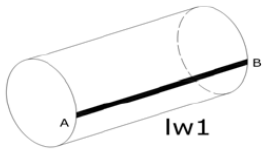
PROCEDURE / PROCEDURA | ACCEPTANCE CRITERIA / CRITERI DI ACCETTABILITA' | REF. DRAWINGS / RIF. DISEGNI

WELD PARTICULAR SKETCH / SCHIZZO PARTICOLARE SALDATO

TEST EXTENSION / ESTENSIONE DEL CONTROLLO

TYPE OF JOINT / TIPI DI GIUNTO

WELDING PROCESS / PROCESSO DI SALDATURA



TEST RECORDS / REGISTRAZIONE DEL CONTROLLO

Client Pos. Pos. Cliente	Cimolai Mk.	Base Material Materiale Base	Weld ID	Analyzed / Analizzati						Not Accept.	Accept.
				Cracks Cricche	Under-cuts Incisioni	Reinforcement Sovrametallo	Reinf. Shape Forma cordone	Weld to b. metal transizione	Porosity Porosità		

TEST RESULT / RISULTATO DEL CONTROLLO

✓ ACCEPTABLE / ACCETTABILE	NOT ACCEPTABLE / NON ACCETTABILE

REMARKS / NOTE

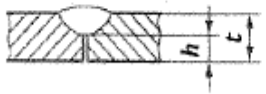
STAMPS AND SIGNATURES / TIMBRI E FIRME

VT Operator / Operatore VT	Cimolai SpA	Testing Authority / Ente Collaudatore	Client Representative / Rappresentante del Cliente

ATTACHMENT N. 2

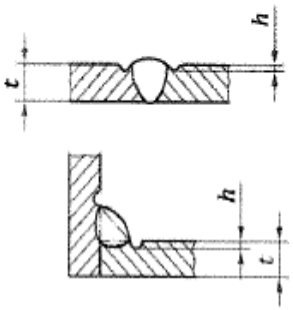
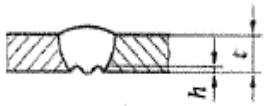
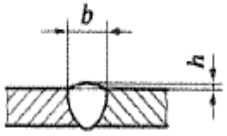
Table 1 extracted from EN ISO 5817 and table 12 extracted from EN 10217-3

Table 1 — Limits for imperfections

No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1 Surface imperfections							
1.1	100	Crack		≥ 0,5	Not permitted	Not permitted	Not permitted
1.2	104	Crater crack		≥ 0,5	Not permitted	Not permitted	Not permitted
1.3	2017	Surface pore	Maximum dimension of a single pore for — butt welds — fillet welds	0,5 to 3	 $d \leq 0{,}3\ s$ $d \leq 0{,}3\ a$	Not permitted	Not permitted
			Maximum dimension of a single pore for — butt welds — fillet welds	> 3	 $d \leq 0{,}3\ s$, but max. 3 mm $d \leq 0{,}3\ a$, but max. 3 mm	 $d \leq 0{,}2\ s$, but max. 2 mm $d \leq 0{,}2\ a$, but max. 2 mm	Not permitted
1.4	2025	End crater pipe		0,5 to 3 > 3	$h \leq 0{,}2\ t$ $h \leq 0{,}2\ t$, but max. 2 mm	Not permitted $h \leq 0{,}1\ t$, but max. 1 mm	Not permitted Not permitted
1.5	401	Lack of fusion (incomplete fusion)	—	≥ 0,5	Not permitted	Not permitted	Not permitted
		Micro lack of fusion	Only detectable by micro examination	≥ 0,5	Permitted	Permitted	Not permitted
1.6	4021	Incomplete root penetration	Only for single side butt welds 	≥ 0,5	Short imperfections: $h \leq 0{,}2\ t$ but max. 2 mm	Not permitted	Not permitted

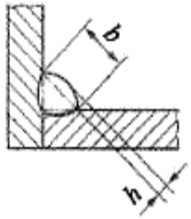
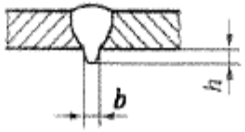
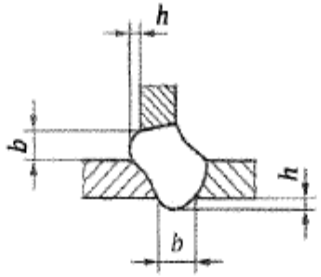
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Date 11/12/2023

No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1.7	5011	Continuous undercut	Smooth transition is required. This is not regarded as a systematic imperfection.	0,5 to 3	Short imperfections: $h \le 0{,}2\ t$	Short imperfections: $h \le 0{,}1\ t$	Not permitted
	5012	Intermittent undercut		> 3	$h \le 0{,}2\ t$, but max. 1 mm	$h \le 0{,}1\ t$, but max. 0,5 mm	$h \le 0{,}05\ t$, but max. 0,5 mm
1.8	5013	Shrinkage groove	Smooth transition is required. 	0,5 to 3	Short imperfections: $h \le 0{,}2$ mm + $0{,}1\ t$	Short imperfections: $h \le 0{,}1\ t$	Not permitted
				> 3	Short imperfections: $h \le 0{,}2\ t$, but max. 2 mm	Short imperfections: $h \le 0{,}1\ t$, but max.1 mm	Short imperfections: $h \le 0{,}05\ t$, but max. 0,5 mm
1.9	502	Excess weld metal (butt weld)	Smooth transition is required. 	≥ 0,5	$h \le 1$ mm + $0{,}25\ b$, but max. 10 mm	$h \le 1$ mm + $0{,}15\ b$, but max. 7 mm	$h \le 1$ mm + $0{,}1\ b$,but max. 5 mm

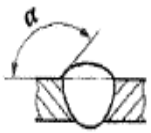
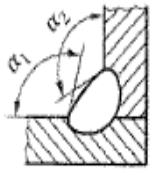
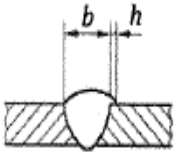
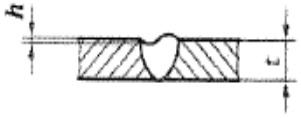
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1.10	503	Excessive convexity (fillet weld)		≥ 0,5	$h \leq 1$ mm + 0,25 b, but max. 5 mm	$h \leq 1$ mm + 0,15 b, but max. 4 mm	$h \leq 1$ mm + 0,1 b, but max. 3 mm
1.11	504	Excess penetration	 	0,5 to 3 > 3	$h \leq 1$ mm + 0,6 b $h \leq 1$ mm + 1,0 b, but max. 5 mm	$h \leq 1$ mm + 0,3 b $h \leq 1$ mm + 0,6 b, but max. 4 mm	$h \leq 1$ mm + 0,1 b $h \leq 1$ mm + 0,2 b,but max. 3 mm

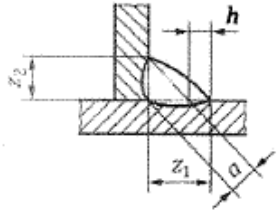
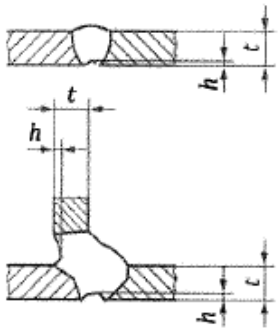
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels D	C	B
1.12	505	Incorrect weld toe	— butt welds 	≥ 0,5	$\alpha \geq 90°$	$\alpha \geq 110°$	$\alpha \geq 150°$
			— fillet welds  $\alpha_1 \geq \alpha$ and $\alpha_2 \geq \alpha$	≥ 0,5	$\alpha \geq 90°$	$\alpha \geq 100°$	$\alpha \geq 110°$
1.13	506	Overlap		≥ 0,5	$h \leq 0,2\,b$	Not permitted	Not permitted
1.14	509	Sagging	Smooth transition is required	0,5 to 3	Short imperfections: $h \leq 0,25\,t$	Short imperfections: $h \leq 0,1\,t$	Not permitted
	511	Incompletely filled groove		> 3	Short imperfections: $h \leq 0,25\,t$, but max. 2 mm	Short imperfections: $h \leq 0,1\,t$, but max. 1 mm	Short imperfections: $h \leq 0,05\,t$, but max. 0,5 mm

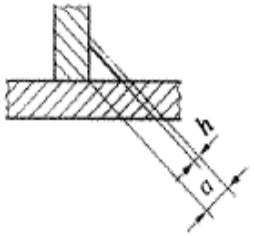
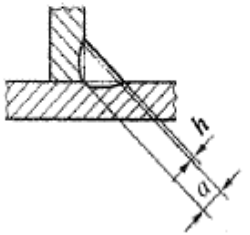
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Date 11/12/2023

No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1.15	510	Burn through	—	≥ 0,5	Not permitted	Not permitted	Not permitted
1.16	512	Excessive asymmetry of fillet weld (excessive unequal leg length)	In cases where an asymmetric fillet weld has not been prescribed. 	≥ 0,5	$h \leq 2$ mm + 0,2 a	$h \leq 2$ mm + 0,15 a	$h \leq 1,5$ mm + 0,15 a
1.17	515	Root concavity	Smooth transition is required. 	0,5 to 3	$h \leq 0,2$ mm + 0,1 t	Short imperfections: $h \leq 0,1\ t$	Not permitted
				> 3	Short imperfections: $h \leq 0,2\ t$, but max. 2 mm	Short imperfections: $h \leq 0,1\ t$, but max. 1 mm	Short imperfections: $h \leq 0,05\ t$, but max. 0,5 mm

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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1.18	516	Root porosity	Spongy formation at the root of a weld due to bubbling of the weld metal at the moment of solidification (e. g. lack of gas backing)	≥ 0,5	Locally permitted	Not permitted	Not permitted
1.19	517	Poor restart	—	≥ 0,5	Permitted The limit depends on the type of imperfection occurred due to restart.	Not permitted	Not permitted
1.20	5213	Insufficient throat thickness	Not applicable to processes with proof of greater depth of penetration 	0,5 to 3 > 3	Short imperfections: $h \leq 0{,}2$ mm + 0,1 a Short imperfections: $h \leq 0{,}3$ mm + 0,1 a, but max. 2 mm	Short imperfections: $h \leq 0{,}2$ mm Short imperfections: $h \leq 0{,}3$ mm + 0,1 a, but max. 1 mm	Not permitted Not permitted
1.21	5214	Excessive throat thickness	The actual throat thickness of the fillet weld is too large. 	≥ 0,5	Permitted	$h \leq 1$ mm + 0,2 a, but max. 4 mm	$h \leq 1$ mm + 0,15 a, but max. 3 mm

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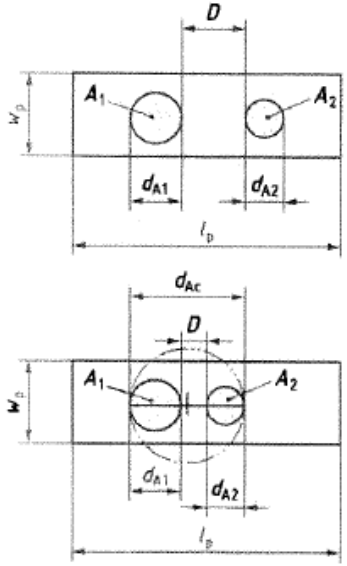
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels			
					D	C	B	
1.22	601	Stray arc	—	≥ 0,5	Permitted, if the properties of the parent metal are not affected.	Not permitted	Not permitted	
1.23	602	Spatter	—	≥ 0,5	Acceptance depends on application, e.g. material, corrosion protection	Acceptance depends on application, e.g. material, corrosion protection	Acceptance depends on application, e.g. material, corrosion protection	
1.24	610	Temper colour (Discolouration)	—	≥ 0,5	Acceptance depends on application, e.g. material, corrosion protection	Acceptance depends on application, e.g. material, corrosion protection	Acceptance depends on application, e.g. material, corrosion protection	

No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2 Internal imperfections							
2.1	100	Cracks	All types of crack except microcracks and crater cracks	≥ 0,5	Not permitted	Not permitted	Not permitted
2.2	1001	Microcracks	A crack usually only visible under the microscope (50 ×)	≥ 0,5	Permitted	Acceptance depends on type of parent metal with particular reference to crack sensitivity	Acceptance depends on type of parent metal with particular reference to crack sensitivity
2.3	2011 2012	Gas pore Uniformly distributed porosity	The following conditions and limits for imperfections shall be fulfilled. See also Annex A for information.				
			a1) Maximum dimension of the area of the imperfections (inclusive of systematic imperfection) related to the projected area	≥ 0,5	For single layer: ≤ 2,5 % For multi-layer: ≤ 5 %	For single layer: ≤ 1,5 % For multi-layer: ≤ 3 %	For single layer: ≤ 1 % For multi-layer: ≤ 2 %
			NOTE The porosity in the project area depends on the numbers of layers (volume of the weld).				
			a2) Maximum dimension of the cross-sectional area of the imperfections (inclusive of systematic imperfection) related to the fracture area (only applicable to test pieces: production test, welder or procedure qualification tests)	≥ 0,5	≤ 2,5 %	≤ 1,5 %	≤ 1 %
			b) Maximum dimension for a single pore for	≥ 0,5	$d \leq 0{,}4\ s$, but max. 5 mm	$d \leq 0{,}3\ s$, but max. 4 mm	$d \leq 0{,}2\ s$, but max. 3 mm
			— butt welds		$d \leq 0{,}4\ a$, but max. 5 mm	$d \leq 0{,}3\ a$, but max. 4 mm	$d \leq 0{,}2\ a$, but max. 3 mm
			— fillet welds				

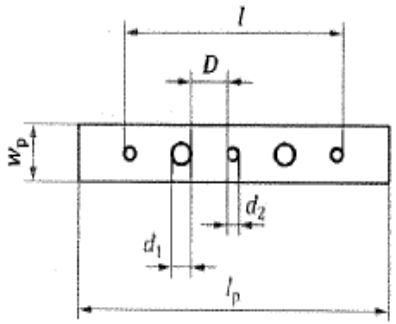
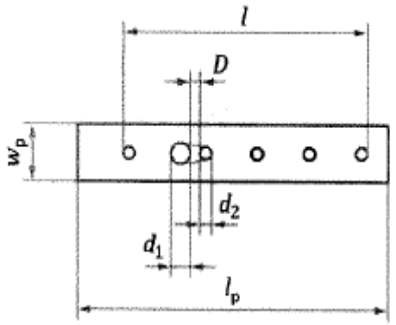
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2.4	2013	Clustered (localized) porosity	 Reference length for l_p is 100 mm. The total gas pore area within the cluster is represented by a circle of diameter d_A surrounding all the gas pores. The requirement for a single gas pore shall be met by all the gas pores within this circle. A permitted porous area shall be local. The possibility of the pore cluster masking other imperfections shall be taken into consideration. If D is less than d_{A1} or d_{A2}, whichever is smaller, then the total gas pore area is represented by a circle of diameter d_{AC}, where $d_{AC} = d_{A1} + d_{A2} + D$. Systematic cluster porosity is not permitted. d_A corresponds to d_{A1}, d_{A2} or d_{AC}, whichever is applicable.	≥ 0,5	$d_A \leq 25$ mm or $d_{A,\,max} \leq w_p$	$d_A \leq 20$ mm or $d_{A,\,max} \leq w_p$	$d_A \leq 15$ mm or $d_{A,\,max} \leq w_p/2$

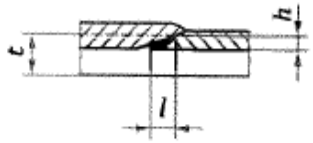
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2.5	2014	Linear porosity	— butt welds	≥ 0,5	$h \leq 0{,}4\,s$, but max. 4 mm $l \leq s$, but max. 75 mm	$h \leq 0{,}3\,s$, but max. 3 mm $l \leq s$, but max. 50 mm	$h \leq 0{,}2\,s$, but max. 2 mm $l \leq s$, but max. 25 mm
			— fillet welds	≥ 0,5	$h \leq 0{,}4\,a$, but max. 4 mm $l \leq a$, but max. 75 mm	$h \leq 0{,}3\,a$, but max. 3 mm $l \leq a$, but max. 50 mm	$h \leq 0{,}2\,a$, but max. 2 mm $l \leq a$, but max. 25 mm
			Case 1 ($D > d_2$)  Case 2 ($D < d_2$)  Reference length for l_p is 100 mm. For case 1: $d_1 = h$ For case 2: $d_1 + d_2 + D = h$				

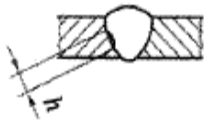
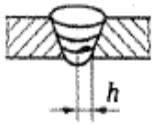
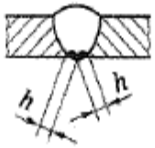
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2.6	2015 2016	Elongated cavity Wormholes	— butt welds	≥ 0,5	$h \le 0{,}4\ s$, but max. 4 mm $l \le s$, but max. 75 mm	$h \le 0{,}3\ s$, but max. 3 mm $l \le s$, but max. 50 mm	$h \le 0{,}2\ s$, but max. 2 mm $l \le s$, but max. 25 mm
			— fillet welds	≥ 0,5	$h \le 0{,}4\ a$, but max. 4 mm $l \le a$, but max. 75 mm	$h \le 0{,}3\ a$, but max. 3 mm $l \le a$, but max. 50 mm	$h \le 0{,}2\ a$, but max. 2 mm $l \le a$, but max. 25 mm
2.7	202	Shrinkage cavity		≥ 0,5	Short imperfections permitted, but not breaking of the surfaces: butt welds: $h \le 0{,}4\ s$, but max. 4 mm fillet welds: $h \le 0{,}4\ a$, but max. 4 mm	Not permitted	Not permitted
2.8	2024	Crater pipe	 The larger value of h or l will be measured	0,5 to 3 > 3	h or $l \le 0{,}2\ t$ h or $l \le 0{,}2\ t$, but max. 2 mm	Not permitted	Not permitted
2.9	300 301 302 303	Solid inclusions Slag inclusions Flux inclusions Oxide inclusions	— butt welds	≥ 0,5	$h \le 0{,}4\ s$, but max. 4 mm $l \le s$, but max. 75 mm	$h \le 0{,}3\ s$, but max. 3 mm $l \le s$, but max. 50 mm	$h \le 0{,}2\ s$, but max. 2 mm $l \le s$, but max. 25 mm
			— fillet welds	≥ 0,5	$h \le 0{,}4\ a$, but max. 4 mm $l \le a$, but max. 75 mm	$h \le 0{,}3\ a$, but max. 3 mm $l \le a$, but max. 50 mm	$h \le 0{,}2\ a$, but max. 2 mm $l \le a$, but max. 25 mm

