Base Load Power Hub (BLPH)

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RADIOGRAPHIC EXAMINATION OF WELDS BY MEANS OF X RAYS AND γ RAYS ACCORDING TO UNI EN ISO 17636-1 SPECIFICATION

I.R.T.E.C. s.r.l.

RADIOGRAPHIC TESTING PROCEDURE

IR TEC SRL
SISTEMA DI QUALITA'
CERTIFICATO ISO 9001:2008

RADIOGRAPHIC EXAMINATION OF WELDS BY MEANS OF X RAYS AND γ RAYS ACCORDING TO UNI EN ISO 17636-1 SPECIFICATION

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By signature and date on the front sheet of this Procedure by the relevant persons, the signature on each page of this Procedure are waived

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dott. Ing. G. GROSSI

RADIOGRAPHIC EXAMINATION OF WELDS BY MEANS OF X RAYS AND γ RAYS ACCORDING TO UNI EN ISO 17636-1 SPECIFICATION

1. SCOPE AND APPLICABILITY

1.1. This procedure describes the method used for X-Ray or γ-Ray examination of butt welds in plates, shells, flat and formed heads, structural shapes, tubes and pipes.

1.2. In the case of examination of T-joints and branch connections the test arrangement shall be agreed between the contracting parties.

1.3. This procedure is applicable to ferrous and non ferrous alloys for the following maximum thicknesses (equivalent in steel):

1.3.1. 50 mm for X-Rays exposures (300 kV)

1.3.2. 90 mm for Ir 192 exposures

1.4. For what not specified here, the requirements of UNI EN 17636-1 shall be considered as requirements that integrate the present procedure.

1.5. The need of the radiographic examination, when required by the design, shall be indicated in the drawing of vessel or other item to be tested. Shall also clearly indicated the required extension of examination.

2. NORMATIVE REFERENCES

2.1. UNI EN ISO 17636-1

2.2. UNI EN ISO 9712

2.3. UNI EN ISO 11699-1

2.4. UNI EN ISO 11699-2

2.5. UNI EN ISO 5579

2.6. UNI EN ISO 10675-1

2.7 Specification K559-2254-MT-SPE-001 Structural fabrication specification

3. TERMS AND DEFINITIONS

3.1. Nominal thickness **t** - Nominal thickness of the parent material (manufacturing tolerances do not have to be taken in account)

3.2. Penetrated thickness **w** – Thickness of material in the direction of the radiation beam calculated on the basis of the nominal thicknesses of all penetrated walls

3.3. Object to film distance **b** – Distance between the radiation side of the radiographed part of the test object and the film surface measured along the central axis of the radiation beam.

3.4. Source size **d** – the maximum projected dimension of the radiating source (or effective focal spot) in the plane perpendicular to the distance from the weld or object being radiographed. See paragraph 7.6.3.

3.5. Source to film distance **SFD** – Distance between the source of radiation and the film measured in the direction of the beam.

3.6. Source to object distance **f** – distance between the source of radiation and the source side of the test object measured along the central axis of the radiation beam.

3.7. External diameter $\mathbf{D_e}$ – nominal external diameter of the pipe.

3.8. Panoramic exposure . Exposure with radiation source centrally located inside the object and with the film outside (see figure 3).

4. SYMBOLS AND ABBREVIATED TERMS

4.1. SWE – Single wall exposure

4.2. DWE – Double wall exposure

4.3. SWV – Single wall viewing

4.4. DWV – Double wall viewing

4.5. IQI - Image quality indicator

5. CLASSIFICATION OF RADIOGRAPHIC TECHNIQUES

5.1. The radiographic techniques are divided into two classes:

5.1.1. Class A: basic techniques

5.1.2. Class B: improved techniques

5.2. Unless otherwise required the class B techniques shall be used.

5.3. If, for technical or industrial reasons, it is not possible to meet **one** of the following conditions specified for class B:

5.3.1. Type of radiation source

5.3.2. Source to object distance

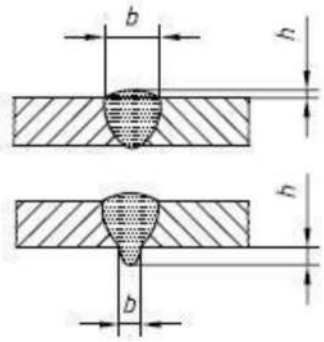
It may be agreed by contracting parties that the **condition selected** may be that specified for class A. The loss of sensitivity shall be compensated by an increase of minimum density to 3.0 or by selection of a better film system class with a minimum density of 2.6.
The other conditions for class B remain unchanged, especially the image quality achieved.
This does not apply if the special SFD reduction as described in 7.6 are used (panoramic and SWE-SWV with source in the concave side of the object).

6. GENERAL PREPARATIONS AND REQUIREMENTS

6.1. **Protection against ionizing radiation** – National safety precautions shall be strictly applied.

6.2. **Surface preparation and stage of manufacture** - The weld ripples or weld surface irregularities on both the inside (where accessible) and outside shall be removed by any suitable process to such a degree that the images of surface irregularities cannot mask or be confused with the image of any discontinuity on the resulting radiograph. The finished surface of all butt-welded joints may be flush with the base material or may have reasonably uniform crowns, with reinforcement not to exceed that specified in the referencing Code Section.
According to UNI EN ISO 5817 the maximum allowed excess weld metal and penetration shall be :

Quality level UNI EN ISO 5817	Maximum excess weld metal (mm)	Maximum Penetration (mm)
C	0.15 b + 1 – max. 7	0.6 b + 1 – max. 4
B	0.1 b + 1 – max. 5	0.2 b + 1 – max. 3



Unless otherwise specified, radiography shall be carried out after the final stage of manufacture, e.g. after heat treatment.

6.3. **Location of the weld in the radiographs** – Where the radiograph does not show the weld, lead markers shall be placed on either side of the weld.

6.4. **Identification of radiographs and location markers** – Lead symbols shall be affixed to each section of the object being radiographed.
The images of these symbols shall appear in the radiograph outside the area of interest where possible and shall assure unambiguous identification of the section and permitting the area of interest on a radiograph to be accurately traceable to its location on the part.
In all exposure techniques except the techniques in the figures 8 and 9 the location markers indicate the start and the end of the radiographed length.
In the case of the exposure techniques in figures 8 and 9 (DWE-DWV) one location marker in the middle of the examined length shall be used.

6.5. **Marking** – Permanent markings on the object to be examined shall be made **by the manufacturer** in the positions of the location markers which have been indelibly marked by the personnel performing radiography .
When inaccessibility or other limitations prevent the placement of markers as stipulated in 6.4 a dimensioned map of the actual marker placement shall accompany the radiographs to show that full coverage has been obtained.

6.6. **Overlap of films** – When radiographing an area with two or more separate films, the films shall overlap sufficiently to ensure the complete coverage of the region of interest. This is verified by the location markers which are to appear on each film.
In every case the minimum distance between the location marker and the end of the film shall be 20 mm.

6.7. **Types and positions of image quality indicators** – The quality of image shall be verified by use of wire image quality indicators (IQI) in accordance with UNI EN ISO 19232-1. In the following table are listed the materials of which the wires are made and the materials :

Wire material	Suitable for testing of the following materials
CU - Copper	Copper, Zinc, Tin and their alloys
FE - Steel	Ferrous materials
TI - Titanium	Titanium, titanium alloy
AL - Aluminium	Aluminium, aluminium alloys

6.7.1. The IQI shall be placed **source side at the center of each radiographed length**. The identification numbers and, when used the lead letter F, shall not be in the area of interest, except when geometric configuration makes it impractical. The IQI shall be in close contact with the surface of the object. Its location shall be made in a section of uniform thickness characterized by a uniform optical density on the film.
The following points shall also be considered:

- The wires of the IQI shall be directed perpendicular to the weld and its location shall ensure that at least 10 mm of wire shows in the parent metal adjacent to the weld.
- For elliptic and perpendicular exposures (DWE-DWV figures 8 and 9) the IQI may be placed **either on the source or on the film side.**
- Where inaccessibility prevents hand placing the IQI on the source side, the IQI shall be placed on the film side in contact with the part being examined.
  A lead letter "F" shall be placed adjacent to or on the IQI(s).
  In this case shall be visible the smaller wire adjacent to that required for the source side position (see paragraph 6.9).
- For panoramic exposures of pipes and shells with diameter 200 mm and above at least three IQIs should be placed equally spaced at the circumference.

6.8. **Evaluation of image quality** - Viewing facilities shall provide subdued background lighting of an intensity that will not cause reflections, shadows, or glare on the radiograph that interfere with the interpretation process.
Equipment used to view radiographs for interpretation shall provide a variable light source sufficient for designated wire to be visible for the density of 4.0.
The viewing conditions shall be such that light from around the outer edge of the radiograph or coming through low-density portions of the radiograph does not interfere with interpretation.

6.9. **Minimum image quality values** – Tables 1 ÷ 6 show the minimum quality values required for class A and B radiographic technique.
In the case where Ir 192 sources are used, IQI values worse than the ones listed in tables 1 ÷ 6 may be accepted by agreement of contracting parties as allowed in UNI EN ISO 17636-1 paragraph 6.9.

6.10. **Personnel qualification** – Personnel performing non destructive examination shall be qualified in accordance with ISO 9712 to the appropriate level.

7. RECOMMENDED TECHNIQUES

7.1. Test arrangements

7.1.1. A single wall exposure technique shall be used for radiography whenever practical. When it is not practical to use a single wall technique a double wall technique shall be used. An adequate number of exposures shall be made to demonstrate that the required coverage has been obtained. In any case films shall be placed as close to the object as possible.
Multi-film techniques shall not be used to reduce exposure times on uniform sections.
Multi-film technique may be agreed by the contracting parties when it is useful for reasons such as the geometry of the piece or differences in material thickness (e.g. butt weld between plates of different thicknesses).

7.1.2. **Single wall technique** - In the single wall technique, the radiation passes through only one wall of the weld which is viewed for acceptance on the radiograph. See in figures 1 ÷ 4 the test arrangements.

7.1.3. **Double-Wall Technique** - When it is not practical to use a single-wall technique, one of the following double-wall techniques shall be used:

7.1.3.1. **Single-Wall Viewing** - For welds in components, a technique may be used in which the radiation passes through two walls and only the weld (material) on the film-side wall is viewed for acceptance on the radiograph. When complete coverage is required for circumferential welds, a minimum of three exposures taken 120 deg to each other shall be made. See in figure 5 ÷ 7 the test arrangements.

7.1.3.2. **Double-Wall Viewing**

7.1.3.2.1. **Elliptic technique -** For welds in pipes and tubes a technique may be used in which the radiation passes through two walls and the weld in both walls is viewed for acceptance on the same radiograph
The radiation beam shall be offset from the plane of the weld at an angle sufficient to separate the images of the source-side and film-side portions of the weld so that there is no overlap of the areas to be interpreted. The distance between the two projected weld images shall be about one weld width.

The elliptic technique **should not** be used if :

- $D_e > 100$ mm
- $t > 8$ mm
- Weld width > De/4

Two 90° displaced images are sufficient if t/De < 0.12; otherwise three exposures 120° or 60° apart are required. See in figure 8 the test arrangement

7.1.3.2.2. **Perpendicular technique** - When it is difficult to carry out an elliptic examination at De ≤ 100 mm, the perpendicular technique may be used. The weld may be radiographed with the radiation beam positioned so that the images of both walls are superimposed. When complete coverage is required, a minimum of three exposures taken at either 60° or 120° to each other shall be made for each joint. See in figure 9 the test arrangement.

7.2. **Choice of tube voltage and radiation source**

7.2.1. **X-ray devices up to 300 kV** - To maintain a good flaw sensitivity, the X-ray tube voltage should be as low as possible. The maximum values of X-ray tube voltage versus thickness are given in figure 10.
For some applications where there is a thickness change across the area of the object being radiographed, a slightly higher voltage may be used :

Copper and nickel alloys	60 kV
Steel	50 kV
Titanium and alloys	40 kV
Aluminium and alloys	30 kV

7.2.2. **Iridium 192 sources** – The allowable ranges of penetrated thickness for steel, copper and nickel base alloys are listed in the following table:

Penetrated thickness, w (mm)	
Class A	Class B
$20 \le w \le 100$	$20 \le w \le 90$

The travel time to position the source shall not exceed 10% of the total exposure time.

7.2.3. **For certain applications, wider wall thickness ranges may be permitted, if sufficient image quality can be achieved.**

7.3. Film systems and lead screens

7.3.1. In table 7 are listed the minimum film system classes (according to UNI EN 160 11699-1) to be used for the radiography of steels, copper and nickel based alloys.
In table 8 are listed the minimum film system classes (according to UNI EN 160 11699-1) to be used for the radiography of aluminium, titanium and their alloys.

7.3.2. When using metal screens, good contact between film and screens is absolutely required.
Other screen thicknesses may also be agreed between the contracting parties, provided the required image quality is achieved.

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7.4. Alignment of beam

7.4.1. The beam of radiation shall be directed to the centre of the area being examined and should be perpendicular to the object surface at that point. Other arrangements may be agreed between the contracting parties.

7.5. Reduction of scattered radiation

7.5.1. The presence of excessive scattered radiation prevents to obtain the required sensitivity.

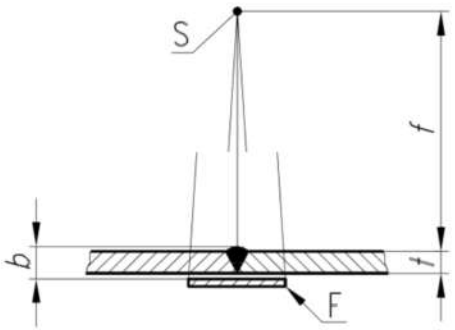
7.5.2. In order to reduce the effect of backscattered radiation, direct radiation shall be collimated to the section under examination and the film shall be shielded, if necessary by a sheet of lead of a convenient thickness (e.g. 1 ÷ 5mm) placed behind the film-screen combination.
May be, also, necessary to intercept edge scatter by lead sheets of convenient thickness (e.g. 1 ÷ 5mm).

7.5.3. If necessary, the presence of excessive backscattered radiation shall be checked by means of a lead letter B (with a minimum height of 12.7 mm and a minimum thickness of 1.5 mm) placed behind the cassette.
If a light image of the "B" appears on a darker background, protection from back scatter is insufficient and the radiograph shall be considered unacceptable . No image or a dark image of the "B" on a lighter background is not cause for rejection.

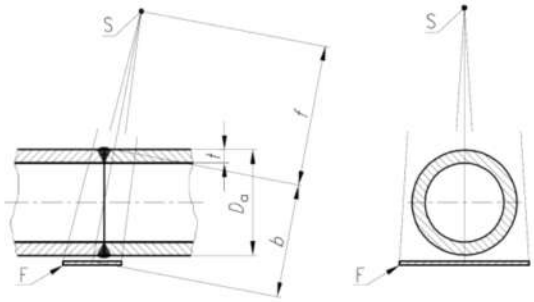
7.6. Source to object distance

7.6.1. The **minimum source to object distance f_{min}** depends on the source size **d** and on the object to film distance **b** and shall be:

Class A	Class B
$f_{min} \geq d*7.5*b^{2/3}$	$f_{min} \geq d*15*b^{2/3}$

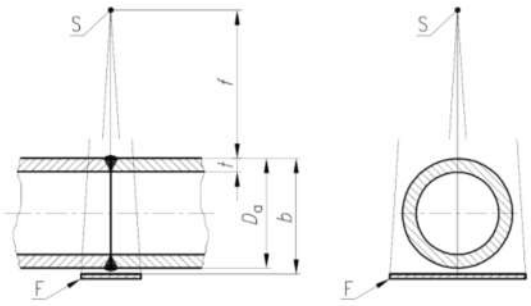


7.6.2. Source size - The equipment manufacturer's or supplier's publications, such as technical manuals, decay curves, or written statements documenting the actual or maximum source size or focal spot, shall be
acceptable as source size verification.



7.6.3. When the source size or focal spot size is defined by two dimensions, the larger shall be used.

- The focal spot of a radiographic tube has an elliptic, rectangular or trapezoidal shape; the focal spot dimension is the major axis of the ellipse, the longer side of the rectangle and the larger base of the trapezium.
- An Ir 192 source has a cylindrical shape; the dimension is the greater between the diameter and the length.



7.6.4. If the dimension **b** (total weld thickness) is less than 1.2*t it may be
replaced by the nominal thickness **t**.

7.6.5. For determination of the source to object f_{min}, the nomogram in figure 11 may be used.

7.6.6. When using the elliptic or perpendicular technique (figures 8 and 9) the dimension **b** shall be replaced by the external diameter $\mathbf{D_e}$ of the pipe.

7.6.7. When using the technique in figure 4 (source inside the object), the minimum source to object distance **f** may be reduced up to 20%.

7.6.8. When using the technique in figure 3 (panoramic exposure) and provided that the IQI requirements are met, the minimum source to object distance **f** may be reduced up to 50%.
A further reduction can be agreed by the contracting parties provided that the IQI requirements are met.

7.7. Maximum area for a single exposure

7.7.1. The number of radiographs for a complete examination of welds shall be specified in accordance with the following technical requirements:

7.7.1.1. 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 for class B and 1.2 for class A :

7.7.1.2. The densities resulting from any variation of penetrated thickness should not be lower or higher than those indicated in 7.8.

7.7.1.3. The size of the area to be examined includes the weld and the heat affected zones. In general, about 10 mm of parent metal shall be examined on each side of the weld.

7.7.2. Recommendations for the number of radiographs are indicated in Annex A of UNI EN ISO 17636-1which gives an acceptable examination of a circumferential butt weld.

7.8. Density of radiograph

7.8.1. Exposure conditions should be such that the optical density of the radiograph in the area examined satisfies the requirements of the following table

Class	Optical density	
	Required	Admitted (special agreement)
A	2.0 ÷ 4.0	1.5 ÷ 4.0
B	2.3 ÷ 4.0	2.0 ÷ 4.0
A measuring tolerance of ± 0.1 is permitted		

7.8.2. For composite viewing of multiple film exposures, each film of the composite set shall have a minimum density of 1.3. The maximum density shall be 4.0 for either single or composite viewing.

7.8.3. The fog density shall not exceed 0.3.
Fog density is defined the total density (emulsion and base) of a processed, unexposed film.

7.9. Processing

7.9.1. Films are automatically processed with :
Carestream M37 Filmprocessor using :

- G 135 Developer
- G 335 Fixe

in accordance with the conditions recommended by the film and chemical manufacturer to obtain the selected film system class (cycle 8 minutes temperature 28°C)

7.9.2. The radiographs should be free from defects due to processing or other causes which would interfere with interpretation.