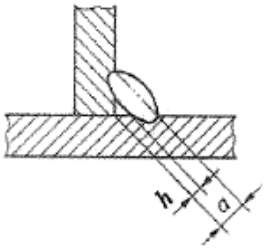
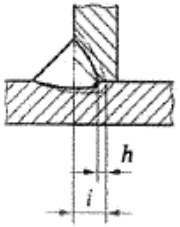
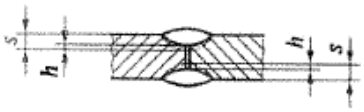
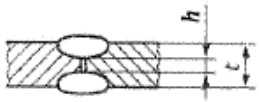
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2.10	304	Metallic inclusions other than copper	— butt welds	≥ 0,5	$h \leq 0{,}4\ s$, but max. 4 mm	$h \leq 0{,}3\ s$, but max. 3 mm	$h \leq 0{,}2\ s$,but max. 2 mm
			— fillet welds	≥ 0,5	$h \leq 0{,}4\ a$, but max. 4 mm	$h \leq 0{,}3\ a$, but max. 3 mm	$h \leq 0{,}2\ a$, but max. 2 mm
2.11	3042	Copper inclusions	—	≥ 0,5	Not permitted	Not permitted	Not permitted
2.12	401	Lack of fusion (incomplete fusion)		≥ 0,5	Short imperfections permitted: butt welds: $h \leq 0{,}4\ s$, but max. 4 mm fillet welds: $h \leq 0{,}4\ a$ but max. 4 mm	Not permitted	Not permitted
	4011	Lack of side wall fusion					
	4012	Lack of inter-run fusion					
	4013	Lack of root fusion					

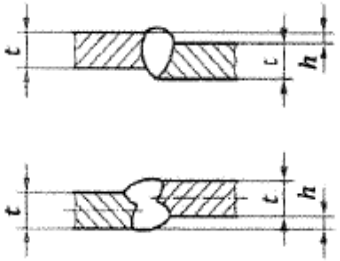
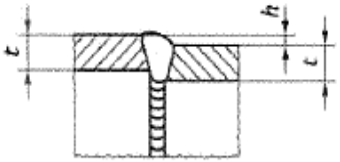
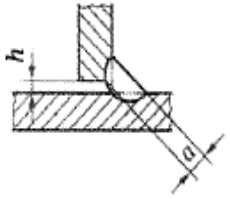
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2.13	402	Lack of penetration	 T-joint (fillet weld)	> 0,5	Short imperfection: $h \le 0{,}2\ a$, but max. 2 mm	Not permitted	Not permitted
			 T-joint (partial penetration)  Butt joint (partial penetration)	≥ 0,5	Short imperfections: butt joint: $h \le 0{,}2s$ or i, but max. 2 mm T-joint: $h \le 0{,}2a$, but max. 2 mm	Short imperfections: butt joint: $h \le 0{,}1\ s$ or i, but max. 1,5 mm fillet joint: $h \le 0{,}1\ a$, but max. 1,5 mm	Not permitted
			 Butt joint (full penetration)	≥ 0,5	Short imperfection: $h \le 0{,}2\ t$, but max. 2 mm	Not permitted	Not permitted

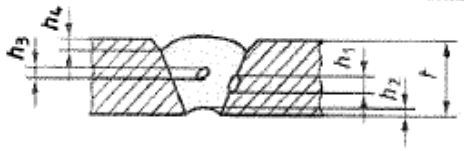
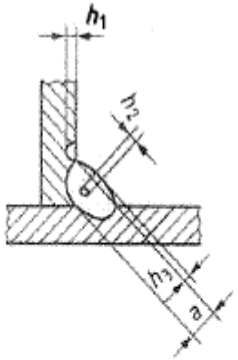
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
3 Imperfections in joint geometry							
3.1	507	Linear misalignment	The limits relate to deviations from the correct position. Unless otherwise specified, the correct position is that when the centrelines coincide (see also Clause 1). t refers to the smaller thickness.				
	5071	Linear misalignment between plates	 Plates and longitudinal welds	0,5 to 3 > 3	$h \le 0{,}2$ mm + $0{,}25\,t$ $h \le 0{,}25\,t$ but max. 5 mm	$h \le 0{,}2$ mm + $0{,}15\,t$ $h \le 0{,}15\,t$, but max. 4 mm	$h \le 0{,}2$ mm + $0{,}1\,t$ $h \le 0{,}1\,t$, but max. 3 mm
	5072	Transversely circular welds at cylindrical hollow sections	 Circumferential welds	≥ 0,5	$h \le 0{,}5\,t$, but max. 4 mm	$h \le 0{,}5\,t$, but max. 3 mm	$h \le 0{,}5\,t$, but max. 2 mm
3.2	617	Incorrect root gap for fillet welds	Gap between the parts to be joined. Gaps exceeding the appropriate limit may, in certain cases, be compensated for by a corresponding increase in the throat thickness. 	0,5 to 3 > 3	$h \le 0{,}5$ mm + $0{,}1\,a$ $h \le 1$ mm + $0{,}3\,a$, but max. 4 mm	$h \le 0{,}3$ mm + $0{,}1\,a$ $h \le 0{,}5$ mm + $0{,}2\,a$, but max. 3 mm	$h \le 0{,}2$ mm + $0{,}1\,a$ $h \le 0{,}5$ mm + $0{,}1\,a$, but max. 2 mm

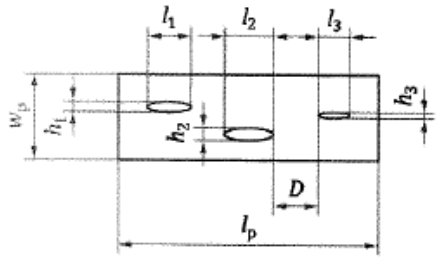
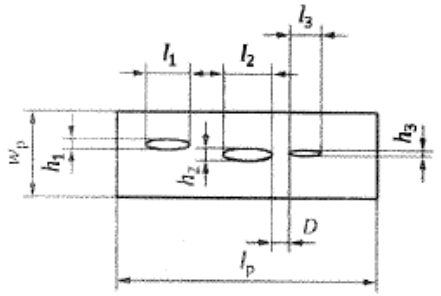
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t	Limits for imperfections for quality levels		
				mm	D	C	B
4 Multiple imperfections							
4.1	None	Multiple imperfections in any cross section	 $h_1 + h_2 + h_3 + h_4 = \sum h$  $h_1 + h_2 + h_3 = \sum h$	0,5 to 3 > 3	Not permitted Maximum total height of imperfections: $\sum h \leq 0{,}4\ t$ or $\leq 0{,}25\ a$	Not permitted Maximum total height of imperfections: $\sum h \leq 0{,}3\ t$ or $\leq 0{,}2\ a$	Not permitted Maximum total height of imperfections: $\sum h \leq 0{,}2\ t$ or $\leq 0{,}15\ a$

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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
4.2	None	Projected or cross-sectional area in longitudinal direction	Case 1 ($D > l_3$)  $h_1 \times l_1 + h_2 \times l_2 + h_3 \times l_3 = \Sigma h \times l$ Case 2 ($D < l_3$)  $h_1 \times l_1 + h_2 \times l_2 + \left(\frac{h_2 + h_3}{2}\right) \times D + h_3 \times l_3 = \Sigma h \times l$ The sum of the areas $\Sigma\, h \times l$ shall be calculated as a percentage to the evaluation area $l_p \times w_p$ (case 1). If D is smaller than the shorter length of one of the neighbouring imperfections, the full connection of the two imperfections shall be applied to the sum of imperfections (case 2). See also Annex A for information.	≥ 0,5	$\Sigma\, h \times l \leq 16\,\%$	$\Sigma\, h \times l \leq 8\,\%$	$\Sigma\, h \times l \leq 4\,\%$

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Table 12 — Maximum height of the weld seam for SAW tubes

Wall thickness T (mm)	Maximum height of the outside and inside weld seam (mm)
$T \leq 12,5$	3
$T > 12,5$	4

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	Rev.	0
	Date	07/12/2023

IOP-MPI-2023263-01
MAGNET EXAMINATION INSTRUCTION

Project: **123A90A - Base Load Power Hub Platform**

Client: **Rosetti Marino SpA**

Revision matrix(revised where underlined)

0	07/12/2023	Gianessi A.	Guzzon A.	Ponte V.
Rev.	**Date**	**Issued**	**Checked**	**Approved**

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1. SCOPE

This procedure is intended for the magnetic particle examination of welds and HAZ on longitudinal welds of pipes in ferromagnetic steel and for the dimensioning of indications by means of comparison with Acceptance Standards .

This procedure describes techniques for Wet Magnetic Particles Examination for detecting cracks and other discontinuities that are open to the surface of the part, employing AC Yoke Technique only.

- Quality level in accordance to ISO5817 : Level B
- Above indicate ISO5817 Level B require that MT examination shall be made at least in accordance with EN ISO 17638
- Above indicate ISO5817 Level B require that applicable MT examination acceptance criteria shall be in accordance with EN ISO 23278 level 2X

2. REFERENCE DOCUMENTS

- EN ISO 17638 : Non destructive testing of welds. Magnetic particle testing
- EN ISO 23278 : Non destructive testing of welds. Magnetic particle testing of welds. Acceptance criteria.
- EN 473 : Qualification and Certification of NDT Personnel.
- ISO 9712 : Qualification and Certification of NDT Personnel.
- EN ISO 3059 : Non-destructive testing – Penetrant testing and magnetic particle testing – Viewing conditions.
- EEMUA 158: Construction Specification for fixed offshore structures

3. PERSONNEL QUALIFICATION

Examination shall be carried out by NDE examiners holding a level II or III qualification in accordance with the following document or other equivalent standard:

- EN 473
- ISO 9712

The personnel employed for the execution of NDE Examination shall have an annual vision test to assure:

- Near vision acuity: the examination should ensure natural or corrected near distance acuity such that they are capable of reading standard J-1 letters on standard Jaeger test type charts or Times Roman No.4,5 (having a height of 1,6mm) or equivalent characters to a distance of not less than 30 cm with one or both eyes. Equivalent near vision tests are acceptable
- Color contrast differentiation: the examination should demonstrate the capability of distinguishing and differentiating contrast among colors or shades of gray (reading of Ishiara test or equivalent)

4. EXTENT OF EXAMINATION

Extent of Examination shall be as follow:

- From outside: 100% on longitudinal welds after weld completion
- From inside:
  - For diameter equal to or greater than 800 mm, 100% on longitudinal welds after weld completion
  - For diameter less than 800 mm, the welds shall be inspected for a length equal to the outer diameter at both pipe ends

The width of the surface shall include the weld metal and the adjacent parent metal up to a distance of 15 mm on each side of the weld, to include a theoretical 5 mm width of heat affected zone (HAZ), in compliance to EN ISO 17638 paragraph 5.6.2.

5. TIME OF EXAMINATION

Magnetic Particle Examination shall be carried out at least 24 hours following completing of welding. When PWHT is performed, final Magnetic Particle Examination shall be carried out when all heat treatments have been completed.

6. SURFACE CONDITIONS

The surface to be inspected shall be cleaned from any dirt, oil, grease, scales, slag and any other contaminations which may interfere with the scanning or interpretation of the results.
Base material surface adjacent to the weld, shall be prepared to a distance at least 25 mm on both side of the weld: shall be free of weld spatter, rust or other foreign particles which could interfere with examination and this could be obtained by sandblasting or light grinding.
The weld surface should be free of irregularities that could impede examination, offer reasonably smooth surface with minimal undercut, rippling and spatter and should merge smoothly into the adjacent base materials. “As welded” weld surface condition is acceptable to perform correctly the examination. If undercuts, imperfect shape, incorrect weld toe or other surface discontinuities are clearly visible before examination start, these shall be removed with adequate operations (grinding, welding etc.).

7. EQUIPMENT

Magnetizing equipment.

The equipment used is an hand-held AC (alternative current) portable electromagnet that produce a magnetic field between the two poles.
Use of permanent magnets is not permitted.
The equipment shall be annually checked and, if necessary, re-calibrated.
Periodical functional checks may be carried out by a lift test as follow:
The electromagnetic yoke shall be capable of supporting a steel plate having a minimum mass of 4,5 kg, with the magnet poles set at their recommended spacing. The major dimension of the plate shall be greater than the pole spacing of the electromagnet.

Generally CGM TWIST 24-0-24 Yoke type and TR. 220/48 V alternative current generator or equivalent shall be used but other equivalent could be used if properly calibrated in accordance to the herein listed requirements.

Magnetic Particle Materials

Non fluorescent Wet magnetic particles (black colored) suspended in a suitable liquid medium (Kerosenoil) shall be used; they shall form a uniform suspension when agitated.
The particles are premixed with the suspending vehicle by the supplier and are available in pressurized spray bottles or tanks and ready to use.
The temperature range of the wet particle suspension and the surface of the test object should be within 0°C ≤ T ≤ 57°C
Generally CGM LK35, or equivalent shall be used. Products of other manufacturers may be employed, but mixing of products from different brand is not allowed.
Magnetic particle material, brand, type used shall be reported in the examination report (see form shown in Attachment N. 1).

8. EXAMINATION SEQUENCE

Magnetization

The part to be inspected must be magnetized in at least two different directions, approximately at right angles to each other. The examination must be carried out with enough overlap to guarantee covering 100% of the area under examination.

Magnetic field strength and magnetic field direction shall be checked by using the field measurer, as in Figure 1, placed on the surface under examination.

When magnetization is induced, a clear line of magnetic particles should appear on the coppered surface of the indicator. If a clearly defined line does not appear, the magnetization method must be changed or refined until it appears.

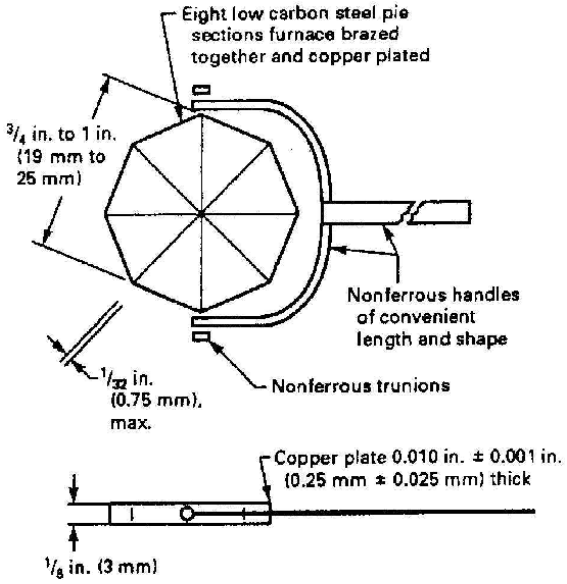


Figure 1 : Magnetic field indicator

Wet Particle application

Wet magnetic particles shall be applied either by spraying or flowing over the areas to be inspected immediately prior to and during magnetization. The magnetization must be

constantly maintained during the examination and during the removal of excess wet particles, if necessary (Continuous Method).

Only upon completion of these operations, namely detector application, removal of excess detector and examination, the magnetic field can be eliminated.

Examination coverage

The effective testing area is the one shadow indicated on Fig.2. All examinations shall be conducted with sufficient field overlap to ensure 100% coverage at the required sensitivity in accordance to parameters indicated in Figures 2 and 3.

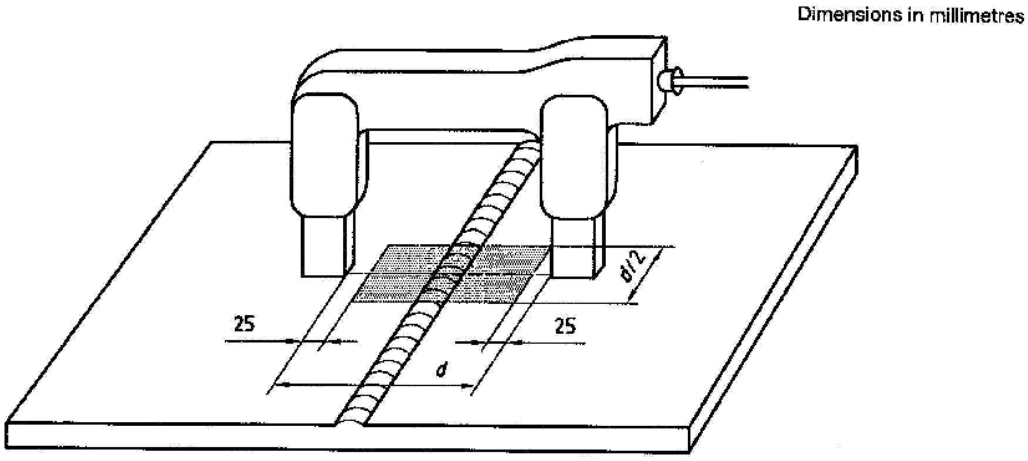
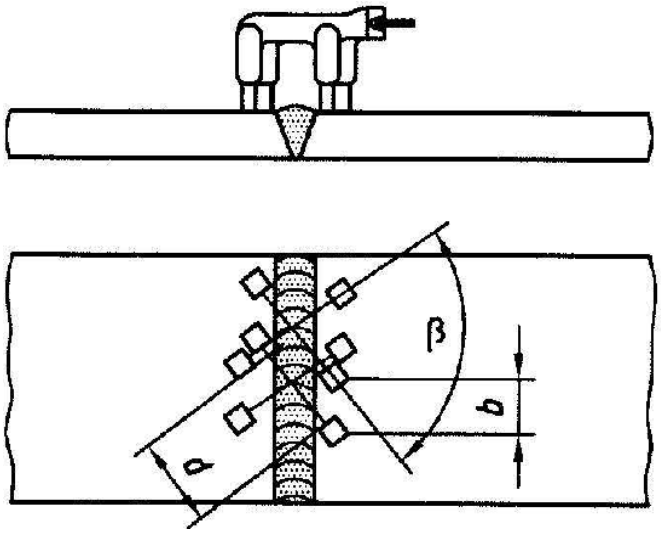


Figure 2 : Effective testing area



d ≥ 150 mm

b ≤ d/2

ß ≈ 90°±30°

Figure 3 : Magnetizing overlap technique

Viewing conditions

The inspection shall be performed in daylight viewing conditions or with artificial light. Use of monochromatic sources such as sodium lamps is not permitted. The test surface must be illuminated uniformly. Flashes and reflections should be avoided. The minimum light intensity at the examination surface shall be 500 lux.