7.10. Film viewing conditions

7.10.1. Viewing facilities shall provide subdued background lighting of an intensity that will not cause reflections, shadows, or glare on the radiograph that interfere with the interpretation process. Equipment used to view radiographs for interpretation shall provide a variable light source in accordance with EN 25580 sufficient for the designated wire to be visible for the specified density range. The viewing conditions shall be such that light from around the outer edge of the radiograph or coming through low-density portions of the radiograph does not interfere with interpretation.

8. ACCEPTANCE CRITERIA

8.1. Before radiographic testing the welds must have successfully passed the visual examination.

8.2. Acceptance criteria shall be in accordance with ISO 10675-1 Level 1

9. TEST REPORT

9.1. The test report shall include the following information :

9.1.1. Name of examination body
9.1.2. Object
9.1.3. Material
9.1.4. Heat treatment
9.1.5. Material thickness
9.1.6. Specification of examination including requirements for acceptance
9.1.7. Radiographic technique and class, required sensitivity
9.1.8. Test arrangement
9.1.9. Radiation source, size of focal spot and identification of equipment
9.1.10. Film type and system, screens and filters
9.1.11. Tube voltage used and current or source type and activity
9.1.12. Source to film distance and time of exposure
9.1.13. Processing technique : manual or automatic
9.1.14. Type and position of IQIs
9.1.15. Data on film density, IQI readings
9.1.16. Results of examination
9.1.17. Any deviation by special agreement from this procedure
9.1.18. Geometry of the weld
9.1.19. System of marking used
9.1.20. Film position plan
9.1.21. Welding process

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TABLE 1 – CLASS "A" – SINGLE WALL				
	Source side IQI			
Nominal thickness t (mm)	**Wire type**	**Wire diameter (mm)**	**IQI Denomination and thinnest visible wire**	**Sensitivity (%)**
$t \leq 1.2$	W18	0.063	6th wire of 13 XX EN	≥ 5.25
$1.2 < t \leq 2.0$	W17	0.080	5th wire of 13 XX EN	4.0 ÷ 6.67
$2.0 < t \leq 3.5$	W16	0.100	4th wire of 13 XX EN (7th wire of 10 XX EN)	2.86 ÷ 5.0
$3.5 < t \leq 5.0$	W15	0.125	3rd wire of 13 XX EN 6th wire of 10 XX EN	2.5 ÷ 3.57
$5.0 < t \leq 7$	W14	0.16	2nd wire of 13 XX EN 5th wire of 10 XX EN	2.29 ÷ 3.2
$7 < t \leq 10$	W13	0.20	(1st wire of 13 XX EN) 4th wire of 10 XX EN	2.0 ÷ 2.86
$10 < t \leq 15$	W12	0.25	3rd wire of 10 XX EN (7thwire of 6 XX EN)	1.67 ÷ 2.5
$15 < t \leq 25$	W11	0.32	2nd wire of 10 XX EN 6thwire of 6 XX EN	1.28 ÷ 2.13
$25 < t \leq 32$	W10	0.40	(1st wire of 10 XX EN) 5th wire of 6 XX EN	1.25 ÷ 1.6
$32 < t \leq 40$	W9	0.50	4th wire of 6 XX EN	1.25 ÷ 1.56
$40 < t \leq 55$	W8	0.63	3rd wire of 6 XX EN	1.15 ÷ 1.58
$55 < t \leq 85$	W7	0.80	2nd wire of 6 XX EN (7th wire of 1 XX EN)	0.94 ÷ 1.45
$85 < t \leq 150$	W6	1.00	(1st wire of 6 XX EN) 6th wire of 1 XX EN	0.67 ÷ 1.18
$150 < t \leq 250$	W5	1.25	5th wire of 1 XX EN	0.5 ÷ 0.83
$250 < t$	W4	1.60	4th wire of 1 XX EN	<. 0.64

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TABLE 2 – CLASS "B" – SINGLE WALL				
	Source side IQI			
Nominal thickness t (mm)	**Wire type**	**Wire diameter (mm)**	**IQI Denomination and thinnest visible wire (*)**	**Sensitivity (%)**
$t \leq 1.5$	W19	0.05	7th wire of 13 XX EN	≥ 3.33
$1.5 < t \leq 2.5$	W18	0.063	6th wire of 13 XX EN	2.52 ÷ 4.2
$2.5 < t \leq 4$	W17	0.080	5th wire of 13 XX EN	2.0 ÷ 3.2
$4 < t \leq 6$	W16	0.100	4th wire of 13 XX EN 7th wire of 10 XX EN	1.67 ÷ 2.5
$6.0 < t \leq 8$	W15	0.125	3th wire of 13 XX EN 6th wire of 10 XX EN	1.56 ÷ 2.08
$8 < t \leq 12$	W14	0.16	2nd wire of 13 XX EN 5th wire of 10 XX EN	1.33 ÷ 2.0
$12 < t \leq 20$	W13	0.20	(1st wire of 13 XX EN) 4th wire of 10 XX EN	1.0 ÷ 1.67
$20 < t \leq 30$	W12	0.25	3rd wire of 10 XX EN (7th wire of 6 XX EN)	0.83 ÷ 1.25
$30 < t \leq 35$	W11	0.32	2nd wire of 10 XX EN 6th wire of 6 XX EN	0.91 ÷ 1.07
$35 < t \leq 45$	W10	0.40	(1st wire of 10 XX EN) 5th wire of 6 XX EN	0.89 ÷ 1.14
$45 < t \leq 65$	W9	0.50	4th wire of 6 XX EN	0.77 ÷ 1.11
$65 < t \leq 120$	W8	0.63	3th wire of 6 XX EN	0.53 ÷ 0.97
$120 < t \leq 200$	W7	0.80	2th wire of 6 XX EN (7th wire of XX EN)	094 ÷ 0.67
$200 < t \leq 350$	W6	1.00	(1st wire of 6 XX EN) 6th wire of 1 XX EN	0.29 ÷ 0.5
$350 < t$	W5	1.25	5th wire of 1 XX EN	< 0.36

(*) If possible do not use the IQI in brackets

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TABLE 3 – CLASS "A" – DOUBLE WALL EXPOSURE – DOUBLE WALL VIEWING				
	Source side IQI			
Penetrated thickness w (mm)	**Wire type**	**Wire diameter (mm)**	**IQI Denomination and thinnest visible wire (*)**	**Sensitivity (%)**
w ≤ 1.2	W18	0.063	6th wire of 13 XX EN	≥ 10,5
1.2 < w ≤ 2.0	W17	0.080	5th wire of 13 XX EN	8.0 ÷ 13.33
2.0 < w ≤ 3.5	W16	0.100	4th wire of 13 XX EN (7th wire of 10 XX EN)	5.71 ÷ 10.0
3.5 < w ≤ 5.0	W15	0.125	3th wire of 13 XX EN 6th wire of 10 XX EN	5.0 ÷ 7.14
5.0 < w ≤ 7	W14	0.16	2nd wire of 13 XX EN 5th wire of 10 XX EN	4.57 ÷ 6.4
7 < w ≤ 12	W13	0.20	(1st wire of 13 XX EN) 4th wire of 10 XX EN	3.33 ÷ 5.71
12 < w ≤ 18	W12	0.25	3th wire of 10 XX EN 7th wire of 6 XX EN	2.78 ÷ 4.17
18 < w ≤ 30	W11	0.32	2nd wire of 10 XX EN 6th wire of 6 XX EN	2.13 ÷ 3.56
30 < w ≤ 40	W10	0.40	(1th wire of 10 XX EN) 5th wire of 6 XX EN	2.0 ÷ 2.67
40 < w ≤ 50	W9	0.50	4th wire of 6 XX EN	2.0 ÷ 2.5
50 < w ≤ 60	W8	0.63	3rd wire of 6 XX EN	2.1 ÷ 2.52
60 < w ≤ 85	W7	0.80	2th wire of 6 XX EN (7th wire of 1 XX EN)	1.88 ÷ 2.67
85 < w ≤ 120	W6	1.00	(1st wire of 6 XX EN) 6th wire of 1 XX EN	1.67 ÷ 2.35
120 < w ≤ 220	W5	1.25	5th wire of 1 XX EN	1.14 ÷ 2.08
220 < w ≤ 380	W4	1.60	4th wire of 1 XX EN	0.84 ÷ 1.45
380 < w	W3	2.00	3rd wire of 1 XX EN	<. 1.05