Interpretation of indication

The following definitions have to be applied

- *Linear indication*: An indication in which the length is at least three times the width.
- *Non-linear indication*: An indication of circular or elliptical shape with a length less than three times the width.
- *Aligned indication*: Three or more indications in a line, separated by 2 mm or less edge-to-edge.
- *Open indication*: An indication visible after removal of the magnetic particles or that can be detected by the use of contrast dye penetrant.
- *Non-open indication*: An indication that is not visually detectable after removal of the magnetic particles or that cannot be detected by the use of contrast dye penetrant.
- *Relevant indication*: An indication that is caused by a condition or type of discontinuity that requires evaluation. Only indications which have any dimension equal or greater than 1,5 mm shall be considered relevant.

Post inspection cleaning and demagnetization

No post inspection cleaning or demagnetization is required

9. ACCEPTANCE CRITERIA

The Acceptance Level for welds are specified in table below: table15 form EEMUA 158 3rd ed.
All indications exceeding -10dB DAC shall be investigate to the extent that they can be evaluated in terms of the Acceptance Criteria. All indications exceeding Acceptance Criteria shall be reported.

Table 15 Ultrasonic testing acceptance criteria

Type of flaw	Acceptance level (see *Note*)	
Three dimensional flaws (i.e. slag, porosity).	a)	Indications greater than 100% of the reference curve shall be reported. The maximum acceptable length shall be $\frac{t}{3}$ or 20mm, whichever is the smaller.
	b)	Indications less than 100% but greater than 50% of the reference curve shall be reported. The maximum acceptable length shall be 2t or 50mm, whichever is the smaller.
	c)	Indications less than 50% of the reference curve are acceptable.
Two dimensional flaws other than cracks (i.e. lack of side wall fusion, lack of inter-run fusion).	a)	Not acceptable if the indications exceed the reference curve, or lie within 6mm of either surface, regardless of amplitude.
	b)	Indications more than 6mm from either surface which are less than 100% but greater than 50% of the reference curve shall be reported. The maximum acceptable length shall be $\frac{t}{3}$ or 20mm, whichever is the smaller.
	c)	Indications more than 6mm from either surface which are less than 50% of the reference curve are acceptable.
Cracks or suspect cracks.	Not acceptable.	
Incomplete penetration or lack of root fusion in single-sided welds.	Not acceptable.	
Single point reflectors: (indications which show Pattern 1 behaviour in both directions, as per EN ISO 17640:2010).	If separated by a distance of 25mm or greater, acceptable regardless of amplitude. If separated by less than 25mm, indications with an amplitude greater than 100% of the reference curve shall be reported.	

Note: t = thickness of member under test.

10. REPAIR

Local grinding may be used to reduce or remove imperfections which are the cause of unacceptable indications, while all repairs foreseen use of welding processes, shall be carried out in accordance with established procedures.

Repair By Welding

Before repair welding, the defects shall be completely removed. Each unacceptable discontinuity shall be marked on the weld, over the discontinuity, for its entire length directly. The depth from the surface and indication rating shall be marked on base metal next to the defect.

The excavated area shall have smooth transitions to the metal surface and allow a good access for both NDT and subsequent repair welding. After excavation, complete removal of the defects shall be confirmed by MT or PT. PWHT shall be performed after repair by welding. The excavated groove shall extend minimum 25 mm after both start and end of

defect, measured at defect depth. Defects spaced less than 100 mm shall be repaired as one continuous defect.
After repair welding the complete weld (i.e. the repaired area plus at least 100 mm on each side) shall be subjected at least to the same NDT as specified for the original weld.
Repair welding may only be carried out once in the same area: the second require customer involvement.

Re-welding
Re-welding shall be performed in accordance with the procedures and WPS utilized for the original weld, and includes complete removal of the original weld and HAZ

11. MAGNETIC PARTICLE EXAMINATION REPORT

A report which clearly identifies the work and the area of inspection shall be completed by the MT operator at the time of inspection. Examination results for each weld shall be reported on the Magnetic Particle Report Form. The Magnetic Particle Report (sample form) is enclosed as Attachment 1 to this procedure: any change or update to this form, does not invalidate this procedure as long all therein information are maintained.

The report shall be signed by the Quality Control Manager and when required by the Client's Inspector and other Testing Authority.

The MT report, which are acceptable, need only to contain sufficient information to identify the weld, the operator (signature), and the acceptability of the weld.

When a defect shall be identified and repair shall be required, the relevant report issued at completion of the inspection operation will have to record both inspections prior and after the repair of the defect.

Evaluation of retested repaired weld areas shall be tabulated on a new line on the report form. If the original report form is used, an R1, R2, ...Rn shall prefix the indication number. If additional report forms are used, the R number shall prefix the report number.

All NDT shall be properly documented in such a way that the performed testing can be easily retraced at a later stage. The reports shall identify the unacceptable defects present in the tested area, and a conclusive statement as to whether the weld satisfies the acceptance criteria or not.

The report shall include a reference to the applicable standard, NDT procedure and acceptance criteria. In addition, as a minimum, the following information must be given or easily retrievable from therein included information:

- object and drawing references
- place and date of examination
- material type and dimensions
- post weld heat treatment, if required
- location of examined areas, type of joint
- welding process used

- name and certification level of the operator carrying out the testing
- surface conditions
- contract requirements e.g. order no., specifications, special agreements etc.
- sketch showing location and information regarding detected defects
- extent of testing
- test equipment used
- description and location of all recordable indications
- examination results with reference to acceptance level.
- number of repairs to be specified in the report, such as once or twice repairs in the same area.
- type of magnetization equipment
- type of current
- detection media
- demagnetization, if required.
- lifting force
- other means of magnetic field strength verification

The report shall be such that there is no doubt about what is tested, where it has been carried out and give a clear and exact description of reportable defect location.

The format of report is not a reason for rejection as long all above indicated information are included and any change induced by addition doesn't be considered a rejection of those already issued

CIMOLAI Pordenone - Italy	**Doc. ref.**	IOP-MPI-2023263-01
	Rev.	0
	Date	07/12/2023

ATTACHMENT N. 1

CIMOLAI S.p.A.	CERTIFICATO DI CONTROLLO MAGNETOSCOPICO Magnetic Particles Examination Report	Cert. Nr. / Report nr. Foglio / Sheet Data / Date

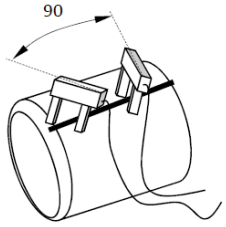
COSTRUTTORE / Manufacturer	COMM. COSTRUTT. / Manufactorer's Job	ATTREZZ. IMPIEGATA / Equipment employed
CLIENTE / Customer	COMM. CLIENTE / Customer's Job -	Costruttore / Manufacturer Tipo / Type Sist. di Magn. / Sist. of Magn. Corrente / Current Forza di Sollev. / Lifting Power Distanza Puntali / Prodes space Verifica / Verification
DESTINATARIO / Consignee	ORDINE DESTINATARIO / Consignee Order	
ITEM / Item	LUOGO DELL'ESAME / Place of Examination	
MARCA / Serial nr.	DATA DELL'ESAME / Date of Examination	Note / Remarks

SI CERTIFICA CHE LA PROVA E' STATA ESEGUITA SECONDO LE NORME DI RIFERIMENTO INDICATE E CHE I RISULTATI SONO QUELLI TRASCRITTI

This is to certify that the test has been performed according to indicated referene code, and the results are those recorded

OGGETTO DEL PRESENTE CERTIFICATO / Subject of this certificate **CONTROLLO MAGNETOSCOPICO SALDATURA TESTA-TESTA** **MAGNETIC PARTICLE INSPECTION OF BUTT WELD**		PROCEDURE / Procedure	
		STANDARD DI ACCETTAZIONE / Acceptance Standards	
		MATERIALE BASE / Base Material	SPESSORE / Thickness
DISEGNO DI RIFER. / Reference Drawing -	P.C.Q. / Q.C.P.	COND. SUP. Surface Conditions	MAT. / Base Material Saldatura / Weld
FASE DI LAVORAZIONE / Reference Drawing **(FINAL CHECK)**		PROC DI SALD. / Welding Process TIPO DI GIUNTO / Joint Type ESTENS. DELL'ESAME Extent. Of Examin.	

SCHIZZO DEL PARTICOLARE CONTROLLATO / Sketch of examined particular



A: punto inizio saldatura / welding start point
B: punto fine saldatura / welding end point

RILEVATORE IMPIEGATO
Type of magnetic particles employed

- [ ] FLUORESCENTE / Fluorescent
- [X] A CONTRASTO DI COLORE / Visible
- [ ] SECCO / Dry
- [X] UMIDO / Wet

MARCA / Trade Mark

TIPO / Type

Lotto / Batch

VERNICE DI CONTRASTO
Background paint

MARCA / Trade Mark

TIPO / Type **VECOPLAST**

SMAGNETIZZAZ. / Demagnetization

- [ ] SI / Yes
- [X] NO / No

ESITO / Results

- [X] ACCETTABILE / Acceptable
- [ ] NON ACCETTABILE / Not acceptable

OPERATORE. / Operator	COSTRUTTORE / Manufacturer	ENTE D'ISPEZIONE / Inspect. Auth.	DESTINATARIO / Consignee

CIMOLAI Pordenone - Italy	**Doc. ref.** IOP-MPI-2023263-01 **Rev.** 0 **Date** 07/12/2023

CIMOLAI s.p.a.	**CERTIFICATO DI CONTROLLO MAGNETOSCOPICO** **Magnetic Particles Examination Report**	**Cert. Nr. / Report nr.** **Foglio / Sheet** **2 di/of 2** **Data / Date**
COSTRUTTORE / Manufacturer	COMM. COSTRUTT. / Manufactorer's Job	DATA DELL'ESAME / Date of Examination
CLIENTE / Customer	COMM. CLIENTE / Customer's Job	ITEM / Item
DESTINATARIO / Consignee	ORDINE DESTINATARIO / Consignee Order	MARCA / Serial nr.

REGISTRAZIONI DELLE INDICAZIONI RILEVATE - Record of the recorder indications

Num. CND NDE Id.	Item Destinatario Consignee item	Marca Mark	Sigla Saldatura WPS utilizzata WELD ID used WPS	N. Indicaz. Indic. Nr.	Dist. Da 0-MPI / Start from 0-Mpi		Lungh. Lenght (mm)	Difetto Defect	GIUDIZIO JUDGEM. (**)
					Rifer. Di partenza Start point ref. (0-MPI)	Misura Value (mm)			

(**) **A = ACCETTABILE / Acceptable** **NA = NON ACCETTABILE / Not Acceptable**

OPERATORE. / Operator	COSTRUTTORE / Manufacturer	ENTE D'ISPEZIONE / Inspect. Auth.	DESTINATARIO / Consignee

IOP-RT-2023263-01
RADIOGRAPHIC EXAMINATION INNATRUCTION

Project: **123A90A - Base Load Power Hub Platform**

Client: **Rosetti Marino SpA**

Revision matrix (revised where underlined)

0	07/12/2023	Gianessi A.	Guzzon A.	Scaini S.
Rev.	**Date**	**Issued**	**Checked**	**Approved**

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1. SCOPE

This procedure shall be used for the radiographic examination of the longitudinal SAW welded pipes (base material EN 10028-3: P355NH) having nominal thickness 15 mm and 17 mm.
This Procedure is intended for X-ray Testing and it complies with EN 17636-1 class A.

2. REFERENCE DOCUMENTS

- EN ISO 17637-2 : Radiographic Examination of Welded Joints
- EN ISO 17636-1 : Non-destructive testing of welds - Radiographic testing of fusion welded joints
- EN ISO 5817: Fusion welded joints in steel, ... – Quality levels for imperfections
- EN 473 : Qualification and Certification of NDT Personnel.
- ISO 9712 : Qualification and Certification of NDT Personnel.
- ISO 19232-1: Image quality of radiographs – Part 1: Image quality indicators (wire type – Determination of image quality value.
- ISO 11669-1: Industrial Radiographic Film – Classification of film systems for industrial Radiographic
- EN 25580: Industrial radiographic illuminators – Minimum requirements
- EEMUA 158: Construction Specification for fixed offshore structures
- K559-2254-MT-SPE-001 rev.01: Structural Fabrication Specification Base Load Power Hub (BLPH)

3. PERSONNEL QUALIFICATION

Examination shall be carried out by NDE examiners holding a level II or III qualification in accordance with the following document or other equivalent standard:

- EN 473
- ISO 9712

The personnel employed for the execution of NDE Examination shall have an annual vision test to assure:

- Near vision acuity: the examination should ensure natural or corrected near distance acuity such that they are capable of reading standard J-1 letters on standard Jaeger test type charts or Times Roman No.4,5 (having a height of 1,6mm) or equivalent characters to a distance of not less than 30 cm with one or both eyes. Equivalent near vision tests are acceptable
- Color contrast differentiation: the examination should demonstrate the capability of distinguishing and differentiating contrast among colors or shades of gray (reading of Ishiara test or equivalent)

4. EXTENT OF EXAMINATION

Examination shall be carried out on 100% of longitudinal welds since welds are performed in workshop

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5. TIME OF EXAMINATION

Radiographic Examination shall not carried out until at least 24 hours have elapsed following completion of welding. However, for welds which are subject to a PWHT requirement, the examination may be performed and reported immediately following completion of the PWHT process.
The inspection and NDE before heat treatment will be at the sole discretion of the Contractor and does not prevent the rear controls.

6. SURFACE CONDITIONS

The surface irregularities that might hide or be confused with discontinuities must be removed. The irregularities of the seams, as regards both the inside (if accessible) and outside, must be removed with a suitable method so that they do not disturb the evaluation of the films.

7. SURFACE CONDITIONS

X-Ray source shall be used.

8. FILM SELECTION AND SCREEN

Film system classes shall be used in accordance with ISO11699-1 and ISO 5579. Table 1 shows film system classes and metal screens used.

Normally following film or equivalent shall be used:

Agfa D7 or Kodak AA400 for film class C5

Radiation source	Penetrated thickness	Film system class	Type and thickness of metal screens
X-ray potentials		C5	0.02 mm to 0.15 mm front and back screens of lead
X-ray potentials	≤ 50 mm	C5	0.02 mm to 0.2 mm front and back screens of lead
X-ray potentials > 250 Kv to	> 50 mm	C5	*0.1* mm to 0.2 mm front screens of lead *(note 1)* 0.2 mm to 0.2 mm back screens of lead

Note 1: Ready packed films with a front screen up to 0,03mm may be used if an additional lead screen of 0,1mm is placed between the object and the film

Table 1: Film system classes and metal screens

All screens should be handled carefully to avoid dents and scratches, dirt, or grease on active surfaces.

Good contact between films and screens is required; this may be achieved also using vacuum- packed films.

Table 3 — Film system classes and metal screens for the radiography of steels, copper and nickel based alloys

Radiation source	Penetrated thickness w	Film system class[a]		Type and thickness of metal screens	
		Class A	Class B	Class A	Class B
X-ray potentials $\leqslant$ 100 kV		C 5	C 3	None or up to 0,03 mm front and back screens of lead	
X-ray potentials > 100 kV to 150 kV				Up to 0,15 mm front and back screens of lead	
X-ray potentials > 150 kV to 250 kV			C 4	0,02 mm to 0,15 mm front and back screens of lead	
Yb 169 Tm 170	$w < 5$ mm	C 5	C 3	None or up to 0,03 mm front and back screens of lead	
	$w \geqslant 5$ mm		C 4	0,02 mm to 0,15 mm front and back screens of lead	
X-ray potentials > 250 kV to 500 kV	$w \leqslant 50$ mm	C 5	C 4	0,02 mm to 0,2 mm front and back screens of lead	
	$w > 50$ mm		C 5	0,1 mm to 0,2 mm and front screens of lead[b] 0,02 mm to 0,2 mm back screens of lead	
Se 75		C 5	C 4	0,1 mm to 0,2 mm front and back screens of lead	
Ir 192		C 5	C 4	0,02 mm to 0,2 mm front screens of lead[b]	0,1 mm to 0,2 mm front screens of lead[b]
				0,02 mm to 0,2 mm back screens of lead	
Co 60	$w \leqslant 100$ mm	C 5	C 4	0,25 mm to 0,7 mm front and back screens of steel or copper[c]	
	$w > 100$ mm		C 5		
X-ray equipment with energy from 1 MeV to 4 MeV	$w \leqslant 100$ mm	C 5	C 3	0,25 mm to 0,7 mm front and back screens of steel or copper [c]	
	$w > 100$ mm		C 5		
X-ray equipment with energy from 4 MeV to 12 MeV	$w \leqslant 100$ mm	C 4	C 4	Up to 1 mm front screen of copper, steel or tantalum[d].	
	100 mm < $w \leqslant$ 300 mm	C 5			
	$w > 300$ mm		C 5	Back screen of copper or steel up to 1 mm and tantalum up to 0,5 mm [d]	
X-ray equipment with energy above 12 MeV	$w \leqslant 100$ mm	C 4	—	Up to 1 mm front screen of tantalum [e] No back screen	
	100 mm < $w \leqslant$ 300 mm	C 5	C 4		
	$w > 300$ mm		C 5	Up to 1 mm front screen of tantalum [e] Up to 0,5 mm back screen of tantalum	

[a] Better film system classes may also be used.

[b] Ready packed films with a front screen up to 0,03 mm may be used if an additional lead screen of 0,1 mm is placed between the object and the film.

[c] In class A, 0,5 mm to 2,0 mm screens of lead may also be used.

[d] In class A, 0,5 mm to 1 mm screens of lead may also be used.

[e] Tungsten screens may also be used.

9. FILM PROCESSING

Manual or automatic film processing may be used. Automatic processingequipment is periodically checked. In case of continuous service a weekly check will be performed. The check consists of washing the rollers and basins, the latter every three months.

All the radiographs shall be processed in accordance with UNI EN ISO 11699-2.

All the films shall be free from defects due to fabrication or processing which could confuse or limit proper interpretation of the radiographs.

Normally products (or equivalent) for film processing are:

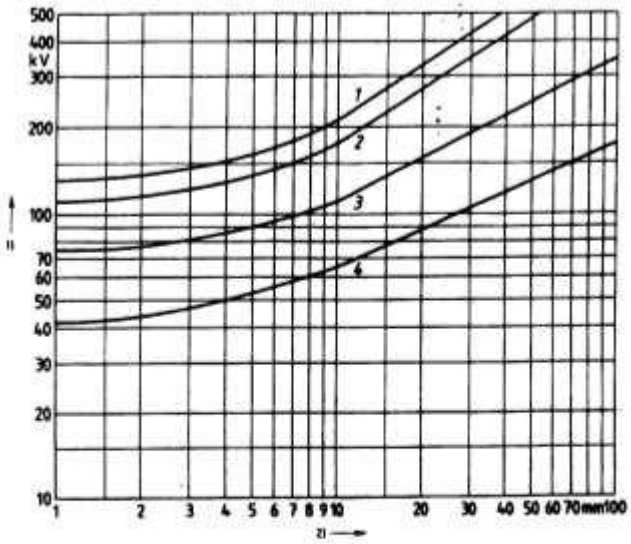
a) Manual processing
Developer: AGFA GEVAERT type G 128
Fixer: AGFA GEVAERT type G 328

b) Automatic processing
Equipment: AGFA NDT M ECO
Developer: AGFA GEVAERT type G 127
Fixer: AGFA GEVAERT type G 321

10. EQUIPMENT

Manufacturer	Model	Beam	Penetration (mm in steel)	Focal spot (mm)	Max Voltage (KV)
SEIFERT	ERESCO 65 MF2	Directional	65	3	300
SEIFERT	ERESCO 42 MF2	Directional	42	1.5	200
GILARDONI	MHF 300 D	Directional	65	3	300
ICM	SITE-X C3005	Panoramic	52	0.5 x 5	300

The maximum voltage used for steel in the examinations shall not exceed the value shown in Figure 1.



1 Copper/Nickel and alloys
2 Steel
3 Titanium and alloys
4 Alluminium and alloys

Figure 20 : Maximum X-ray voltage for X-ray devices up to 500 kV as a function of penetrated thickness and material

Figure 1: Maximum X-ray voltage as a function of penetrated thickness and material

11. TYPES AND POSITION OF IMAGE QUALITY INDICATORS (IQI)

ISO Wire-type IQIs shall be used. They shall be W 1 FE, W 6 FE, W 10 FE as given in figure 2, in accordance with ISO 19232-1:2004. IQIs shall be manufactured and identified in accordance with the requirements allowed in ISO 19232-1 (equal to EN 462-1).

One wire penetrameter shall be placed on the weld with the wires across to the weld axis at the centre of the area of interest.

The wires shall be directed perpendicular to the weld and its location shall ensure that at least 10 mm of the wire length will show in a section of uniform optical density, which is normally in the parent metal adjacent to the weld so that the length of the wires is perpendicular to the length of the weld.

Dimensions in millimetres

Image quality indicator including				Wire			Wire centreline spacing, a
W 1	W 6	W 10	W 13	Wire number	Nominal wire diameter	Tolerances	
X				W 1	3.20		9.6^{+1}_{0}
X				W 2	2.50	± 0.03	7.5^{+1}_{0}
X				W 3	2.00		6^{+1}_{0}
X				W 4	1.60		
X				W 5	1.25		
X	X			W 6	1.00	± 0.02	
X	X			W 7	0.80		
	X			W 8	0.63		
	X			W 9	0.50		
	X	X		W 10	0.40		
	X	X		W 11	0.32		
	X	X		W 12	0.25	± 0.01	5^{+1}_{0}
		X	X	W 13	0.20		
		X	X	W 14	0.16		
		X	X	W 15	0.125		
		X	X	W 16	0.100		
			X	W 17	0.080	± 0.005	
			X	W 18	0.063		
			X	W 19	0.050		

Figure 2: Image Quality Indicators. Designation, wire diameters and fundamental wires

The IQI used shall be placed on the source side of the object when Radiographic Technique shown in fig.3 will be applied.

Depending on the applicable Radiographic Technique and pipe thickness, IQI shall be referred to Tables 2 and 3.

The procedure shall be qualified to demonstrate that the minimum required sensitivity is achieved all throught the wall thickness including the two opposite surfaces.
If the penetrameter is placed on film side shall be marked with a letter “F”.

Table 2
Single-wall technique IQI on source side

Table A.3 — Wire IQI

Image quality class B				
Nominal thickness t mm				IQI value[a]
		⩽	1,5	W 19
>	1,5	⩽	2,5	W 18
>	2,5	⩽	4	W 17
>	4	⩽	6	W 16
>	6	⩽	8	W 15
>	8	⩽	12	W 14
>	12	⩽	20	W 13
>	20	⩽	30	W 12
>	30	⩽	35	W 11
>	35	⩽	45	W 10
>	45	⩽	65	W 9
>	65	⩽	120	W 8
>	120	⩽	200	W 7
>	200	⩽	350	W 6
>	350			W 5

a When using Ir 192 sources, IQI values lower than listed values can be accepted as follows:

12 mm to 40 mm: up to 1 value.

Table 3
Double-wall technique - single image IQI on film side

Table A.7 — Wire IQI

Image quality class B				
Penetrated thickness w mm				IQI value[a]
		⩽	1,5	W 19
>	1,5	⩽	2,5	W 18
>	2,5	⩽	4	W 17
>	4	⩽	6	W 16
>	6	⩽	8	W 15
>	8	⩽	15	W 14
>	15	⩽	25	W 13
>	25	⩽	38	W 12
>	38	⩽	45	W 11
>	45	⩽	55	W 10
>	55	⩽	70	W 9
>	70	⩽	100	W 8
>	100	⩽	170	W 7
>	170	⩽	250	W 6
>	250			W 5

12. RADIOGRAPHS TECHNIQUE

Improved techniques (Class B according to EN ISO 17636-1) shall be chosen as radiographic technique.

A single-wall exposure with single film technique shall be used for radiography whenever practical. When it is not practical to use a single-wall technique, a double-wall technique – single image shall be used.

Remark: When radiographing a weld, if the ratio between thickness of weld reinforcement and base material is such that it is impossible to obtain a film density of 2.0 ÷ 4.0 in the area of interest using one film only, then two subsequent "single film" exposures of different film density shall be performed. Each radiograph shall be evaluated in the film area where the density is 2.0 ÷ 4.0. This means that in such a case, two films will be necessary for the same weld position.
The evaluation of both radiographs together must ensure that an acceptable film density covers the full area under testing.
If double film viewing is used, the optical density of one single film shall not be lower than 1,3.

Test arrangement: radiation source located outside the pipe and the film inside (see Fig.3)

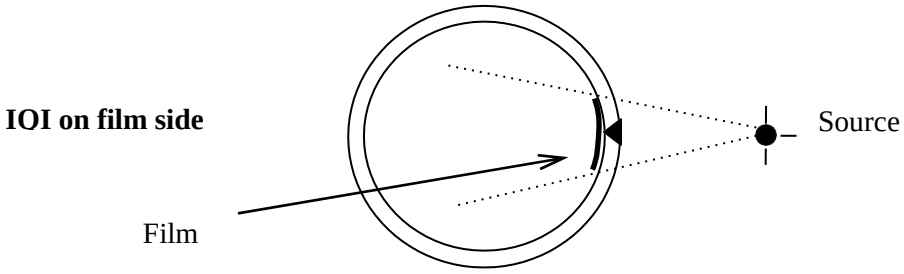


Figure 3: Test arregement

13. OVERLAPS OF FILMS

When radiographing a weld with two or more separate films, the films shall be overlapped sufficiently to ensure that the complete region of interest is radiographed. This shall be verified with the same location marker (normally lead number) visible on two successive radiographs.
At least an overlap of 25 mm minimum shall be demonstrate from each end of the film.

14. DENSITY OF RADIOGRAPHS

Density limitation

The densities resulting from any variation of penetrated thickness should be 2.0 up to 3.0 in the area of interest for single film exposure. When double film is used image density of the weld shall be 2.6 up to 3.8, with a minimum of 1,3 on each film. A measuring tolerance of ± 0.1 is permitted. High optical density can be used with advantage where the viewing light is sufficiently bright in accordance with EN 25580

Density measurement

In order to judge the density a densitometer must be employed. The densitometer calibration is verified by comparison with a calibrated step wedge tablet in accordance with Tecnocontrol internal procedure N. DEN 02 rev.0. Densitometer normally used is type X-Rite 301, checked with calibrated X-RAY FILM STEP TABLET

15. MAXIMUM AREA OF SINGLE EXPOSURE

The number of radiographs for a complete examination of a longitudinal weld shall be calculated on the base of the following conditions:

The ratio of the penetrated thickness at the outer edge of an evaluated area of uniform thickness to that at the centre beam shall not be more than 1.1, according to class B of ISO 17636-1

The size of the area to be examined includes the weld plus 10 mm of parent metal on each side of the weld.

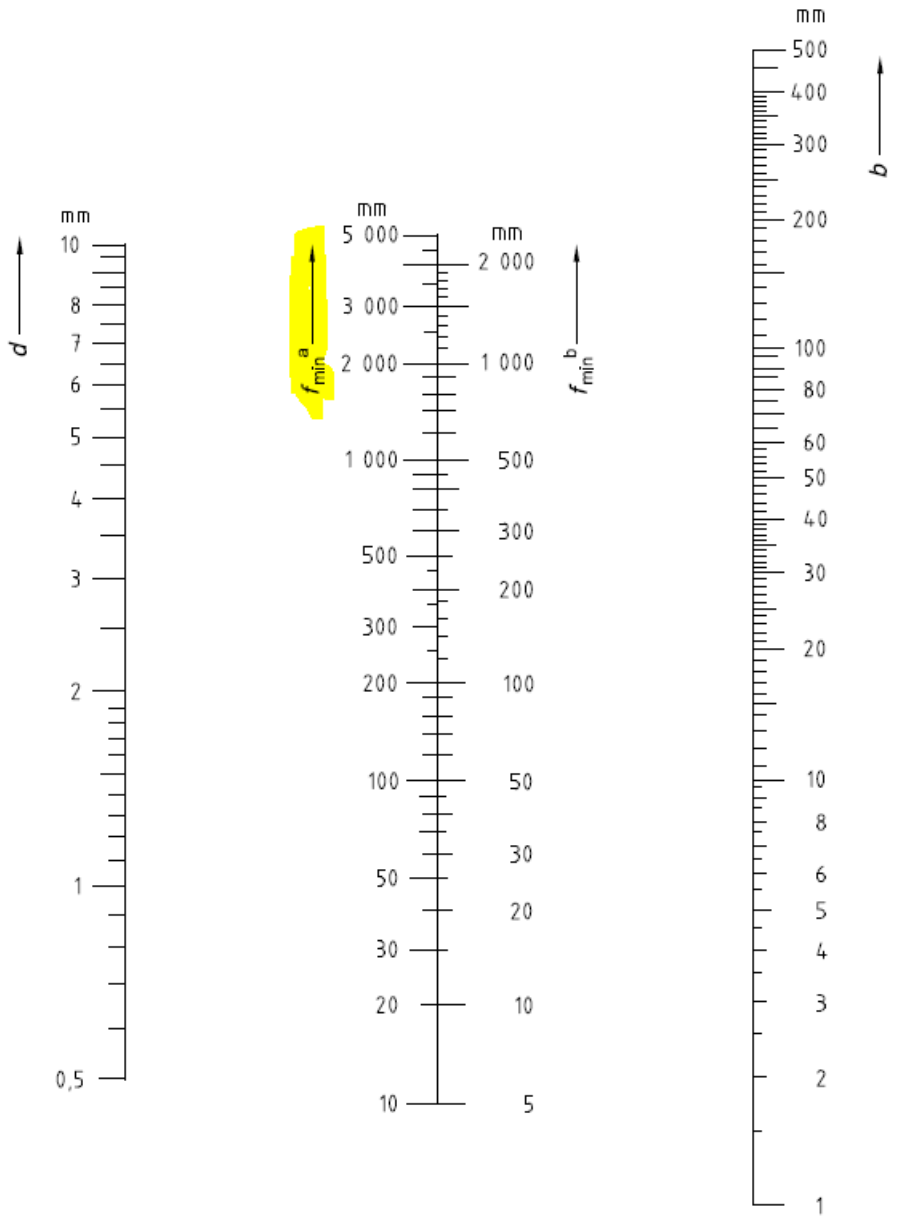
16. SOURCE TO OBEJECT DISTANCE

The minimum source-to-object distance, f min, depends on the source size d and the object-to-film distance, b.

The distance, f, shall, where practicable, be chosen so that the ratio of this distance to the source size, d, i.e. f/d, is not below the values given by the following equations according to ISO 17636-1 class B.

For Class B: $\frac{f}{d} \geq 15\left(\frac{b}{mm}\right)^{\frac{2}{3}}$ (1) b is given mm

If the distance b < 1,2 t, the dimension b in Equations (1) and (2) and Figure 4 extracted from ISO 17636-1 shall be replaced by the nominal thickness t. For determination of the source-to-object distance, f min, the normogram in figure 4 based on equation may be used.



a Class B.

b Class A.

Figure 21 — Nomogram for the determination of minimum source-to-object distance, f_{min}, in relation to object-to-film distance, b, and the source size, d.

Figure 4: Normogram for the determination of minimum source to object distance f min. in relation to object to film distance and the sorce size. Source: ISO 17636-1

17. IDENTIFICATION SYSTEM

Identification on the film holders

The following data is permanently marked on the film holder:
Manufacturer; Manufacturer Job; Identification Pipe Mark; Weld identification (if more than one); position of area examined; data of examination; thickness; radiation source type; film density; results; judgement for acceptance.

Identification on the films

The following data are permanently included in the film as radiographic image:
Data of examination; Manufacturer; Manufacturer Job; Identification Pipe Mark; Identification weld (if more than one); location marks; IQI;
The identification by lead letters or numbers that must appear on the radiographic image must be put on the pipe and not on the envelope containing the film, and their position must be marked on the pipe itself, so that the examined area can be exactly localized.
The system adopted must not, however, hide the area involved in the examination.

18. SCATTERED RADIATION

If necessary, the film shall be shielded from scattered radiation by an adeguate thickness of lead at least 1 mm, or of tin at least 1,5 mm, placed behind the film-screen combination.
The presence of back scattered radiation shall be checked for each new test arrangement by a letter B (with a height of minimum 10 mm and a thickness of minimum 1.5 mm) placed immediately behind each cassette. If the image of this symbol records as a lighter image on the radiograph, it shall be rejected. If the symbol is darker or visible the radiograph is acceptable and demonstrates good protection against scattered radiation.

19. EVALUATION OFRADIOGRAPHS

Quality of the films

All the films must be free from damage of a mechanical, chemical or other nature in the measure in which they might hide defects or make it difficult to interpret the image in the relative area of the object under examination.
Such damage can be of the following types, among others:
clouding;
development defects such as striation, drops of water or spots;
scratches, fingerprints, creases, dirt, marks, irregularities or tears;
loss of definition due to poor screen-plate contact;
false indications due to defects or irregularities in the reinforcement screen.

Image Quality values (Radiographic sensitivity)

The sensitivity shall be assessed by the number of the smallest wire that can be discerned from the examination of the image of IQI on the radiograph.

Table 2 and 3 of this procedure show the minimum quality values. The image quality value obtained shall be indicated on the Radiographic Examination Report

20. ACCEPTANCE CRITERIA FOR FLAWS

Acceptance Criteria shall be in according to Level. B of Table 1 EN ISO 5817 attached to this procedure as Attachment 2

21. REPAIR OF WELDS

No rectification, repair or modification shall be made without the approval of the purchaser or Inspecting Authority.

Unacceptable imperfections shall be either repaired or deemed not to comply with this Specification. Repair welds shall be carried out to an approved procedure and subjected to the same Acceptance Criteria as original work.

Examination of the repaired area should include the repaired area, together with a distance of three material thicknesses (not repair weld thicknesses) on either side of the repair, and should include a similar distance along any weld seams intersecting the area of repair.

Radiographs of repair welds shall be clearly identified R1, R2 etc. for the first repair, second repair, etc.

22. CERTIFICATION

A Report giving information on the radiographic examination performed as required by EN 1435 shall be made for each pipe.

The report form for welds that are acceptable need only contain sufficient information to identify the

weld, the operator (signature), and the acceptability of the weld.

Evaluation of retested repaired weld areas shall be tabulated on a new line on the report form. If the original report form is used, an R1, R2, …Rn shall prefix the indication number. If additional report forms are used, the R number shall prefix the report number.