(*) If possible do not use the IQI in brackets

RADIOGRAPHIC EXAMINATION OF WELDS BY MEANS OF X RAYS AND γ RAYS ACCORDING TO UNI EN ISO 17636-1 SPECIFICATION

TABLE 4 – CLASS "B" – DOUBLE WALL EXPOSURE – DOUBLE WALL VIEWING				
	Source side			
Penetrated thickness w (mm)	**Wire type**	**Wire diameter (mm)**	**IQI Denomination and thinnest visible wire (*)**	**Sensitivity (%)**
$w \leq 1.5$	W19	0.05	7th wire of 13 XX EN	≥ 6.66
$1.5 < w \leq 2.5$	W18	0.063	6th wire of 13 XX EN	5.04 ÷ 8.4
$2.5 < t \leq 4$	W17	0.080	5th wire of 13 XX EN	4.0 ÷ 6.4
$4 < w \leq 6$	W16	0.100	4th wire of 13 XX EN 7th wire of 10 XX EN	3.33 ÷ 5.0
$6.0 < w \leq 8$	W15	0.125	3rd wire of 13 XX EN 6th wire of 10 XX EN	3.13 ÷ 4.17
$8 < w \leq 15$	W14	0.16	2nd wire of 13 XX EN 5th wire of 10 XX EN	2.13 ÷ 4.0
$15 < w \leq 25$	W13	0.20	(1st wire of 13 XX EN) 4th wire of 10 XX EN	1.6 ÷ 2.67
$25 < w \leq 38$	W12	0.25	3rd wire of 10 XX EN 7th wire of 6 XX EN	1.32 ÷ 2.0
$38 < w \leq 45$	W11	0.32	2nd wire of 10 XX EN 6thfilodi 6 XX EN	1.42 ÷ 1.68
$45 < w \leq 55$	W10	0.40	(1st wire of 10 XX EN) 5th wire of 6 XX EN	1.45 ÷ 1.78
$55 < w \leq 70$	W9	0.50	4th wire of 6 XX EN	1.43 ÷ 1.82
$70 < w \leq 100$	W8	0.63	3rd wire of 6 XX EN	1.26 ÷ 1.8
$100 < w \leq 170$	W7	0.80	2th wire of 6 XX EN 7th wire of XX EN	0.94 ÷ 1.6
$170 < w \leq 250$	W6	1.00	(1st wire of 6 XX EN) 6th wire of 1 XX EN	0.8 ÷ 1.18
$250 < w$	W5	1.25	5th wire of 1 XX EN	< 1.0

(*) If possible do not use the IQI in brackets

RADIOGRAPHIC EXAMINATION OF WELDS BY MEANS OF X RAYS AND γ RAYS ACCORDING TO UNI EN ISO 17636-1 SPECIFICATION

TABLE 5 – CLASS "A" – DOUBLE WALL EXPOSURE – SINGLE OR DOUBLE WALL VIEWING				
	Film side IQI			
Penetrated thickness w (mm)	**Wire type**	**Wire diameter (mm)**	**IQI Denomination and thinnest visible wire (*)**	**Sensitivity (%)**
$w \leq 1.2$	W18	0.063	6th wire of 13 XX EN	≥ 10,5
$1.2 < w \leq 2.0$	W17	0.080	5th wire of 13 XX EN	8.0 ÷ 13.33
$2.0 < w \leq 3.5$	W16	0.100	4th wire of 13 XX EN (7th wire of 10 XX EN)	5.71 ÷ 10.0
$3.5 < w \leq 5.0$	W15	0.125	3rd wire of 13 XX EN 6th wire of 10 XX EN	5.0 ÷ 7.14
$5.0 < w \leq 10$	W14	0.16	2nd wire of 13 XX EN 5th wire of 10 XX EN	3.2 ÷ 6.4
$10 < w \leq 15$	W13	0.20	(1st wire of 13 XX EN) 4th wire of 10 XX EN	2.67 ÷ 4.0
$15 < w \leq 22$	W12	0.25	3rd wire of 10 XX EN (7th wire of 6 XX EN)	2.27 ÷ 3.44
$22 < w \leq 38$	W11	0.32	2nd wire of 10 XX EN 6th wire of 6 XX EN	1.68 ÷ 2.91
$38 < w \leq 48$	W10	0.40	(1st wire of 10 XX EN) 5th wire of 6 XX EN	1.67 ÷ 2.11
$48 < w \leq 60$	W9	0.50	4th wire of 6 XX EN	1.67 ÷ 2.08
$60 < w \leq 85$	W8	0.63	3rd wire of 6 XX EN	1.48 ÷ 2.1
$85 < w \leq 125$	W7	0.80	2nd wire of 6 XX EN (7th wire of XX EN)	1.28 ÷ 1.88
$125 < w \leq 225$	W6	1.00	(1st wire of 6 XX EN) 6th wire of 1 XX EN	0.89 ÷ 1.6
$225 < w \leq 375$	W5	1.25	5th wire of 1 XX EN	0.67 ÷ 1.11
$375 < w$	W4	1.60	4th wire of 1 XX EN	< 0.85

(*) If possible do not use the IQI in brackets

RADIOGRAPHIC EXAMINATION OF WELDS BY MEANS OF X RAYS AND γ RAYS ACCORDING TO UNI EN ISO 17636-1 SPECIFICATION

TABLE 6 – CLASS "B" – DOUBLE WALL EXPOSURE – SINGLE OR DOUBLE WALL VIEWING				
	Film side			
Penetrated thickness w (mm)	**Wire type**	**Wire diameter (mm)**	**IQI Denomination and thinnest visible wire (*)**	**Sensitivity (%)**
$w \leq 1.5$	W19	0.05	7th wire of 13 XX EN	≥ 6.67
$1.5 < w \leq 2.5$	W18	0.063	6th wire of 13 XX EN	5.04 ÷ 8.4
$2.5 < w \leq 4$	W17	0.080	5th wire of 13 XX EN	4.0 ÷ 6.4
$4 < w \leq 6$	W16	0.100	4th wire of 13 XX EN (7th wire of 10 XX EN)	3.33 ÷ 5.0
$6.0 < w \leq 12$	W15	0.125	3rd wire of 13 XX EN 6th wire of 10 XX EN	2.08 ÷ 4.17
$12 < w \leq 18$	W14	0.16	2nd wire of 13 XX EN 5th wire of 10 XX EN	1.78 ÷ 2.67
$18 < w \leq 30$	W13	0.20	1st wire of 13 XX EN 4th wire of 10 XX EN	1.33 ÷ 2.22
$30 < w \leq 45$	W12	0.25	3rd wire of 10 XX EN (7th wire of 6 XX EN)	1.11 ÷ 1.67
$45 < w \leq 55$	W11	0.32	2nd wire of 10 XX EN 6th wire of 6 XX EN	1.16 ÷ 1.42
$55 < w \leq 70$	W10	0.40	(1st wire of 10 XX EN) 5th wire of 6 XX EN	1.14 ÷ 1.45
$70 < w \leq 100$	W9	0.50	4th wire of 6 XX EN	1.0 ÷ 1.43
$100 < w \leq 180$	W8	0.63	3rd wire of 6 XX EN	0.7 ÷ 1.26
$180 < w \leq 300$	W7	0.80	2nd wire of 6 XX EN (7th wire of XX EN)	0.53 ÷ 0.89
$300 < w$	W6	1.00	(1st wire of 6 XX EN) 6th wire of 1 XX EN	≤ 0.67

(*) If possible do not use the IQI in brackets

RADIOGRAPHIC EXAMINATION OF WELDS BY MEANS OF X RAYS AND γ RAYS ACCORDING TO UNI EN ISO 17636-1 SPECIFICATION

TABLE 7 – Film system classes and metal screens for the radiography of steels, copper and nickel based alloys					
Radiation source	**Penetrated thickness, w (mm)**	**Film system class (*) (***)**		**Thickness of lead screens (mm)**	
		Class A	Class B	Front screen	Back screen
≤ 100 kV	Any	C5	C3	None or ≤ 0.03	None or ≤ 0.03
100 < kV ≤ 150	Any	C5	C3	0.03 ÷ 0.15	0.03 ÷ 0.15
150 < kV ≤ 250	Any	C5	C4	0.03 ÷ 0.15	0.03 ÷ 0.15
250 < kV ≤ 500	≤ 50	C5	C4	0.03 ÷ 0.2	0.03 ÷ 0.2
250 < kV ≤ 500	> 50	C5	C5	0.1 ÷ 0.2 (**)	0.02 ÷ 0.2
Ir 192	Any			Class A	
		C5	C4	0.02 ÷ 0.2	0.02 ÷ 0.2
				Class B	
		C5	C4	0.1 ÷ 0.2 (**)	0.02 ÷ 0.2

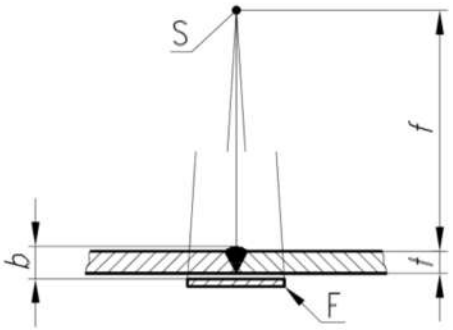
TABLE 8 – Film system classes and metal screens for the radiography of aluminium and titanium				
Radiation source	**Film system class (*) (***)**		**Thickness of lead screens (mm)**	
	Class A	Class B	Front screen	Back screen
kV ≤ 125	C5	C3	None	None
125 < kV ≤ 150	C5	C3	≤ 0.03	0.03 ÷ 0.15
150 < kV ≤ 250	C5	C3	0.03 ÷ 0.15	0.03 ÷ 0.15
250 < kV ≤ 300	C5	C3	0.1 ÷ 0.2	0.1 ÷ 0.2

(*) Better film system classes may also be used.

(**) Films with front and back lead screens 0.03 mm may be used if an additional lead screen of 0.1 mm is placed between the object and the film.