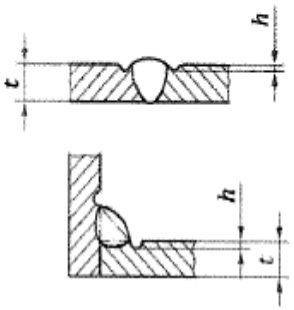
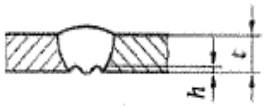
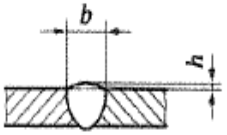
The format of the radiographic Examination report is given in Annex 1 of this procedure. Annex 1 is essential part of this procedure

ATTACHMENT N. 1

Table 1 extracted from EN ISO 5817 and table 12 extracted from EN 10217-3

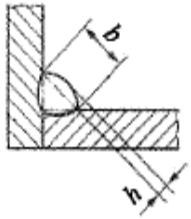
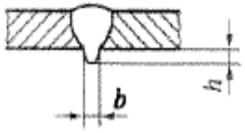
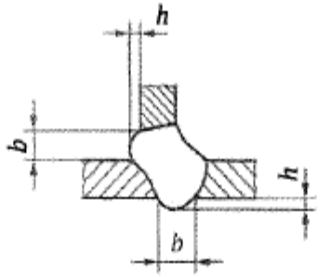
Table 1 — Limits for imperfections

No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1 Surface imperfections							
1.1	100	Crack		≥ 0,5	Not permitted	Not permitted	Not permitted
1.2	104	Crater crack		≥ 0,5	Not permitted	Not permitted	Not permitted
1.3	2017	Surface pore	Maximum dimension of a single pore for	0,5 to 3		Not permitted	Not permitted
			— butt welds		$d \leq 0{,}3\ s$		
			— fillet welds		$d \leq 0{,}3\ a$		
			Maximum dimension of a single pore for	> 3			Not permitted
			— butt welds		$d \leq 0{,}3\ s$, but max. 3 mm	$d \leq 0{,}2\ s$, but max. 2 mm	
			— fillet welds		$d \leq 0{,}3\ a$, but max. 3 mm	$d \leq 0{,}2\ a$, but max. 2 mm	
1.4	2025	End crater pipe		0,5 to 3	$h \leq 0{,}2\ t$	Not permitted	Not permitted
				> 3	$h \leq 0{,}2\ t$, but max. 2 mm	$h \leq 0{,}1\ t$, but max. 1 mm	Not permitted
1.5	401	Lack of fusion (incomplete fusion)	—	≥ 0,5	Not permitted	Not permitted	Not permitted
		Micro lack of fusion	Only detectable by micro examination	≥ 0,5	Permitted	Permitted	Not permitted
1.6	4021	Incomplete root penetration	Only for single side butt welds	≥ 0,5	Short imperfections: $h \leq 0{,}2\ t$ but max. 2 mm	Not permitted	Not permitted

No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1.7	5011	Continuous undercut	Smooth transition is required. This is not regarded as a systematic imperfection.	0,5 to 3	Short imperfections: $h \le 0{,}2\ t$	Short imperfections: $h \le 0{,}1\ t$	Not permitted
	5012	Intermittent undercut		> 3	$h \le 0{,}2\ t$, but max. 1 mm	$h \le 0{,}1\ t$, but max. 0,5 mm	$h \le 0{,}05\ t$, but max. 0,5 mm
1.8	5013	Shrinkage groove	Smooth transition is required. 	0,5 to 3	Short imperfections: $h \le 0{,}2$ mm + $0{,}1\ t$	Short imperfections: $h \le 0{,}1\ t$	Not permitted
				> 3	Short imperfections: $h \le 0{,}2\ t$, but max. 2 mm	Short imperfections: $h \le 0{,}1\ t$, but max.1 mm	Short imperfections: $h \le 0{,}05\ t$, but max. 0,5 mm
1.9	502	Excess weld metal (butt weld)	Smooth transition is required. 	≥ 0,5	$h \le 1$ mm + $0{,}25\ b$, but max. 10 mm	$h \le 1$ mm + $0{,}15\ b$, but max. 7 mm	$h \le 1$ mm + $0{,}1\ b$,but max. 5 mm

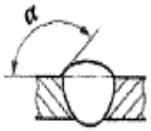
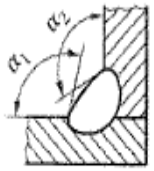
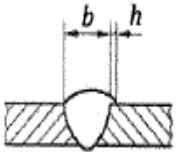
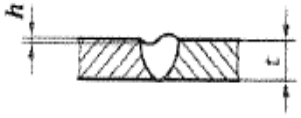
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Date 07/12/2023

No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1.10	503	Excessive convexity (fillet weld)		≥ 0,5	$h \leq 1$ mm + 0,25 b, but max. 5 mm	$h \leq 1$ mm + 0,15 b, but max. 4 mm	$h \leq 1$ mm + 0,1 b, but max. 3 mm
1.11	504	Excess penetration	 	0,5 to 3 > 3	$h \leq 1$ mm + 0,6 b $h \leq 1$ mm + 1,0 b, but max. 5 mm	$h \leq 1$ mm + 0,3 b $h \leq 1$ mm + 0,6 b, but max. 4 mm	$h \leq 1$ mm + 0,1 b $h \leq 1$ mm + 0,2 b,but max. 3 mm

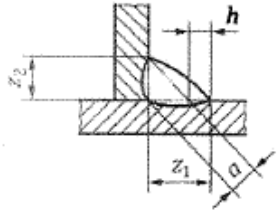
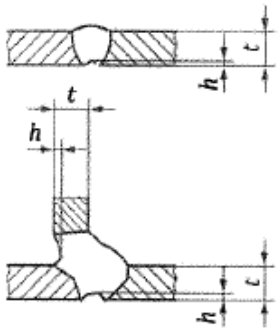
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1.12	505	Incorrect weld toe	— butt welds 	≥ 0,5	$\alpha \geq 90°$	$\alpha \geq 110°$	$\alpha \geq 150°$
			— fillet welds  $\alpha_1 \geq \alpha$ and $\alpha_2 \geq \alpha$	≥ 0,5	$\alpha \geq 90°$	$\alpha \geq 100°$	$\alpha \geq 110°$
1.13	506	Overlap		≥ 0,5	$h \leq 0,2\,b$	Not permitted	Not permitted
1.14	509	Sagging	Smooth transition is required	0,5 to 3	Short imperfections: $h \leq 0,25\,t$	Short imperfections: $h \leq 0,1\,t$	Not permitted
	511	Incompletely filled groove		> 3	Short imperfections: $h \leq 0,25\,t$, but max. 2 mm	Short imperfections: $h \leq 0,1\,t$, but max. 1 mm	Short imperfections: $h \leq 0,05\,t$, but max. 0,5 mm

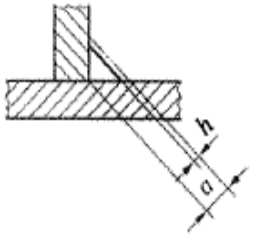
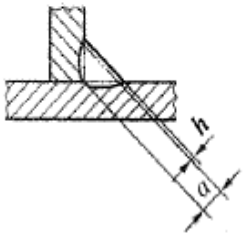
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1.15	510	Burn through	—	≥ 0,5	Not permitted	Not permitted	Not permitted
1.16	512	Excessive asymmetry of fillet weld (excessive unequal leg length)	In cases where an asymmetric fillet weld has not been prescribed. 	≥ 0,5	$h \leq 2$ mm + 0,2 a	$h \leq 2$ mm + 0,15 a	$h \leq 1,5$ mm + 0,15 a
1.17	515	Root concavity	Smooth transition is required. 	0,5 to 3 > 3	$h \leq 0,2$ mm + 0,1 t Short imperfections: $h \leq 0,2\ t$, but max. 2 mm	Short imperfections: $h \leq 0,1\ t$ Short imperfections: $h \leq 0,1\ t$, but max. 1 mm	Not permitted Short imperfections: $h \leq 0,05\ t$, but max. 0,5 mm

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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1.18	516	Root porosity	Spongy formation at the root of a weld due to bubbling of the weld metal at the moment of solidification (e. g. lack of gas backing)	≥ 0,5	Locally permitted	Not permitted	Not permitted
1.19	517	Poor restart	—	≥ 0,5	Permitted The limit depends on the type of imperfection occurred due to restart.	Not permitted	Not permitted
1.20	5213	Insufficient throat thickness	Not applicable to processes with proof of greater depth of penetration 	0,5 to 3 > 3	Short imperfections: $h \leq 0{,}2$ mm + 0,1 a Short imperfections: $h \leq 0{,}3$ mm + 0,1 a, but max. 2 mm	Short imperfections: $h \leq 0{,}2$ mm Short imperfections: $h \leq 0{,}3$ mm + 0,1 a, but max. 1 mm	Not permitted Not permitted
1.21	5214	Excessive throat thickness	The actual throat thickness of the fillet weld is too large. 	≥ 0,5	Permitted	$h \leq 1$ mm + 0,2 a, but max. 4 mm	$h \leq 1$ mm + 0,15 a, but max. 3 mm

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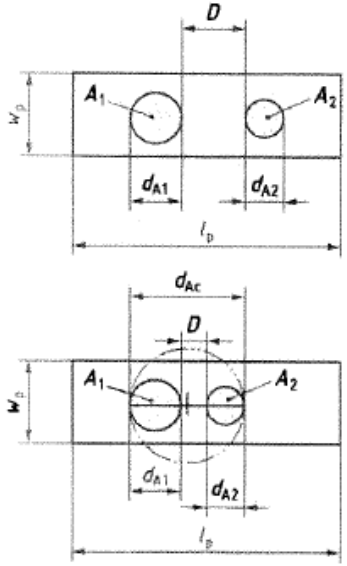
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
1.22	601	Stray arc	—	≥ 0,5	Permitted, if the properties of the parent metal are not affected.	Not permitted	Not permitted
1.23	602	Spatter	—	≥ 0,5	Acceptance depends on application, e.g. material, corrosion protection	Acceptance depends on application, e.g. material, corrosion protection	Acceptance depends on application, e.g. material, corrosion protection
1.24	610	Temper colour (Discolouration)	—	≥ 0,5	Acceptance depends on application, e.g. material, corrosion protection	Acceptance depends on application, e.g. material, corrosion protection	Acceptance depends on application, e.g. material, corrosion protection

No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2 Internal imperfections							
2.1	100	Cracks	All types of crack except microcracks and crater cracks	≥ 0,5	Not permitted	Not permitted	Not permitted
2.2	1001	Microcracks	A crack usually only visible under the microscope (50 ×)	≥ 0,5	Permitted	Acceptance depends on type of parent metal with particular reference to crack sensitivity	Acceptance depends on type of parent metal with particular reference to crack sensitivity
2.3	2011 2012	Gas pore Uniformly distributed porosity	The following conditions and limits for imperfections shall be fulfilled. See also Annex A for information.				
			a1) Maximum dimension of the area of the imperfections (inclusive of systematic imperfection) related to the projected area	≥ 0,5	For single layer: ≤ 2,5 % For multi-layer: ≤ 5 %	For single layer: ≤ 1,5 % For multi-layer: ≤ 3 %	For single layer: ≤ 1 % For multi-layer: ≤ 2 %
			NOTE The porosity in the project area depends on the numbers of layers (volume of the weld).				
			a2) Maximum dimension of the cross-sectional area of the imperfections (inclusive of systematic imperfection) related to the fracture area (only applicable to test pieces: production test, welder or procedure qualification tests)	≥ 0,5	≤ 2,5 %	≤ 1,5 %	≤ 1 %
			b) Maximum dimension for a single pore for	≥ 0,5	$d \leq 0{,}4\ s$, but max. 5 mm	$d \leq 0{,}3\ s$, but max. 4 mm	$d \leq 0{,}2\ s$, but max. 3 mm
			— butt welds		$d \leq 0{,}4\ a$, but max. 5 mm	$d \leq 0{,}3\ a$, but max. 4 mm	$d \leq 0{,}2\ a$, but max. 3 mm
			— fillet welds				

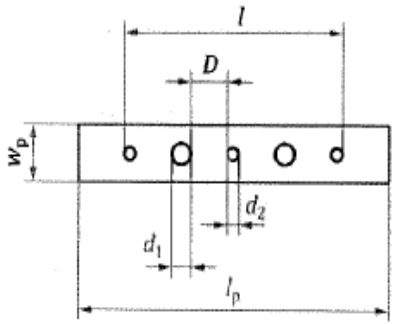
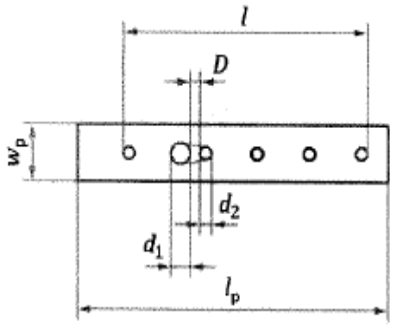
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2.4	2013	Clustered (localized) porosity	 Reference length for l_p is 100 mm. The total gas pore area within the cluster is represented by a circle of diameter d_A surrounding all the gas pores. The requirement for a single gas pore shall be met by all the gas pores within this circle. A permitted porous area shall be local. The possibility of the pore cluster masking other imperfections shall be taken into consideration. If D is less than d_{A1} or d_{A2}, whichever is smaller, then the total gas pore area is represented by a circle of diameter d_{AC}, where $d_{AC} = d_{A1} + d_{A2} + D$. Systematic cluster porosity is not permitted. d_A corresponds to d_{A1}, d_{A2} or d_{AC}, whichever is applicable.	≥ 0,5	$d_A \leq 25$ mm or $d_{A,\,max} \leq w_p$	$d_A \leq 20$ mm or $d_{A,\,max} \leq w_p$	$d_A \leq 15$ mm or $d_{A,\,max} \leq w_p/2$

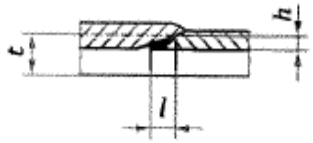
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2.5	2014	Linear porosity	— butt welds	≥ 0,5	$h \leq 0{,}4\,s$, but max. 4 mm $l \leq s$, but max. 75 mm	$h \leq 0{,}3\,s$, but max. 3 mm $l \leq s$, but max. 50 mm	$h \leq 0{,}2\,s$, but max. 2 mm $l \leq s$, but max. 25 mm
			— fillet welds	≥ 0,5	$h \leq 0{,}4\,a$, but max. 4 mm $l \leq a$, but max. 75 mm	$h \leq 0{,}3\,a$, but max. 3 mm $l \leq a$, but max. 50 mm	$h \leq 0{,}2\,a$, but max. 2 mm $l \leq a$, but max. 25 mm
			Case 1 ($D > d_2$)  Case 2 ($D < d_2$)  Reference length for l_p is 100 mm. For case 1: $d_1 = h$ For case 2: $d_1 + d_2 + D = h$				

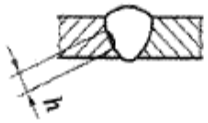
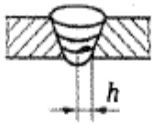
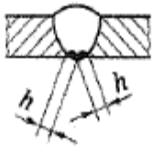
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Date 07/12/2023

No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2.6	2015 2016	Elongated cavity Wormholes	— butt welds	≥ 0,5	$h \le 0{,}4\ s$, but max. 4 mm $l \le s$, but max. 75 mm	$h \le 0{,}3\ s$, but max. 3 mm $l \le s$, but max. 50 mm	$h \le 0{,}2\ s$, but max. 2 mm $l \le s$, but max. 25 mm
			— fillet welds	≥ 0,5	$h \le 0{,}4\ a$, but max. 4 mm $l \le a$, but max. 75 mm	$h \le 0{,}3\ a$, but max. 3 mm $l \le a$, but max. 50 mm	$h \le 0{,}2\ a$, but max. 2 mm $l \le a$, but max. 25 mm
2.7	202	Shrinkage cavity		≥ 0,5	Short imperfections permitted, but not breaking of the surfaces: butt welds: $h \le 0{,}4\ s$, but max. 4 mm fillet welds: $h \le 0{,}4\ a$, but max. 4 mm	Not permitted	Not permitted
2.8	2024	Crater pipe	 The larger value of h or l will be measured	0,5 to 3 > 3	h or $l \le 0{,}2\ t$ h or $l \le 0{,}2\ t$, but max. 2 mm	Not permitted	Not permitted
2.9	300 301 302 303	Solid inclusions Slag inclusions Flux inclusions Oxide inclusions	— butt welds	≥ 0,5	$h \le 0{,}4\ s$, but max. 4 mm $l \le s$, but max. 75 mm	$h \le 0{,}3\ s$, but max. 3 mm $l \le s$, but max. 50 mm	$h \le 0{,}2\ s$, but max. 2 mm $l \le s$, but max. 25 mm
			— fillet welds	≥ 0,5	$h \le 0{,}4\ a$, but max. 4 mm $l \le a$, but max. 75 mm	$h \le 0{,}3\ a$, but max. 3 mm $l \le a$, but max. 50 mm	$h \le 0{,}2\ a$, but max. 2 mm $l \le a$, but max. 25 mm

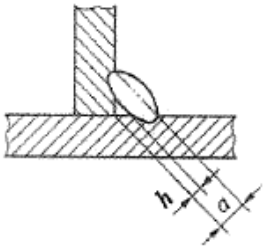
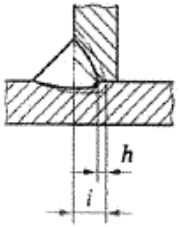
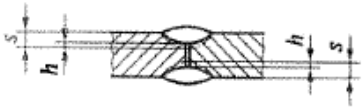
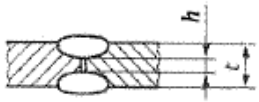
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2.10	304	Metallic inclusions other than copper	— butt welds	≥ 0,5	$h \leq 0{,}4\ s$, but max. 4 mm	$h \leq 0{,}3\ s$, but max. 3 mm	$h \leq 0{,}2\ s$,but max. 2 mm
			— fillet welds	≥ 0,5	$h \leq 0{,}4\ a$, but max. 4 mm	$h \leq 0{,}3\ a$, but max. 3 mm	$h \leq 0{,}2\ a$, but max. 2 mm
2.11	3042	Copper inclusions	—	≥ 0,5	Not permitted	Not permitted	Not permitted
2.12	401	Lack of fusion (incomplete fusion)		≥ 0,5	Short imperfections permitted: butt welds: $h \leq 0{,}4\ s$, but max. 4 mm fillet welds: $h \leq 0{,}4\ a$ but max. 4 mm	Not permitted	Not permitted
	4011	Lack of side wall fusion					
	4012	Lack of inter-run fusion					
	4013	Lack of root fusion					

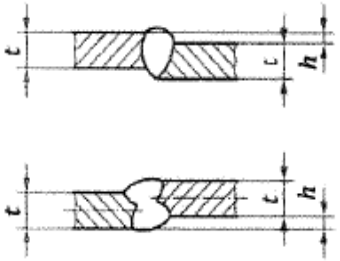
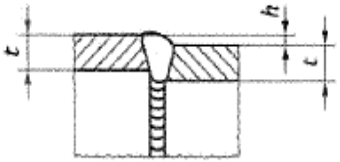
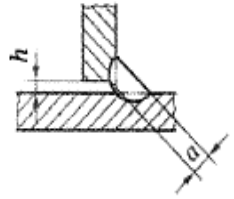
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
2.13	402	Lack of penetration	 T-joint (fillet weld)	> 0,5	Short imperfection: $h \le 0{,}2\ a$, but max. 2 mm	Not permitted	Not permitted
			 T-joint (partial penetration)  Butt joint (partial penetration)	≥ 0,5	Short imperfections: butt joint: $h \le 0{,}2s$ or i, but max. 2 mm T-joint: $h \le 0{,}2a$, but max. 2 mm	Short imperfections: butt joint: $h \le 0{,}1\ s$ or i, but max. 1,5 mm fillet joint: $h \le 0{,}1\ a$, but max. 1,5 mm	Not permitted
			 Butt joint (full penetration)	≥ 0,5	Short imperfection: $h \le 0{,}2\ t$, but max. 2 mm	Not permitted	Not permitted

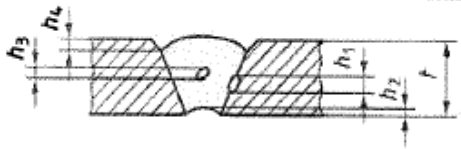
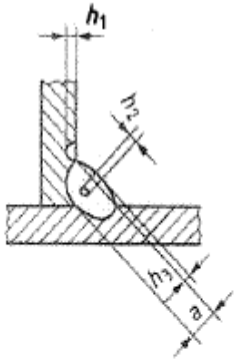
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
3 Imperfections in joint geometry							
3.1	507	Linear misalignment	The limits relate to deviations from the correct position. Unless otherwise specified, the correct position is that when the centrelines coincide (see also Clause 1). t refers to the smaller thickness.				
	5071	Linear misalignment between plates	 Plates and longitudinal welds	0,5 to 3 > 3	$h \le 0{,}2$ mm + $0{,}25\,t$ $h \le 0{,}25\,t$ but max. 5 mm	$h \le 0{,}2$ mm + $0{,}15\,t$ $h \le 0{,}15\,t$, but max. 4 mm	$h \le 0{,}2$ mm + $0{,}1\,t$ $h \le 0{,}1\,t$, but max. 3 mm
	5072	Transversely circular welds at cylindrical hollow sections	 Circumferential welds	≥ 0,5	$h \le 0{,}5\,t$, but max. 4 mm	$h \le 0{,}5\,t$, but max. 3 mm	$h \le 0{,}5\,t$, but max. 2 mm
3.2	617	Incorrect root gap for fillet welds	Gap between the parts to be joined. Gaps exceeding the appropriate limit may, in certain cases, be compensated for by a corresponding increase in the throat thickness. 	0,5 to 3 > 3	$h \le 0{,}5$ mm + $0{,}1\,a$ $h \le 1$ mm + $0{,}3\,a$, but max. 4 mm	$h \le 0{,}3$ mm + $0{,}1\,a$ $h \le 0{,}5$ mm + $0{,}2\,a$, but max. 3 mm	$h \le 0{,}2$ mm + $0{,}1\,a$ $h \le 0{,}5$ mm + $0{,}1\,a$, but max. 2 mm

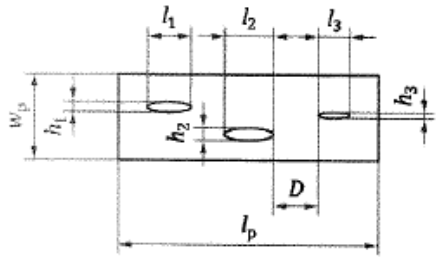
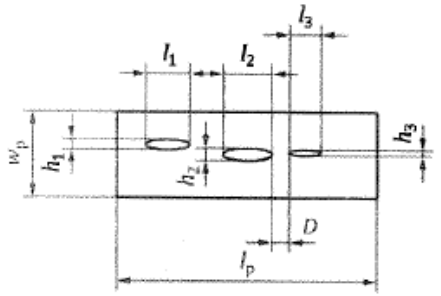
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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t	Limits for imperfections for quality levels		
				mm	D	C	B
4 Multiple imperfections							
4.1	None	Multiple imperfections in any cross section	 $h_1 + h_2 + h_3 + h_4 = \sum h$  $h_1 + h_2 + h_3 = \sum h$	0,5 to 3 > 3	Not permitted Maximum total height of imperfections: $\Sigma h \leq 0{,}4\ t$ or $\leq 0{,}25\ a$	Not permitted Maximum total height of imperfections: $\Sigma h \leq 0{,}3\ t$ or $\leq 0{,}2\ a$	Not permitted Maximum total height of imperfections: $\Sigma h \leq 0{,}2\ t$ or $\leq 0{,}15\ a$

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No.	Reference to ISO 6520-1	Imperfection designation	Remarks	t mm	Limits for imperfections for quality levels		
					D	C	B
4.2	None	Projected or cross-sectional area in longitudinal direction	Case 1 ($D > l_3$)  $h_1 \times l_1 + h_2 \times l_2 + h_3 \times l_3 = \Sigma h \times l$ Case 2 ($D < l_3$)  $h_1 \times l_1 + h_2 \times l_2 + \left(\frac{h_2 + h_3}{2}\right) \times D + h_3 \times l_3 = \Sigma h \times l$ The sum of the areas $\Sigma\, h \times l$ shall be calculated as a percentage to the evaluation area $l_p \times w_p$ (case 1). If D is smaller than the shorter length of one of the neighbouring imperfections, the full connection of the two imperfections shall be applied to the sum of imperfections (case 2). See also Annex A for information.	≥ 0,5	$\Sigma\, h \times l \leq 16\ \%$	$\Sigma\, h \times l \leq 8\ \%$	$\Sigma\, h \times l \leq 4\ \%$

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Table 12 — Maximum height of the weld seam for SAW tubes

Wall thickness T (mm)	Maximum height of the outside and inside weld seam (mm)
$T \leq 12,5$	3
$T > 12,5$	4

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IOP-UT-2023263-01
ULTRASONIC EXAMINATION INSTRUCTION

Project: **123A90A - Base Load Power Hub Platform**

Client: **Rosetti Marino SpA**

Revision matrix (revised where underlined)

0	07/12/2023	Gianessi A.	D'Anna E.	Ponte V.
Rev.	**Date**	**Issued**	**Checked**	**Approved**

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1. SCOPE

This procedure is intended for the manual ultrasonic pulse echo technique examination of groove welds and HAZ on longitudinal welds of pipes in ferritic steel having thickness between 10 mm and 100 mm inclusive and for the dimensioning of indications by means of comparison with Acceptance Standards .

This Procedure is in accordance with EN 17640. As this standard specify a range of available selections, the following has been chosen:

- Quality level in accordance to ISO5817 : Level B
- Above indicate ISO5817 Level B require that UT examination shall be made at least in accordance with EN ISO 17640 testing level B
- Above indicate ISO5817 Level B require that applicable UT examination acceptance criteria shall be in accordance with EN ISO 11666 level 2

2. REFERENCE DOCUMENTS

- EN ISO 17640 : Ultrasonic Examination of welded joints. Non-destructive testing of welds – Ultrasonic testing
- EN ISO 11666 : Acceptance levels Non-destructive testing of welds – Ultrasonic testing
- EN ISO 23279 : Characterization of indications in welds
- ISO 9712 : Qualification and Certification of NDT Personnel.
- EN 12668 All parts : Characterization and verification of ultrasonic examination equipment
- K559-2254-MT-SPE-001 rev.01: Structural Fabrication Specification Base Load Power Hub (BLPH)

3. PERSONNEL QUALIFICATION

Examination shall be carried out by NDE examiners holding a level II or III qualification in accordance with the following document or other equivalent standard:

- EN 473
- ISO 9712

The personnel employed for the execution of NDE Examination shall have an annual vision test to assure:

- Near vision acuity: the examination should ensure natural or corrected near distance acuity such that they are capable of reading standard J-1 letters on standard Jaeger test type charts or Times Roman No.4,5 (having a height of 1,6mm) or equivalent characters to a distance of not less than 30 cm with one or both eyes. Equivalent near vision tests are acceptable
- Color contrast differentiation: the examination should demonstrate the capability of distinguishing and differentiating contrast among colors or shades of gray (reading of Ishiara test or equivalent)

4. EXTENT OF EXAMINATION

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From outside on 100% of longitudinal pipe welds after weld completion have to be examined: full skip from both sides of weld.
Ultrasonic examination shall include weld and parent material for at least 10 mm on each side of the weld or heat affected zone (HAZ), whichever is greater.
The base metal adjacent to the weld, to the extent having width of the scanning area for angle probes, have to be examined with straight beam for laminations and transverse defects that could interfere with examination of the weld.

5. TIME OF EXAMINATION

Ultrasonic Examination shall be carried out at least 24 hours following completing of welding. When PWHT is performed, final Ultrasonic Examination shall be carried out when all heat treatments have been completed.
For Steels with R_e < 360 MPa are allowed to testing after 24h, if the rate of defects is low.
The first 5% of the tested seams, per method and workstation, shall be checked after 48h. Thereafter, the time of examination could be lowered to 24h.

6. SURFACE CONDITIONS

The surface to be inspected shall be cleaned from any dirt, scales, slag and any other contaminations which may interfere with the scanning or interpretation of the results.
Base material surface adjacent to the weld, shall be prepared to a distance at least allowing the full skip scanning of the shallowest angle transducer on either side of the weld: shall be free of weld spatter, rust or other foreign particles which could interfere with probe coupling and this could be obtained by sandblasting or light grinding.
“As welded” weld surface condition is acceptable to perform correctly the examination.
If undercuts, imperfect shape, incorrect weld toe or other surface discontinuities are clearly visible before examination start, these shall be removed with adequate operations (grinding, welding etc.).

7. COUPLANT

Glycerin, gel, special paste or other similar products may be used. The total chlorine and sulphur content shall be less than 1000 ppm.
Usually Cimolai uses C.G.M. type U-49 or Sichozell, made by Henkel, which shall be mixed with water (dilution Approx 1:40). Similar products could be otherwise used, providing the couplant used during examination is the one used for calibration.

8. ULTRASONIC EQUIPMENT

Instrument. \

The UT instrument shall be the pulse-echo type suitable for use with transducers oscillating at frequencies between 1 and 6 MHz. The display shall be an “A” scan rectified video trace.

A pulse-echo instrument calibrated annually by a qualified vendor, in accordance with ASTM E 317 or EN12668-1 shall be employed. Moreover, recorded linearity checks for ultrasonic equipment according with Appendix A, should be carried out at the beginning of each period of extended use but not more than every 3 months.

The linearity of the time base shall be within 2% over the whole range, i.e. the echoes do not deviate by more than 2% of the time base range from their true position. The amplifier shall be linear to an accuracy of ±1 dB at any point within the range 20% to 80% full screen height.

Cimolai normally uses one or more of the following equipments, but other equivalent could be used if properly calibrated in accordance to the herein listed requirements:

- GE Model USM GO Advanced GE Model USN 60 SW
- KRAUTKRAMER Model USK7 B Krautkramer
- OLYMPUS Model EPOCH 600

Probes

The following probes are normally used, but others could be used if equivalent or for a better evaluation and characterization of indications:

TRADE MARK	MANUFACTURER	FREQUENCY (MHz)	BEAM ANGLE (degree)	CRYSTAL SIZE (mm)	Wave Type
MSEB4	Krautkramer	4	0	Dual 3.5 x 10	Compression
B4S	Krautkramer	4	0	Single	Compression
MWB 60-4	Krautkramer	4	60	Single	Shear
MWB 70-4	Krautkramer	4	70	Single	Shear
MWB 45-4	Krautkramer	4	45	Single	Shear
SWB 60-2	Krautkramer	2	60	Single	Shear
SWB 70-2	Krautkramer	2	70	Single	Shear
SWB 45-2	Krautkramer	2	45	Single	Shear

Ultrasonic equipment checks

Other equipment checks, in addition to those previous indicated, shall be performed in as per the following table, in accordance to EN12668-3. This checks doesn’t need to be recorded

Check	**Frequency**
Linearity of timebase	Weekly
Linearity of equipment gain	Weekly

Probe index	Daily
Beam angle	Daily
Physical state and external aspects	Daily
Sensitivity and signal-to-noise ratio	Weekly
Pulse duration	Weekly

9. EXAMINATION OF FULL PENETRATION WELDS

Calibration of range scale and angle determination

The IIW or ISO calibration blocks (K1 or K2; No.1 Reference block of EN12223, or No.2 Reference block of EN 27963), shall be used for calibration of range scale and for angle determination. These calibration blocks shall preferably have the same acoustic properties as the material to be tested. The range (scale) shall be determined depending of thicknesses under testing and shall be appropriate so that to assure the entire volume of weld has been examined.

Reference blocks for calibration of amplification for testing of welds.

For testing of welds, sensitivity setting for the weld examination shall be referred to a Distance/Amplitude Correction (DAC) curve for a series of 3 mm diameter size drilled holes in a suitable calibration block. The curve shall be corrected where necessary for differences between the attenuation and surface condition of the material under test and the test block.

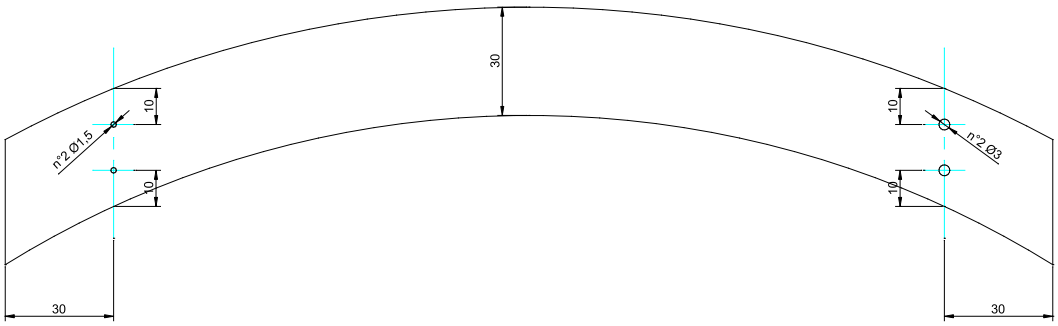
Range and setting sensitivity shall be checked every 4 hours.

If deviation are found during this checks, the correction given in the following table 2 taken off by ISO 17640 shall be carried out.

Table 2 — Sensitivity and range corrections

Sensitivity		
1	Deviations $\leqslant$ 4 dB	Setting shall be corrected before the testing is continued.
2	Reduction of the sensitivity > 4 dB	Setting shall be corrected and all testing carried out with the equipment over the previous period shall be repeated.
3	Increase in sensitivity > 4 dB	Setting shall be corrected and all recorded indications shall be re-examined.
Range		
1	Deviations $\leqslant$ 2 % of the range	Setting shall be corrected before testing is continued.
2	Deviations > 2 % of the range	Setting shall be corrected and testing carried out with the equipment over the previous period shall be repeated.

Basic calibration blocks to be used shall be as in Fig.2 in according with ANNEX B of EN 583-2. Material from which the block is fabricated shall be of the same product form and equivalent P Number grouping of the material being examined. Alternative block may be used provided that the alternative reflector(s) produces a sensitivity equal to than the specified reflector(s). The temperature difference during the range and sensitivity setting and during the test shall be within -15/+15 °C.



Construction of reference curve, DAC

Angle probes:

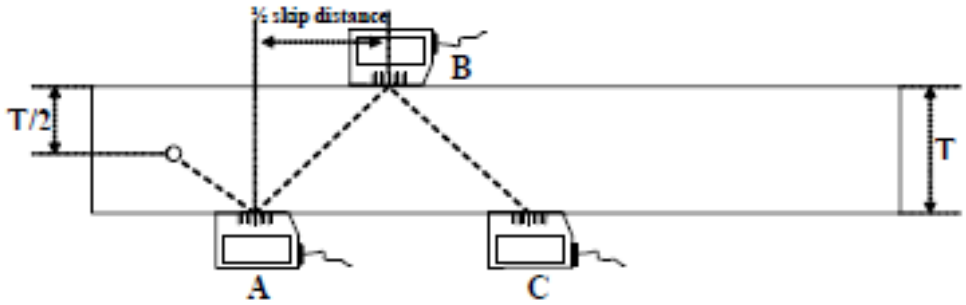
The echo reflected from the drilled hole in the applicable reference block, is maximized and the gain control regulated so that the echo amplitude is 75% of full screen height (FSH).

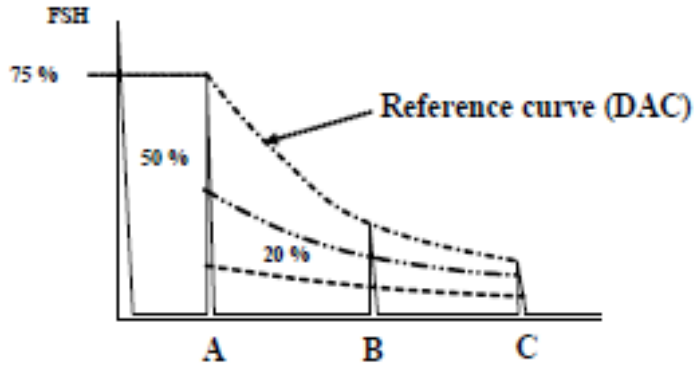
This gain setting is called the primary gain and is to be noted. Without altering the primary gain, the probe is positioned in various skip distances and the respective echo amplitudes are marked on the screen.

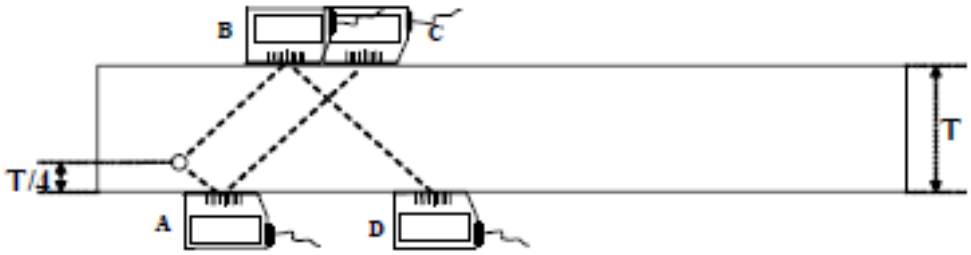
These points are connected with a smooth line with a length, which covers the required scanning area. This is the reference curve (DAC).