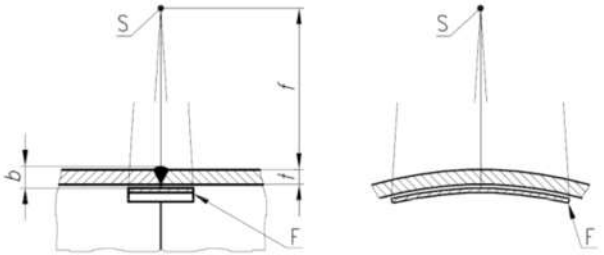
(***) C3 = GE STRUCTURIX D4
C4 = GE STRUCTURIX D5
C5 = GE STRUCTURIX D7

RADIOGRAPHIC EXAMINATION OF WELDS BY MEANS OF X RAYS AND γ RAYS ACCORDING TO UNI EN ISO 17636-1 SPECIFICATION



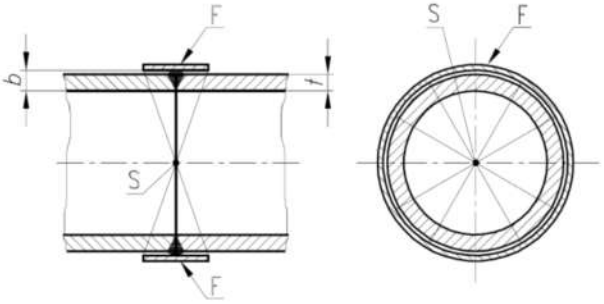
Weld in a flat plate or long. weld in a shell
SWE-SWV

FIGURE 1



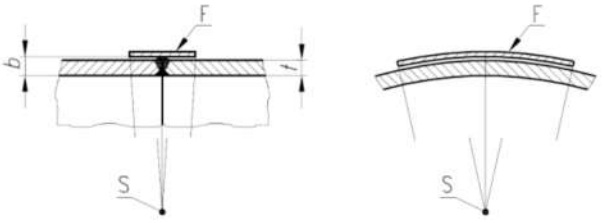
Circumferential weld
Outside source - SWE-SWV

FIGURE 2



Circumferential weld
Panoramic exposure - SWE-SWV

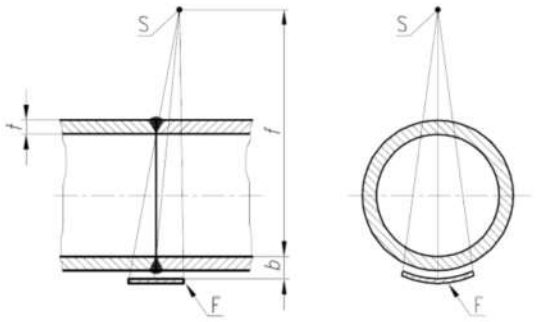
FIGURE 3



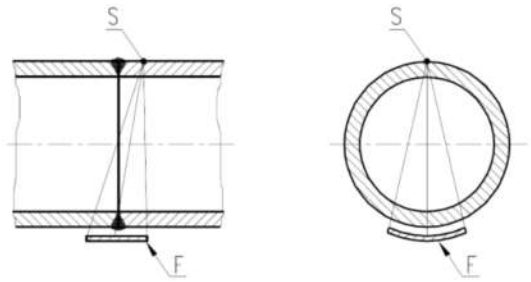
Circumferential weld
Inside source - SWE-SWV

FIGURE 4

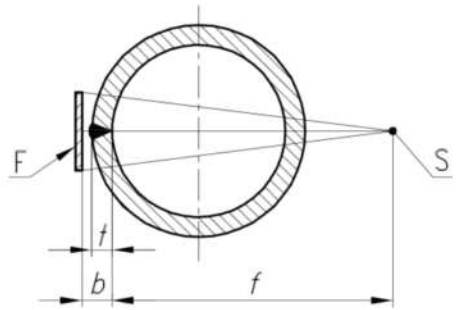
RADIOGRAPHIC EXAMINATION OF WELDS BY MEANS OF X RAYS AND γ RAYS ACCORDING TO UNI EN ISO 17636-1 SPECIFICATION



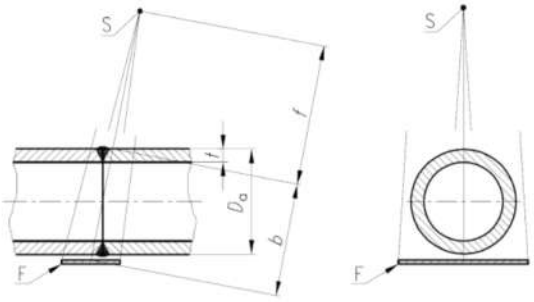
Circumferential weld FIGURE 5
DWE – SWV. The source to object distance shall be kept as small as possible while respecting the requirements of paragraph 7.6..



Circumferential weld FIGURE 6
DWE-SWV

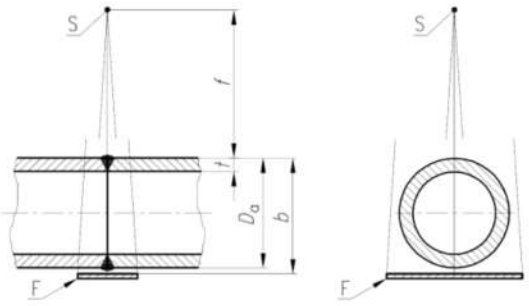


Longitudinal weld FIGURE 7
DWE-SWV



Circumferential weld FIGURE 8
Elliptic exposure - DWE-SWV

RADIOGRAPHIC EXAMINATION OF WELDS BY MEANS OF X RAYS AND γ RAYS ACCORDING TO UNI EN ISO 17636-1 SPECIFICATION



Circumferential weld
Perpendicular exposure - DWE-DWV

FIGURE 9

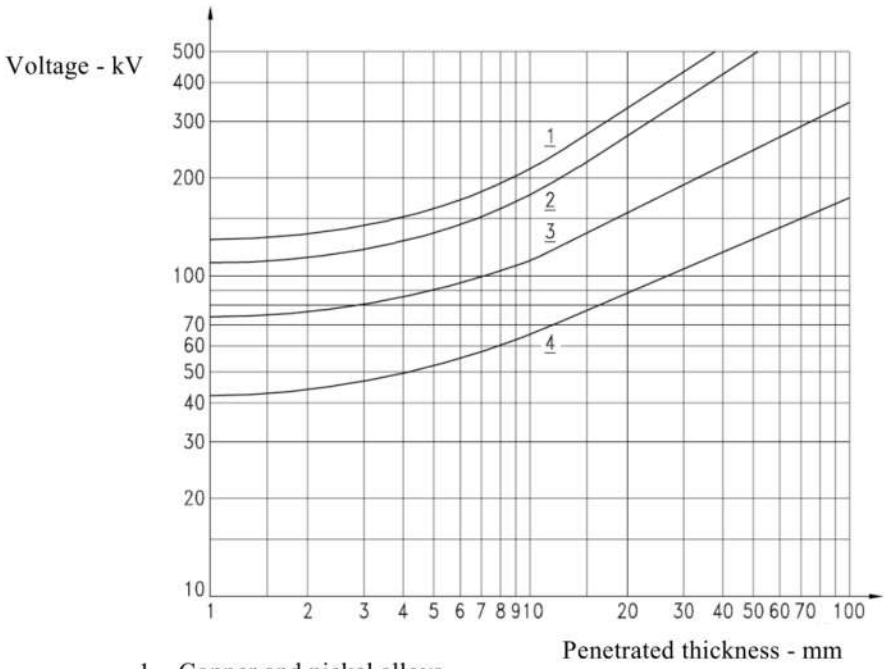
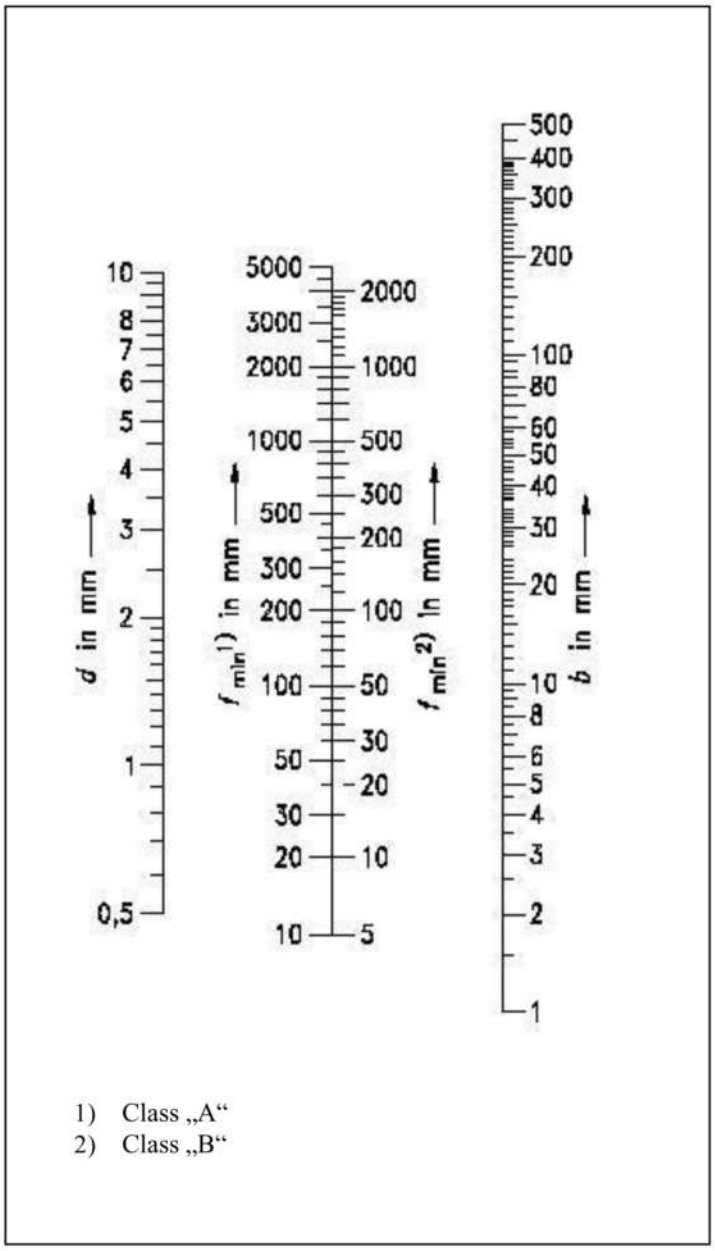


FIGURE 10

1 – Copper and nickel alloys
2 – Steel
3 – Titanium and alloys
4 - Aluminium and alloys

RADIOGRAPHIC EXAMINATION OF WELDS BY MEANS OF X RAYS AND γ RAYS ACCORDING TO UNI EN ISO 17636-1 SPECIFICATION



1) Class „A“
2) Class „B“

FIGURE 11

VISUAL EXAMINATION OF WELDS

Irtec s.r.l.