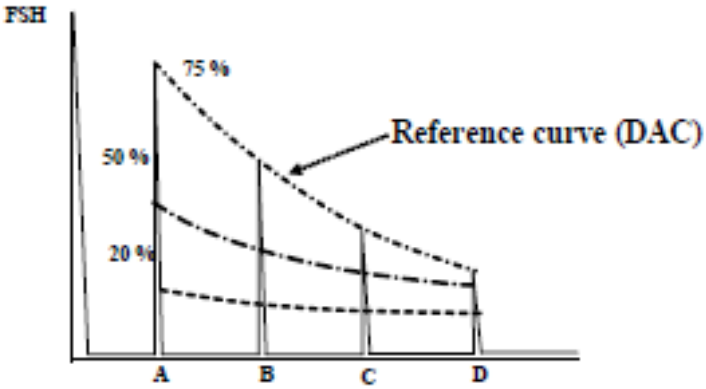
The first point of DAC must be selected so that the distance in sound path from the probe index to the drilled hole is not less than 0.6 N where N is the near field length of the relevant probe.

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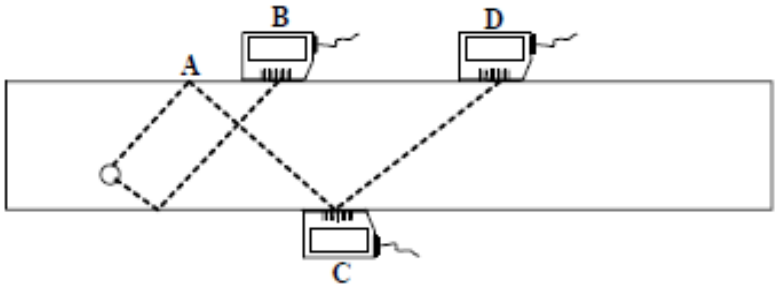

½ skip distance
B
T/2
T
A
C

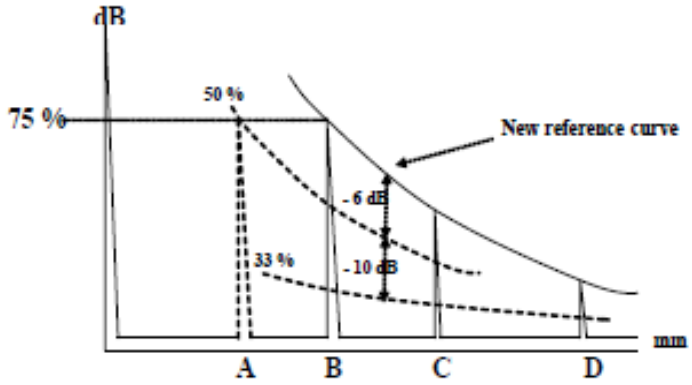

FSH
75 %
Reference curve (DAC)
50 %
20 %
A
B
C


B
C
T
T/4
A
D


FSH
75 %
Reference curve (DAC)
50 %
20 %
A
B
C
D

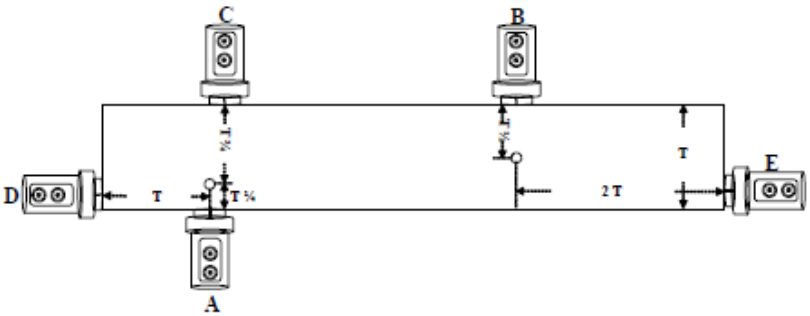
When DAC has been set up it is recommended to draw two additional curves, 33% and 50% of DAC, on the screen. Where DAC by excessive sound paths falls to below 25% of FSH the gain in this area is to be increased and a new DAC must be established, see figure below

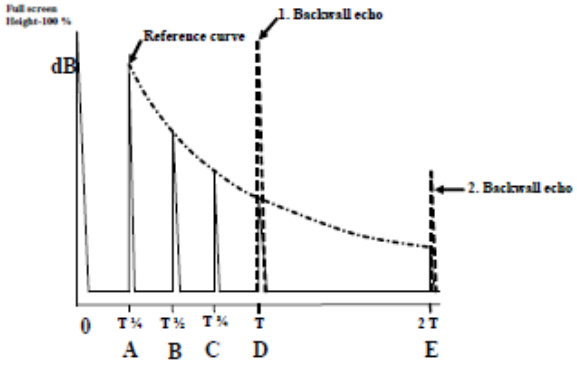




Straight beam probes:

For testing of weld connections using straight beam probes the side drilled hole (SDH) in the reference block is to be used for gain setting as for the angle probes. In order to have relevant DAC, the curve must be established as indicated here following.





Transfer correction:

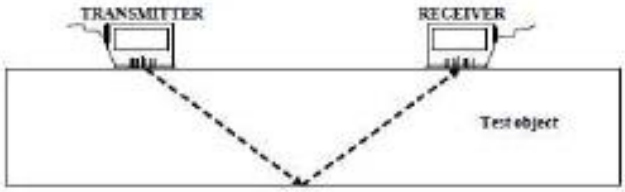
When calibration is not carried out on the piece itself or where reference block is not representative of the surface condition of the part to be examined, any possible difference in attenuation and surface character between the reference block and the object to be tested are to be checked and transfer correction shall be determined as follows:

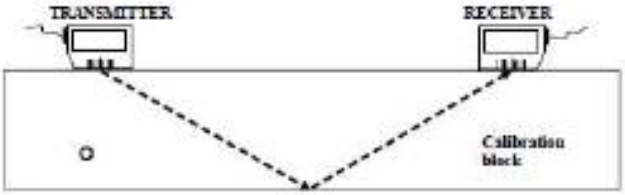
Two angle probes of the same type as those to be utilized during the testing are to be used. The probes are placed on the object to be tested. One of the probes works as a transmitter probe, whilst the other acts as receiver. The first echo is maximized and with the aid of the gain control it is adjusted to reach DAC. The gain setting is noted. Without altering this gain setting the probes are moved to the reference block. The echo is adjusted to reach DAC and the gain setting is noted. Any difference in echo amplitude between the two materials can now be determined with the aid of the gain control.

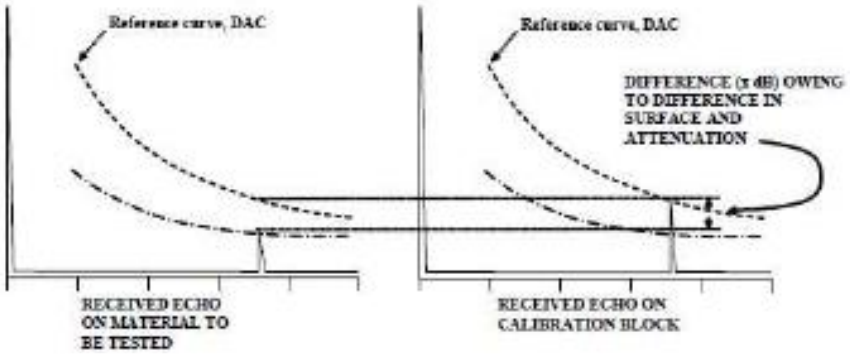
Transfer correction shall be carried out considering the following requirements:

- if the differences are less than 2 dB, correction is not required
- if the differences are greater than 2 dB but smaller than 12 dB they shall be compensate for
- if transfer losses exceed 12 dB, the reason shall be considered and further preparation of the scanning surface shall be carried out, if applicable.

When there are no apparent reasons for high correction values, the attenuation, at various locations on the test object shall be measured. Where it is found to vary significantly, corrective actions must be considered.







The calibration of range scale with straight beam probe is to be carried out with an IIW calibration block, a K2 calibration block or on a defect free area of the material to be tested. The range scale is to be selected such that there are always at least 2 back-wall echoes (reflections) on the screen.

At approximately four-hourly intervals the range scale, probe angle and primary gain must be checked and corrected. Checks shall also be carried out whenever a system parameter is changed or changes in the equivalent settings are suspected.

Calibration time:

Calibration shall be performed, prior to use of the system, in the thickness range under examination. As applicable the calibration shall provide the following measurements: sweep range calibration and Distance Amplitude Correction.

When any part of the examination system is changed, a calibration check shall be made on the basic calibration block to verify that distance range points, sensitivity setting, beam index point, true angle probe satisfy the requirements of the Code. During testing of the weld, the noise level excluding spurious surface conditions, shall remain at least 12 dB below the evaluation level.

At approximately four-hourly intervals the range scale, probe angle and primary gain must be checked and corrected. Checks shall also be carried out whenever a system parameter is changed or changes in the equivalent settings are suspected.
If deviation is found to be >2% of range scale, > 4dB of primary gain setting or >2° of nominal angle probe, the examination carried out with the equipment over the previous period shall be repeated.

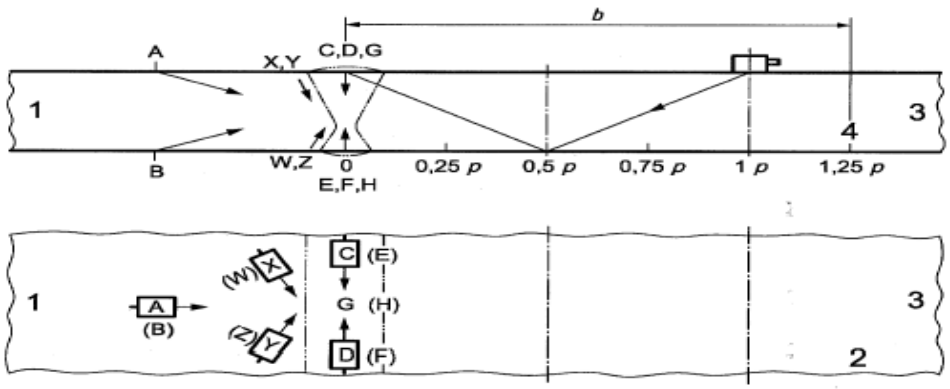
Testing of parent material

The examination is to be performed in order to reveal possible imperfections, which might influence the angle probe testing.
The whole of the area (1.5 × S) which will transfer ultrasound when using angle probes shall be tested. The gain setting shall be calibrated on a defect free place on the parent material. The second back wall echo shall be set to 75% of FSH Imperfections with a cross section larger than the sound beam (loss of back wall echo) shall be reported. The extent of the imperfections is measured with the aid of the 6 dB-drop method when complete loss of back wall echo occurs.

Testing of weld

Welds shall comply with ISO 5817 level B, so Level B in compliance with EN17640 shall be used (See Figure A.1 and Table A.1).

- Primary reference level. Primary reference level is DAC + Transfer Correction
- Scanning sensitivity. Scanning sensitivity is Primary reference level + 10 dB
  Evaluation of discontinuities shall be performed with respect to the primary reference level.



Key

1	position 1
2	position 2
3	position 3
4	position 4
A, B, C, D, E, F, G, H, W, X, Y, Z	probe positions
b	scanning zone width (SZW) related to skip distance, *p*
p	full skip distance

Figure A.1 — Butt joints in plates and pipes

Table A.1 — Butt joints in plates and pipes (for symbols, see key to Figure A.1)

Testing level	Thickness of the parent material	Longitudinal indications						Transverse indications			
		Required number of				Total number of scans	Notes	Required number of		Total number of scans	Notes
		Probe angles	Probe positions	Scanning zone width	Probe positions			Probe angles	Probe positions		
	mm	L-scans			N-scans			T-scans			
A	$8 \leqslant t < 15$	1	A or B	1,25 *p*	—	2	[a]	1	(X and Y) or (W and Z)	4	[c]
	$15 \leqslant t < 40$	1	A or B	1,25 *p*	—	2	[a]	1	(X and Y) or (W and Z)	4	[c]
B	$8 \leqslant t < 15$	1	A or B	1,25 *p*	—	2	[c]	1	(X and Y) or (W and Z)	4	[c]
	$15 \leqslant t < 40$	2[f]	A or B	1,25 *p*	—	4	[be]	1	(X and Y) or (W and Z)	4	[c]
	$40 \leqslant t < 60$	2	A or B	1,25 *p*	—	4	[b]	2	(X and Y) or (W and Z)	8	[c]
	$60 \leqslant t \leqslant 100$	2	A or B	1,25 *p*	—	4	[b]	2	(C and D) or (E and F)	4	[cd]

[a] May be limited by agreement to one scan from one side.

[b] Additional testing by tandem technique by special agreement.

[c] Required only by special agreement.

[d] The surface of the weld cap shall comply with the requirement in Clause 8. This may require dressing of the weld cap. However, for single sided circumferential pipe welds, the outside cap only is to be dressed.

[e] If only accessible from one side, two angles shall be used.

[f] In the range 15 mm < *t* ≤ 25 mm, one angle is sufficient provided the frequency is below 3 MHz.

NOTE L-scan: scan for longitudinal indications using angle beam probes;
N-scan: scan using straight beam probe;
T-scan: scan for transverse indications using angle beam probes;
p is the full skip distance.

Scanning patterns

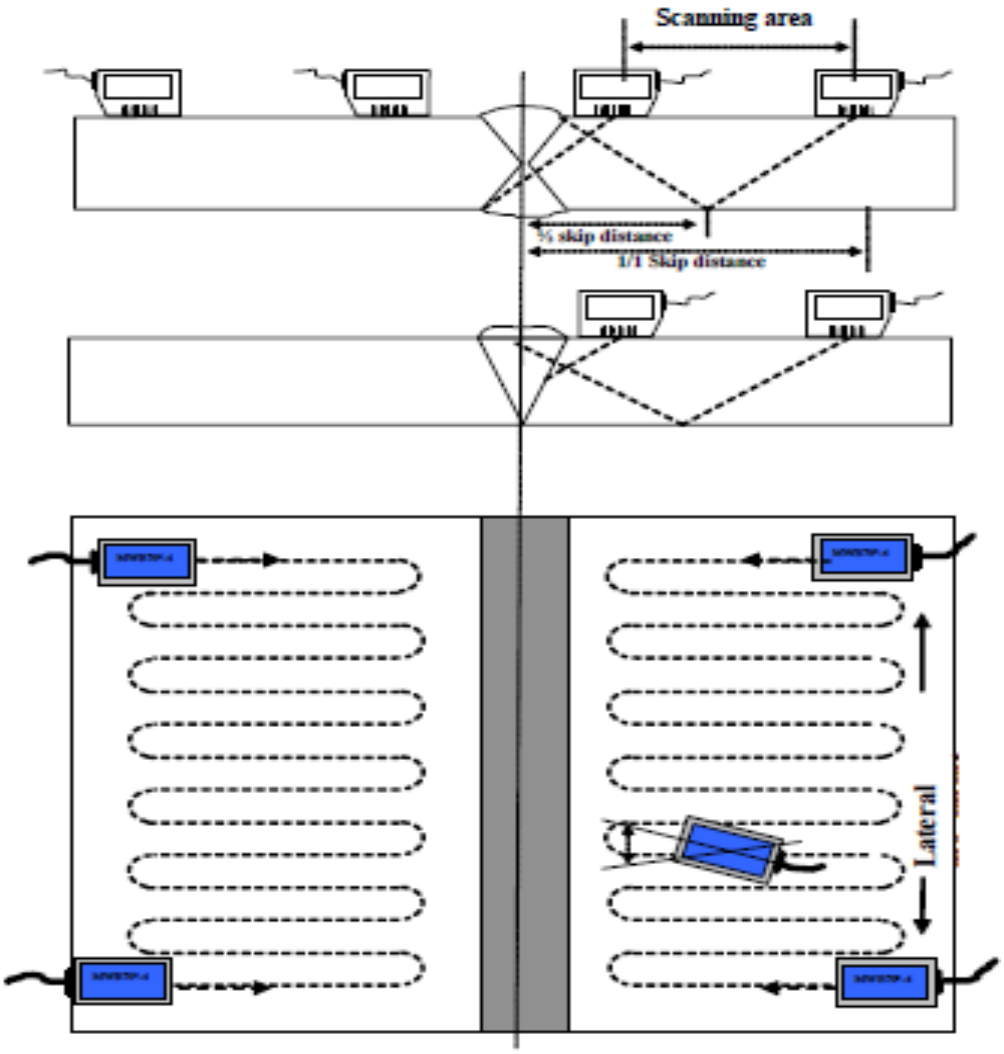
Longitudinal discontinuities detection.

Where possible the welds are to be tested from one surface of the plate and from both sides of the weld connection. The angle probe is placed on the parent material in such a way that the sound beam is normal to the weld. The probe is to be moved forwards and backwards in the scanning area of 1.5 × S.

During this movement the probe is to be continuously turned 5 to 10° in the horizontal plane.

The lower part of the weld and heat-affected zone shall be tested for longitudinal imperfections by half skip techniques. The remainder can be examined by full-skip techniques \

The lateral movement of the probe shall be executed overlapping at least 10% of the previous examined zone. The speed of the probe shall not exceed 150 mm/sec.



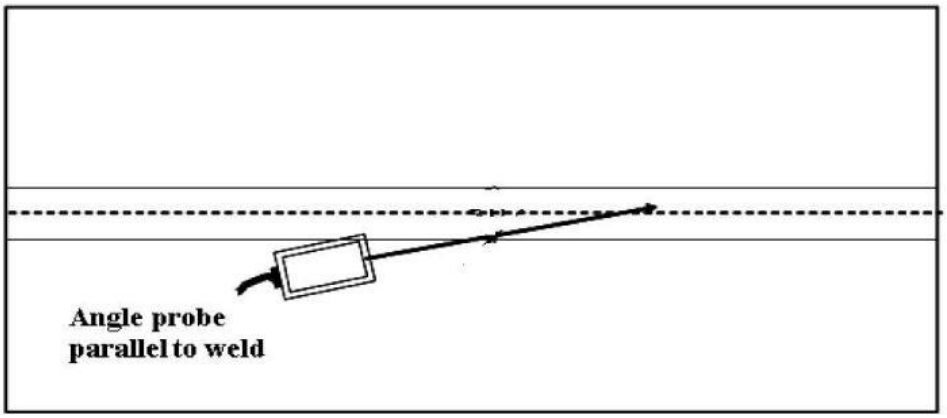
Transversal discontinuities detection.