VISUAL EXAMINATION PROCEDURE

IR TEC SRL
SISTEMA DI QUALITA'
CERTIFICATO ISO 9001:2015

VISUAL EXAMINATION OF WELDS

INDEX

1. **SCOPE AND APPLICABILITY**
2. **REFERENCE DOCUMENTS**
3. **EXAMINATION CONDITIONS AND EQUIPMENT**
4. **PERSONNEL**
5. **GENERAL**
6. **VISUAL EXAMINATION OF JOINT PREPARATION**
7. **VISUAL EXAMINATION DURING WELDING**
8. **VISUAL EXAMINATION OF THE FINISHED WELD**
9. **VISUAL EXAMINATION OF REPAIRED WELDS**
10. **ACCEPTANCE CRITERIA**
11. **EXAMINATION RECORDS**

APPENDIX A

By signature and date on the front sheet of this Procedure by the relevant persons, the signature on each page of this Procedure are waived

1	3	2024/12/16	Revised according to comments
1	2	2018/05/11	Revised according to comments
1	1	2015/04/06	Revised according to ISO 17637: 2011
1	0	2006/03/24	Prima emissione – First issue
Em.	**Rev.**	**Data –Date**	**Descrizione - Description**
REVISIONI - REVISIONS			

Emessa da:
Issued by :
Technical Manager
Dott. Ing G. Grossi

Verificata/Approvata da:
Verified/Approved by :
Technical Manager
dott. Ing. G. GROSSI

VISUAL EXAMINATION OF WELDS

1. SCOPE AND APPLICABILITY

1.1. This procedure describes the method to be followed for visual examination of the following :

1.1.1. Weld preparations.

1.1.2. Surface of fillet and groove steel welds.

1.2. The test shall be conducted in the operative steps as specified by the construction Code :

1.2.1. Tackwelds to be left in place shall be examined visually for defects, and if found to be defective shall be removed.

1.2.2. Finished longitudinal, circumferential, shell to nozzle and fillet welds.

1.2.3. All the joints and connections shall be inspected for leaks during hydrostatic test

2. REFERENCE DOCUMENTS

2.1. EN 17637

2.2. EN 17635

2.3. EN 5817

3. EXAMINATION CONDITIONS AND EQUIPMENT

3.1. The luminance at the surface shall be a minimum of 350 lux.

3.2. For performance of direct inspection, the access shall be sufficient to place the eye within 600 mm of the surface and at an angle not less than approximately 30°. See figure 1

3.3. If required to obtain a good contrast and relief effect between imperfections and background, an additional light source should be used.

4. PERSONNEL

4.1. Personnel performing visual examination shall have an annual visual examination to assure natural or corrected near distance acuity such that they are capable of reading standard J-1 letters on standard Jaeger test type chart and be approved by the Employer.

4.2. If required personnel shall be certified level 2 according to ISO 9712.

5. GENERAL

5.1. The extent of examination shall be defined in advance by an application standard or by agreement between the contracting parties.

5.2. Welds shall, generally, examined in the as welded conditions.

6. VISUAL EXAMINATION OF JOINT PREPARATION

6.1. When visual examination is required prior to welding, the bevels shall be examined to check that :

6.1.1. the shape and dimensions of the weld preparation meet the specified requirements given in the welding procedure specification.

6.1.2. the fusion faces and adjacent surfaces are cleaned.

6.1.3. the parts to be joined by welding are fixed in relation to each other according to drawings or instructíons.

7. VISUAL EXAMINATION DURING WELDING

7.1. When required, the weld shall be examined during the welding process to check that :

7.1.1. Each run or layer of weld metal is cleaned before it is covered by a further run, particular attention being paid to the junctions between the weld metal and the fusion face.

7.1.2. There are no visible imperfections, e.g. cracks or cavities; if such imperfections are observed, they shall be reported so that remedial action can be taken before the deposition of further weld metal.

7.1.3. The transition between the runs and between the weld and the parent metal has such a shape that satisfactory melting can be accomplished when welding the next run.

7.1.4. The depth and shape of gouging is in accordance with the WPS or compared with the original groove shape in order to assure complete removal of the weld metal as specified.

8. VISUAL EXAMINATION OF THE FINISHED WELD

8.1. General

8.1.1. The finished weld shall be examined to determine whether it meets the agreed acceptance standard. If not specifically included within the requirements of an application standard or by agreement between the contracting parties, the items detailed in 8.2 to 8.5 shall be checked.

8.2. Cleaning and dressing

8.2.1. The weld shall be examined to check that :

8.2.1.1. All slag has been removed by manual or mechanical means. This is to avoid imperfections from being obscured.

8.2.1.2. There are no tool impressions or blow marks.

8.2.1.3. When weld dressing is required, overheating of the joint due to grinding is avoided and that grinding marks and an uneven finish are also avoided.

8.2.1.4. For fillet welds and butt welds to be dressed flush, the joint merges smoothly with the parent metal without under flushing.

8.3. Profile and dimensions

8.3.1. The weld shall be examined to check that :

8.3.1.1. The profile of the weld face and the height of any excess weld metal meet the requirements of the acceptance standard.

8.3.1.2. The surface of the weld is regular, the pattern and the pitch of weave marks present an even and satisfactory visual appearance. The distance between the last layer and the parent metal or the position of runs has been measured where required by the WPS.

8.3.1.3. The weld width is consistent over the whole of the joint and that it meets the requirements given in the weld drawing or acceptance standard. In the case of butt welds, it shall be checked that the weld preparation has been completely filled.

8.4. Weld root and surfaces

8.4.1. The visually accessible parts of the weld, i.e. the weld root for a single-sided butt weld and the weld surfaces, shall be examined for deviations from the acceptance standard.

8.4.2. The weld shall be examined to check that :

8.4.2.1. In the case of single-sided butt welds, the penetration, root concavity and any burn-through or shrinkage grooves are within the limits specified in the acceptance standard over the whole of the joint.

8.4.2.2. Any undercut is within the acceptance standard.

8.4.2.3. Any imperfections such as cracks or porosity detected, using optical aids when necessary, or the weld surface or heat affected zones comply with the appropriate acceptance criteria.

8.4.2.4. Any attachments temporarily welded to the object to facilitate production or assembly which are prejudicial to the function of the object or the ability to be examined, are removed so that the object is not damaged. The area where the attachment was fixed shall be checked to ensure freedom of cracks.

8.5. Post-weld heat treatment.

8.5.1. Further examination may be required after post-weld heat treatment.

9. VISUAL EXAMINATION OF REPAIRED WELDS

9.1. General

9.1.1. When welds fail to comply wholly or in part with the acceptance criteria and repair is necessary, the checks detailed in 9.2 and 9.3 shall be made during repair operation.

9.2. Partially removed weld.

9.2.1. It shall be checked that the excavation is sufficiently deep and long to remove all imperfections. It shall also be ensured that there is a gradual taper from the base of the cut to the surface of the weld metal at the ends and sides of the cut, the width and profile of the cut being such that there is adequate access for re-welding.

9.3. Completely removed weld.

9.3.1. It shall be checked that, when a cut has been made through a faulty weld and there has been no serious loss of material, or when a section of materials containing a faulty weld has been removed and a new section is to be inserted, the shape and dimensions of the weld preparation meet the specified requirements.

9.4. Examination

9.4.1. Every repaired weld shall be examined to the same requirements as the original weld, as specified in clause 8.

10. ACCEPTANCE CRITERIA

10.1. **Materials**

10.1.1. All surface and edge examination shall be evaluated in terms of the material specification.

10.1.2. Indications parallel to rolled surfaces on the edges of a plate cut during fabrication or weld preparation shall be removed and weld repaired if the depth is over 3 mm.

10.2. **Welds**

10.2.1. If not otherwise specified the welds shall be evaluated and accepted according to the required acceptance class of EN ISO 5817 (see appendix A for butt welds).