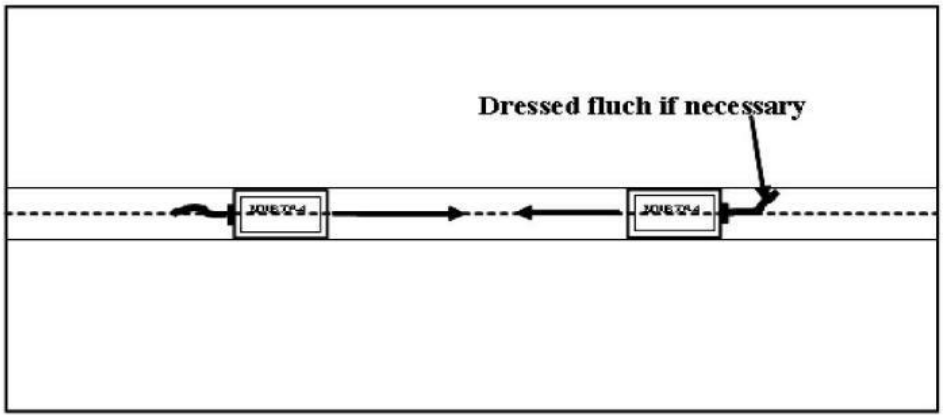
Transverse imperfections can be detected by placing the probe on the surface along the centre line of the weld connection provided the surface finish is sufficient smooth. Alternatively the probe can be placed alongside the weld connection, so that the beam forms a small angle with the centerline.

If using an angle probe along the centre line of the weld is judged to be the only method of reliable examination, the weld cap is to be ground flush or smooth with the parent material, see Fig. 6-13b. The probe is then moved along the centerline, so that the entire weld is covered.

Scanning is in all cases to be performed from both sides of the weld and in both directions.

\





Discontinuity Size Measurement.

The length of the imperfections is to be evaluated by maximizing the echo amplitude in the middle of the defect. Subsequently, the probe is traversed towards the edge of the imperfection until the echo amplitude has dropped to the evaluation level -10 dB (33% of DAC) The centre of the probe is then marked off as the edge of the imperfection. This length shall be recorded under “discontinuity length” on the test report.

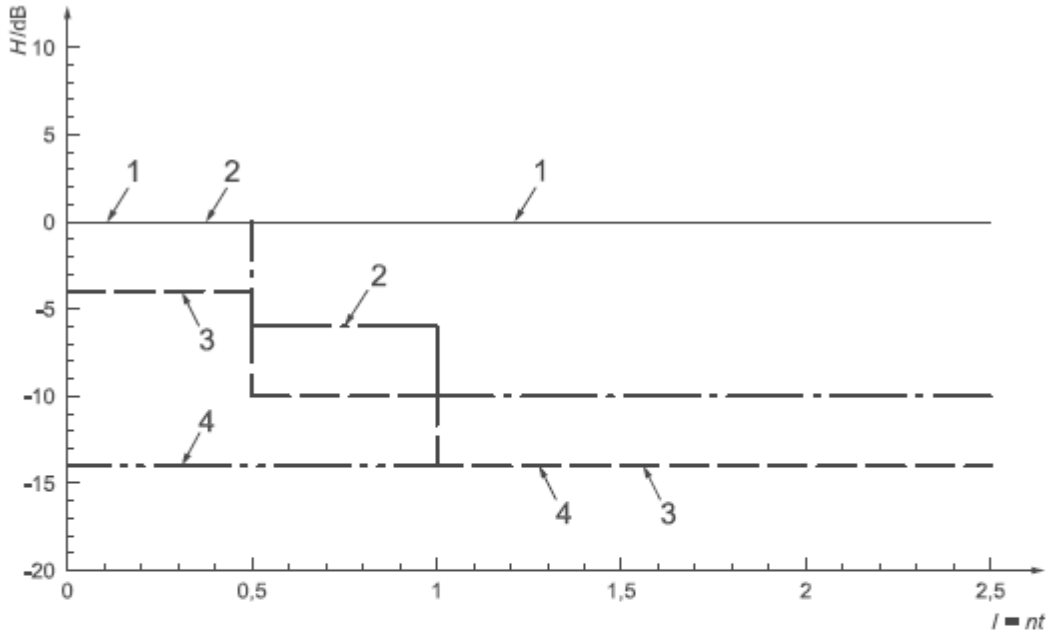
10. ACCEPTANCE STANDARD

Four levels as defined in ISO 17640 are used:

- Reference level
- Evaluation level
- Recording level (4dB below the acceptance level)
- Acceptance level

The Acceptance Criteria for welds shall comply with EN ISO 5817 lev B, so EN ISO 11666 lev. 2 shall be used (see figure A.3 extracted from EN ISO 11666) with the following additions: all imperfections from which the reflected echo amplitude exceeds

the evaluation level shall be characterized and all those that are characterized as planar (e.g. cracks, lack of fusion, incomplete penetration) shall be rejected
Grouping of indications and cumulative length of indications are assessed according to EN 11666:2011 par 5.4 and 5.5



Key
1 reference level
2 acceptance level 2
3 recording level
4 evaluation level
H amplitude
l indication length
n multiplier of *t*
t thickness

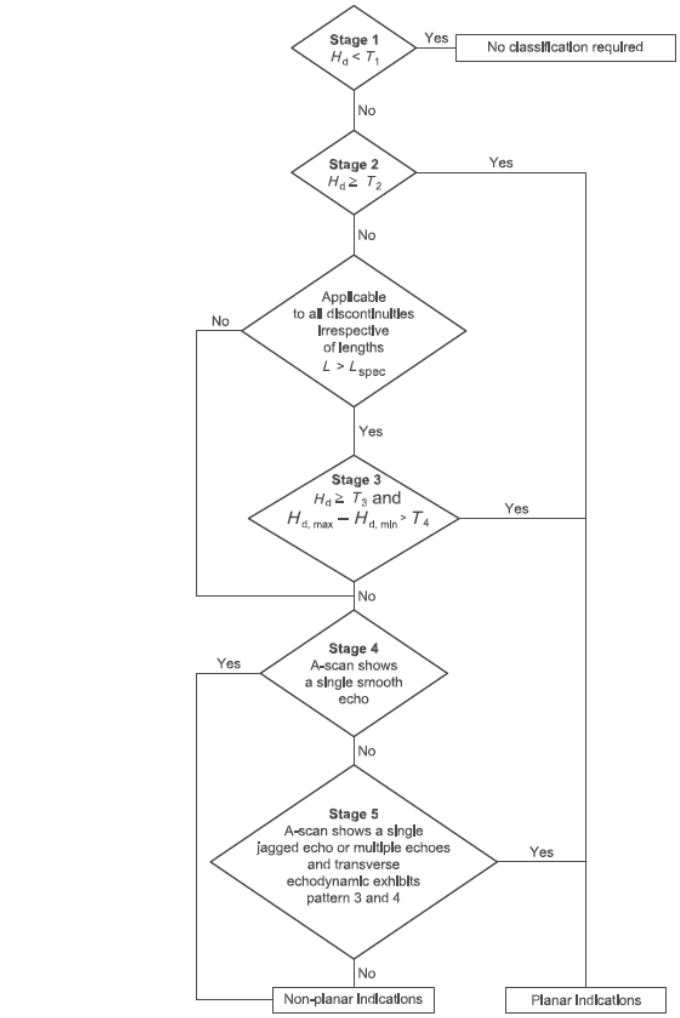
Figure A.3 — Levels for technique 1 for thicknesses 15 mm to 100 mm — Acceptance level 2

Characterization of indications

Characterization of indications are based on echo amplitude – (stage 1 and 2) and directional reflectivity criteria (stage 3) given in ISO 23279:

- Low amplitudes (stage 1): An indication having echo amplitude lower than the evaluation level is not significant and shall not be characterized.
- High amplitude (stage 2): An indication having echo amplitude that is at least equal to the reference level plus 6 dB is a planar defect.
- Directional reflectivity criteria (stage 3): By comparing the maximum echo amplitude from an indication using two probe angles having different refraction angles of more than 10° the difference shall be more than 9 dB. When comparing the amplitude from a shear wave angle probe and a compression wave normal probe, the difference shall be more than 15 dB.

Classification of internal indications in weld Flow chard procedure (ISO23279):



Key

H_d	indication echo amplitude
$H_{d,max}$	maximum echo amplitude
$H_{d,min}$	minimum echo amplitude
L	length
L_{spec}	specified length
T_1, T_2, T_3, T_4	see Table A.1

Table A.1 — Different thresholds used in the flowchart procedure

Threshold	T_1	T_2	T_3	T_4
Threshold values	Evaluation level	Reference level plus 6 dB	Reference level minus 6 dB	9 dB[a] or 15 dB[b]

[a] Shear waves.

[b] Between reflections obtained with a shear wave and a longitudinal wave.

11. REPAIR

All repairs shall be carried out in accordance with established procedures.

Repair By Welding

Before repair welding, the defects shall be completely removed. Each unacceptable discontinuity shall be marked on the weld over the discontinuity for its entire length directly. The depth from the surface and indication rating shall be marked on base metal right next to the defect.
The excavated area shall have smooth transitions to the metal surface and allow good access for both NDT after excavation and subsequent repair welding. After excavation, complete removal of the defects shall be confirmed by MT or PT. PWHT shall be performed after repair if specified for the original weld. The excavated groove shall extend minimum 25 mm behind both start and end of defect, measured at defect depth. Defects spaced less than 100 mm shall be repaired as one continuous defect.
After repair welding the complete weld (i.e. the repaired area plus at least 100 mm on each side) shall be subjected at least to the same NDT as specified for the original weld.
Repair welding may only be carried out once in the same area: the second require customer involvement.

Re-welding

Re-welding shall be performed in accordance with the procedures and WPS utilized for the original weld, and includes complete removal of the original weld and HAZ

12. ULTRASONIC TEST REPORT

A report which clearly identifies the work and the area of inspection shall be completed by the UT operator at the time of inspection. Examination results for each weld shall be reported on the Ultrasonic Examination Report Form. The Ultrasonic Examination Report (sample form) is enclosed as Attachment 1 to this procedure: any change or update to this form, does not invalidate this procedure as long all therein information are maintained.

The report shall be signed by the Quality Control Manager and when required by the Client's Inspector and other Authority Testing.

The report form for welds that are acceptable need only contain sufficient information to identify the weld, the operator (signature), and the acceptability of the weld.

When a defect shall be identified and repair shall be required, the relevant report issued at completion of the inspection operation will have to record both inspections prior and after the repair of the defect.

Evaluation of retested repaired weld areas shall be tabulated on a new line on the report form. If the original report form is used, an R1, R2, ...Rn shall prefix the indication number. If additional report forms are used, the R number shall prefix the report number.

All NDT shall be properly documented in such a way that the performed testing can be easily retraced at a later stage. The reports shall identify the unacceptable defects present in the tested area, and a conclusive statement as to whether the weld satisfies the acceptance criteria or not.

The report shall include a reference to the applicable standard, NDT procedure and acceptance criteria. In addition, as a minimum, the following information must be given or easily retrievable from therein included information: \

- object and drawing references
- place and date of examination
- material type and dimensions
- post weld heat treatment, if required
- location of examined areas, type of joint
- welding process used
- name and certification level of the operator carrying out the testing
- surface conditions
- contract requirements e.g. order no., specifications, special agreements etc.
- sketch showing location and information regarding detected defects
- extent of testing
- test equipment used
- description and location of all recordable indications
- examination results with reference to acceptance level.
- number of repairs to be specified in the report, such as once or twice repairs in the same area.
- probes, type and frequency
- identification of reference blocks used
- couplant medium
- reporting level, if different from acceptance level
- calibration range
- scanning technique, half skip or full skip scanning.
- surface compensation/transfer correction
- defect type (At least defined as Spherical, Volume or Planar

The report shall be such that there is no doubt about what is tested, where it has been carried out and give a clear and exact description of reportable defect location.

The format of report is not a reason for rejection as long all above indicated information are included and any change induced by addition doesn't be considered a rejection of those already issued.

APPENDIX- A

Check of Screen Height Linearity

To verify the ability of the ultrasonic instrument to meet the linearity, as required in paragraph 8, position an angle beam search unit as shown in the Fig. 2 so that indication can be observed from both the 1/2 and 3/4T holes in a basic calibration block. Adjust the search unit position to give a 2:1 ratio of amplitudes between the two indications, with the larger set at 80% of full screen height. Without moving the search unit, adjust sensitivity (gain) to successively set the larger indication from 100% to 20% of full screen height, in increments (of 2 dB steps available), and read the smaller indication at each setting.
The reading must be 50% of the larger amplitude, within 5% of full screen height. The setting and readings must be estimated to the nearest 1% of full screen.
Alternatively, a straight beam search unit may be used on any calibration block which will provide amplitude differences, with sufficient signal separation to prevent overlapping of the two signals.

Check of Amplitude Control Linearity

To verify the accuracy of the amplitude control of the ultrasonic instruments, as required in paragraph 8, position an angle beam search unit as shown in Fig. 1 so that the indication from the 1/2T hole in basic calibration block is peaked on the screen. With the increases and decreases in attenuation shown in the following table, the indication must fall within the specified limits base. Other convenient reflectors from any calibration block may be used with angle or straight beam search units.

Test n°	Indication set at % of full screen	dB control change	Indication limits % of full screen (+20%)
1	80%	-6 dB	32 to 48%
2	80%	-12 dB	16 to 24%
3	40%	+6 dB	64 to 96%
4	20%	+12 dB	64 to 96%

The setting and reading must be estimated to the nearest 1% of full screen.

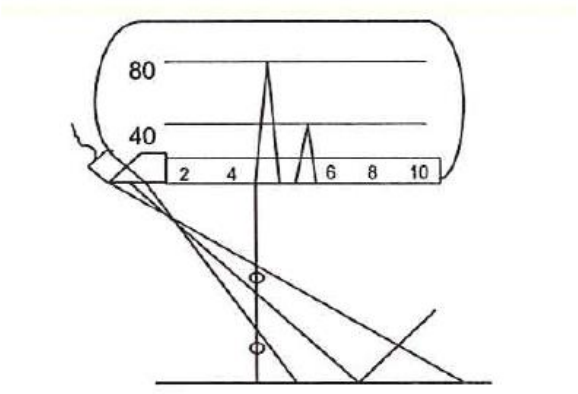


Figure 1

ATTACHMENT N. 1

CIMOLAI

CERTIFICATO DI CONTROLLO ULTRASONORO

Ultrasonic Examination Report

Cert. Nr. / Report nr.
Foglio / Sheet
Data / Date

COSTRUTTORE / Manufacturer — COMM. COSTRUTTORE / Manufacturer's Job

CLIENTE / Customer — COMM. CLIENTE / Customer's Job

DESTINATARIO / Consignee — ORDINE DEL DESTINATARIO / Consignee Order

ITEM / Item — LUOGO DELL'ESAME / Place of Examination

MARCHE / Sorts Nr. — DATA DELL'ESAME / Date of Examination

STRUMENTO IMPIEGATO / Instrument used
COSTRUTT. / Manuf.
TIPO / Type
N. DI SERIE / Serial nr.

SONDE / Probes

n	TIPO Type	f (MHz)	Dim. (mm)	Ang
1				
2				
3				
4				

OPERATORE / Operator

COSTRUTTORE / Manufacturer

ENTE ISPEZIONE / Inspection Authority

SI CERTIFICA CHE LA PROVA E' STATA ESEGUITA SECONDO LE NORME DI RIFERIMENTO INDICATE E CHE I RISULTATI SONO QUELLI TRASCRITTI
This is to certify that the test has been performed according to indicated reference code, and the results are those recorded

OGGETTO DEL PRESENTE CERTIFICATO / Subject of this certificate

CONTROLLO ULTRASONORO SALDATURA TESTA-TESTA
ULTRASONIC EXAMINATION OF BUTT WELD

PROCEDURA / Procedure

STANDARD DI ACCETTAZIONE / Acceptance Standards

MATERIALE / Material — THK.

DISEGNO DI RIF / Reference drawing — TRATT. TERMICO / Heat treatment: -

CONDIZIONI SUP. / Surface conditions — MAT. BASE / Base material — SALDATURA / Weld

FASE DI LAVORAZIONE / Working step: -

PROC. DI SALD. / Welding process
MEZZO DI ACCOPP. / Couplant
RIF. BLOCCO DI CALIBRAZIONE / Calibration block

DESTINATARIO / Consignee

ESITO / Results — GIUDIZIO / Judgement

[X] ACCETTABILE / Acceptable
[ ] NON ACCETTABILE / Not acceptable

NOTE / Remarks

Controllo eseguito dalla superficie esterna
Test carried out from outside surface

SCHIZZO DEL PARTICOLARE CONTROLLATO / Sketch of examined particular

CIMOLAI	CERTIFICATO DI CONTROLLO ULTRASONORO Ultrasonic Examination Report	Cert. Nr. / Report nr. Foglio / Sheet Data / Date

COSTRUTTORE / Manufacturer	COMM. COSTRUTTORE / Manufacturer's Job	DATA DELL'ESAME / Date of Examination	DESTINATARIO / Consignee	ORDINE DEL DESTIN. / Consignee Order

SI CERTIFICA CHE LA PROVA E' STATA ESEGUITA SECONDO LE NORME DI RIFERIMENTO INDICATE E CHE I RISULTATI SONO QUELLI TRASCRITTI
This is to certify that the test has been performed according to indicated reference code, and the results are those recorded

REGISTRAZIONE DELLE INDICAZIONI RILEVATE - Record of detected indications

Pos. Cliente	Marca Cimolai	Materiale Base	Sigla Saldatura	N° Indicaz.	SONDA (*)	Dist. Da 0-UT / Start from 0-UT		Lungh	Prof. / Depht (mm)		Ampiezza	Probabile Natura del Difetto	GIUDIZIO
Client Pos.	Cimolai Mark	Base Material	Weld ID	Indic. N°	PROBE (*)	Rifer. Di partenza Start point ref.	Misura Value (mm)	Lungh	Dall'int. From inside	Dall'est. From outside	Amplitude (% DAC)	Probable Nature of Defect	JUDGEMENT (**)

(*) vedi sonde impiegate a pag. 1 / see employed probes on page 1

(**) A = Accettabile / Acceptable
NA = Non accettabile / Note Acceptable

OPERATORE / Operator	COSTRUTTORE / Manufacturer	ENTE D'ISPEZIONE / Inspection Authority	DESTINATARIO / Consignee

CIMOLAI
Pordenone - Italy

Doc. ref. IOP-UTE-2023263-01
Rev. 0
Date 07/12/2063