11. EXAMINATION RECORDS

11.1. It is not always necessary to keep a record of the examination. However, when specified, a record should be kept to show that every relevant item of the visual examination at each stage has been checked. The following lists the information that should be included in the report :

11.1.1. Name of the component manufacturer

11.1.2. Name of the examining body

11.1.3. Identification of the object examined

11.1.4. Material (if not included in other documents)

11.1.5. Type of joint

11.1.6. Material thickness

11.1.7. Welding process (if not included in other documents)

11.1.8. Acceptance criteria

11.1.9. Imperfections exceeding the acceptance criteria and their location

11.1.10. The extent of examination with reference to drawings as appropriate

11.1.11. Examination devices used

11.1.12. Result of examination with reference to acceptance criteria

11.1.13. Name of examiner and date of examination

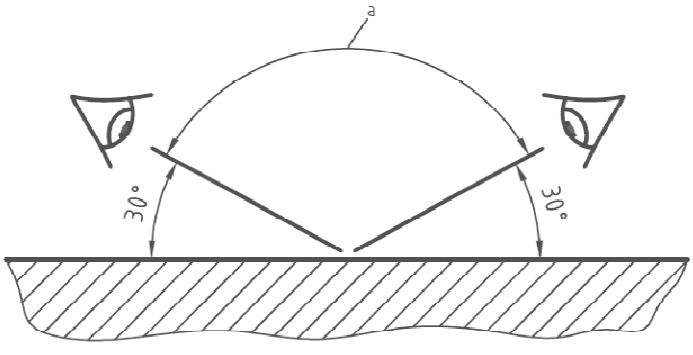
11.2. Where required, welds that have been examined and approved should be suitably marked or identified. When it is required to have a permanent visual record of a weld as examined, photographs or accurate sketches or both should be made with any imperfections clearly indicated.

VISUAL EXAMINATION OF WELDS

APPENDIX A

ACCEPTANCE CRITERIA FOR VISUAL INSPECTION OF BUTT WELDS ACCORDING TO EN 5817

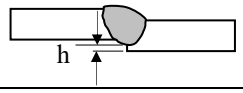
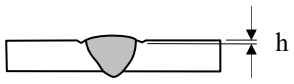
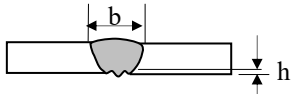
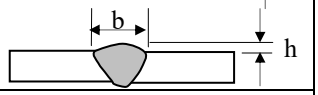
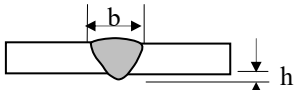
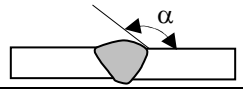
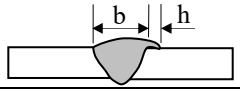
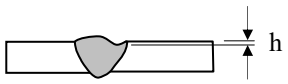
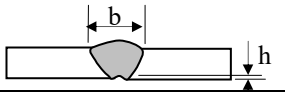
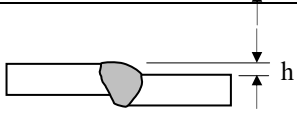
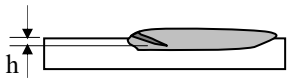
1. Alignment tolerance for butt welds.
   1.1. Alignment of sections at butt welded edges shall be such that the maximum offset is not greater than the applicable amount for the welded joint category given in table A1. The section thickness “t” is the nominal thickness of the thinner section at the joint.
   1.2. Any offset within the allowable tolerance shall be faired at a three to one taper over the width of the finished weld or, if necessary, by adding additional weld metal beyond the edge of the weld.
2. Finished longitudinal and circumferential joints.
   2.1. Butt welded joints shall have complete penetration and full fusion (see the exception in table A1 for joint category D). The surface of the weld shall be left “as welded” provided the weld is free of coarse ripples, grooves, overlaps, abrupt ridges or valleys.
   2.2. A reduction in thickness due to the welding process is acceptable provided the following conditions are met :
      2.2.1. No sharp notch is present.
      2.2.2. The reduction in thickness does not exceed the amount listed in table A1.
   2.3. The thickness of the weld reinforcement on each face or excess penetration shall not exceed the amount listed in table A1.
   2.4. Concavity due to the welding process on the root side of a single welded circumferential butt weld is permitted provided no sharp notch is present and the thickness of the weld is at least equal to the thickness of the thinner member.
   2.5. No overlap is admitted for C and B joint category.
3. Fillet welds
   3.1. Fillet welds shall have complete penetration and full fusion. The surface of the weld shall be left “as welded” provided the weld is free of coarse ripples, grooves, overlaps, abrupt ridges or valleys.
   3.2. The reduction of the thickness of the base metal due to the welding process shall meet the same requirements as for butt welds.
   3.3. The design section of the weld shall result wholly inscribed in the actual section.



a Range

Figure 1 — Access for testing

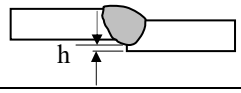
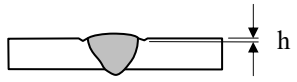
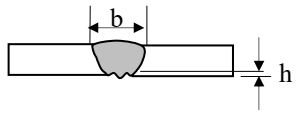
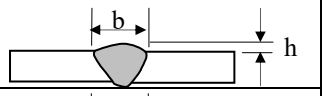
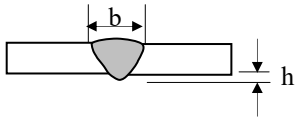
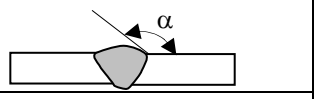
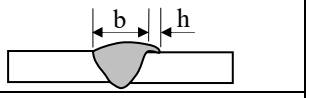
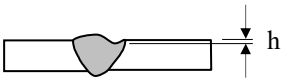
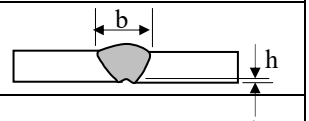
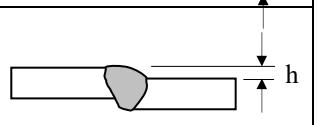
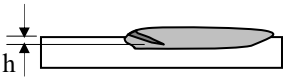
VISUAL EXAMINATION OF WELDS

TABLE A1 (t > 3 mm)				
Defect	**Joint Category**			
	D	**C**	**B**	
Crack	Not permitted	Not permitted	Not permitted	
Lack of fusion	Not permitted	Not permitted	Not permitted	
Stray arc	Depends upon material	Not permitted	Not permitted	
Spatter	Depends upon application	Depends upon application	Depends upon application	
Lack of penetration Single side welds	Short imperfections h ≤ 0.2 t max 2 mm	Not permitted	Not permitted	
Undercut	h ≤ 0.2 t max 1 mm	h ≤ 0.1 t max 0.5 mm	h ≤ 0.05 t max 0.5 mm	
	Short imperfections			
Shrinkage groove	h ≤ 0.2 t max 2 mm	h ≤ 0.1 t max 1 mm	h ≤ 0.05 t max 0.5 mm	
Weld reinforcement	h ≤ 1 + 0.25 b max 10 mm	h ≤ 1 + 0.15 b max 7 mm	h ≤ 1 + 0.1 b max 5 mm	
Excess penetration	h ≤ 1 + 1.0 b max 5 mm	h ≤ 1 + 0.6 b max 4 mm	h ≤ 1 ÷ 0.2 b max 3 mm	
Incorrect weld toe	α ≥ 90°	α ≥ 110°	α ≥ 150°	
Overlap	h ≤ 0.2 b	Not permitted	Not permitted	
Reduction in thickness	Short imperfections			
	h ≤ 0.25 t max 2 mm	h ≤ 0.1 t max 1 mm	h ≤ 0.05 t max 0.5 mm	
Root concavity	Short imperfections			
	h ≤ 0.2 t max 2 mm	h ≤ 0.1 t max 1 mm	h ≤ 0.05 t max 0.5 mm	
Offset of the edges Longitudinal welds and plates	h ≤ 0.25 t max 5 mm	h ≤ 0.15 t max 4 mm	h ≤ 0.1 t max 3 mm	
Offset of the edges Circumferential welds	h ≤ 0.5 t max 4 mm	h ≤ 0.5 t max 3 mm	h ≤ 0.5 t max 2 mm	
End crater pipe	h ≤ 0.2 t max 2 mm	h ≤ 0.1 t max 1 mm	Not permitted	

Short imperfections :

- Weld less than 100 mm long : imperfections whose total length is not greater than 25% of the length of the weld.
- Weld 100 mm long or longer : imperfections whose total length is not greater than 25 mm in the 100 mm of the weld which contains the greatest number of imperfections.

VISUAL EXAMINATION OF WELDS

TABLE A2 (0.5 ≤ t ≤ 3 mm)				
Defect	**Joint Category**			
	D	**C**	**B**	
Crack	Not permitted	Not permitted	Not permitted	
Lack of fusion	Not permitted	Not permitted	Not permitted	
Stray arc	Depends upon material	Not permitted	Not permitted	
Spatter	Depends upon application	Depends upon application	Depends upon application	
Lack of penetration Single side welds	Short imperfections h ≤ 0.2 t max 2 mm	Not permitted	Not permitted	
Undercut	Short imperfections h ≤ 0.2 t	Short imperfections h ≤ 0.1 t max 0.5 mm	Not permitted	
Shrinkage groove	h ≤ 0.2 mm+0.1 t	Short imperfections h ≤ 0.1 t max 1 mm	Short imperfections h ≤ 0.05 t max 0.5 mm	
Weld reinforcement	h ≤ 1 + 0.25 b max 10 mm	h ≤ 1 + 0.15 b max 7 mm	h ≤ 1 + 0.1 b max 5 mm	
Excess penetration	h ≤ 1 + 0.6 b	h ≤ 1 + 0.3 b	h ≤ 1 + 0.1 b	
Incorrect weld toe	α ≥ 90°	α ≥ 110°	α ≥ 150°	
Overlap	h ≤ 0.2 b	Not permitted	Not permitted	
Reduction in thickness	Short imperfections h ≤ 0.25 t	Short imperfections h ≤ 0.1 t	Not permitted	
Root concavity	h ≤ 0.2 mm + 0.1 t	h ≤ 0.1 t	h ≤ 0.05 t	
Offset of the edges Longitudinal welds and plates	h ≤ 0.2 mm+0.25 t	h ≤ 0.2 mm+0.15 t	h ≤ 0.2 mm+0.1 t	
Offset of the edges Circumferential welds	h ≤ 0.5 t max 4 mm	h ≤ 0.5 t max 3 mm	h ≤ 0.5 t max 2 mm	
End crater pipe	h ≤ 0.2 t	Not permitted	Not permitted	

DELTA FERRITE CHECK
AUSTENITIC AND DUPLEX MATERIALS

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9. MEASUREMENT
10. NUMBER OF READINGS
11. ACCEPTANCE CRITERIA
12. REPORT

By signature and date on the front sheet of this Procedure by the relevant persons, the signature on each page of this Procedure are waived

1	0h	2019/04/08	First issue
Em.	**Rev.**	**Date**	**Description**

REVISIONS

Emessa da:

IRTEC srl ISTITUTO DI RICERCHE TECNOLOGIE E COLLAUDI

Verificata/Approvata da:
Technical Manager
dott. Ing. G. GROSSI

DELTA FERRITE CHECK
AUSTENITIC AND DUPLEX MATERIALS

1. PURPOSE

1.1. This document details the procedure to verify the ferrite content (Fe % or FN) of austenitic and duplex stainless steels.

2. APPLICABILITY

2.1. This procedure is applicable to verify :

2.1.1. Materials
2.1.2. Welds
2.1.3. Weld metal overlays

3. EQUIPMENT

3.1. A FISCHER FERITSCOPE FMP30 with a FGAB1.3-Fe type probe shall be used.
3.2. A FISCHER calibration standard set N-0589 shall be used with the following calibration standards :

- Base
- 0.53 FN - 0.52 Fe%
- 1.61 FN – 1.74 Fe%
- 10.2 FN – 11.3 Fe%
- 39.9 FN – 35.0 Fe%
- 123.5 FN – 85.6 Fe%

4. REFERENCE DOCUMENTS

4.1. This document is based and satisfies the requirements of the instruction manual of the apparatus used to perform the examination.
4.2. ASTM A 799 paragraph 5.2 allows using this instrument according to the manufacturer's instructions for calibration.
4.3. NYS B9.10
4.4. AWS A4.2

5. PERSONNEL

5.1. Personnel shall complete sufficient organized training to become familiar with the principles and practices of the method.
5.2. Personnel shall be approved by the technical responsible of IRTEC.

6. SURFACE PREPARATION

6.1. The surface to be checked shall be clean from any dirt, grease, oil, paint, slag. If necessary shall be mechanically brushed using a stainless steel brush and degreased using clean acetone.

7. CALIBRATION

7.1. The instrument shall be calibrated according to the procedure in the user's manual (matrix calibration).

8. CALIBRATION VERIFICATION

8.1. The calibration of the instrument shall be verified before the measurements using two standards near the maximum and the minimum of the required range.
8.2. Verify that the used standards are not damaged.

Calibration Standard		Ferrite		Acceptable readings	
		Ferrite %	FN	% (*)	FN
1	//	Ferrit base	//	//	//
6	58675	85.6%	123.5	83.9 ÷ 87.3	122.5 ÷ 124.5
5	58674	35.0%	39.9	34.5 ÷ 35.5	38.9 ÷ 40.9
4	58673	11.3%	10.2	10.9 ÷ 11.7	9.5 ÷ 10.9
3	58672	1.74%	1.61	1.34 ÷ 2.14	1.21 ÷ 2.01
2	58671	0.52%	0.53	0.12 ÷ 0.92	0.13 ÷ 0.93

(*) Processed by means of the relationship between FN and Ferrite % given by Helmut Fischer GMBH according to ANSI/AWS A4.2-91 table 6 (see the figure 6 in this procedure)

8.2.1. Verification will be regarded as positive where the reading of each calibration standard (average of three readings) is within the guaranteed error limit.

9. MEASUREMENT

9.1. Place the probe perpendicular to the surface and read the ferrite % or the FN.
9.2. Lift the probe at least 25 mm from the surface before taking the following measurement.
9.3. Do not scan the surface to avoid the early wear of the tip of the probe.
9.4. After the measurements apply, if necessary, the correction factors for the curvature and the thickness of the sample, the distance from the edge of the sample and the thickness of the plating (see the figures 1 ÷ 5).
9.5. These corrections are, generally, necessary if :

9.5.1.	Convex curvature radius	< 25 mm
9.5.2.	Concave curvature radius	< 40 mm
9.5.3.	Thickness of the sample	< 2 mm
9.5.4.	Thickness of the plating	< 3 mm
9.5.5.	Edge distance	< 2 mm

10. NUMBER OF READINGS

10.1. If not specified, at least two readings shall be taken in each weld joint.

11. ACCEPTANCE CRITERIA

11.1. Testing shall be carried out before PWHT. Percentage of ferrite shall be btween 3 ÷ 12, and for items thickness over 19 mm and PWHT done shall be 3 ÷ 9.

12. REPORT

12.1. The following data shall be reported on the certificate to be dated and signed by the operator :

12.1.1. Reference to this procedure
12.1.2. Instrument and probe used
12.1.3. Item identification
12.1.4. Material
12.1.5. Heat treatment condition
12.1.6. Surface status
12.1.7. Position of readings
12.1.8. Results

DELTA FERRITE CHECK
AUSTENITIC AND DUPLEX MATERIALS

CORRECTION FACTORS

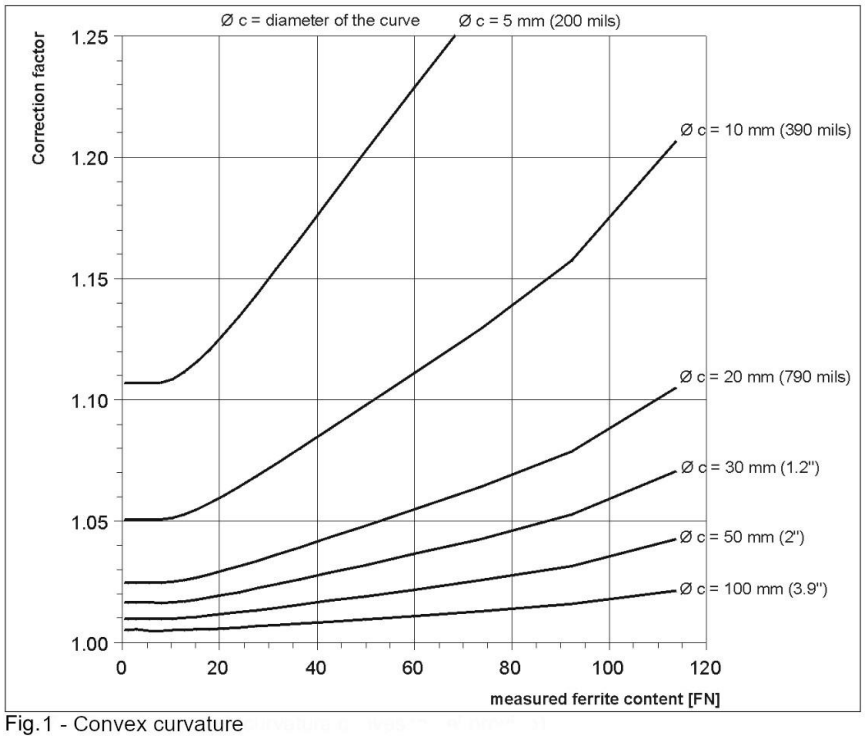


Fig.1 - Convex curvature

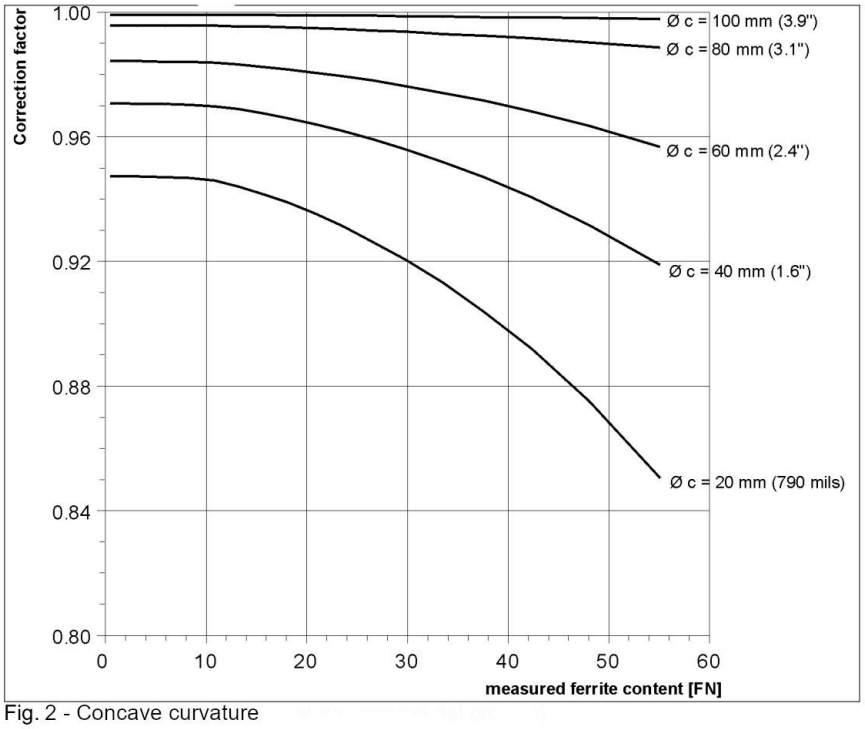


Fig. 2 - Concave curvature

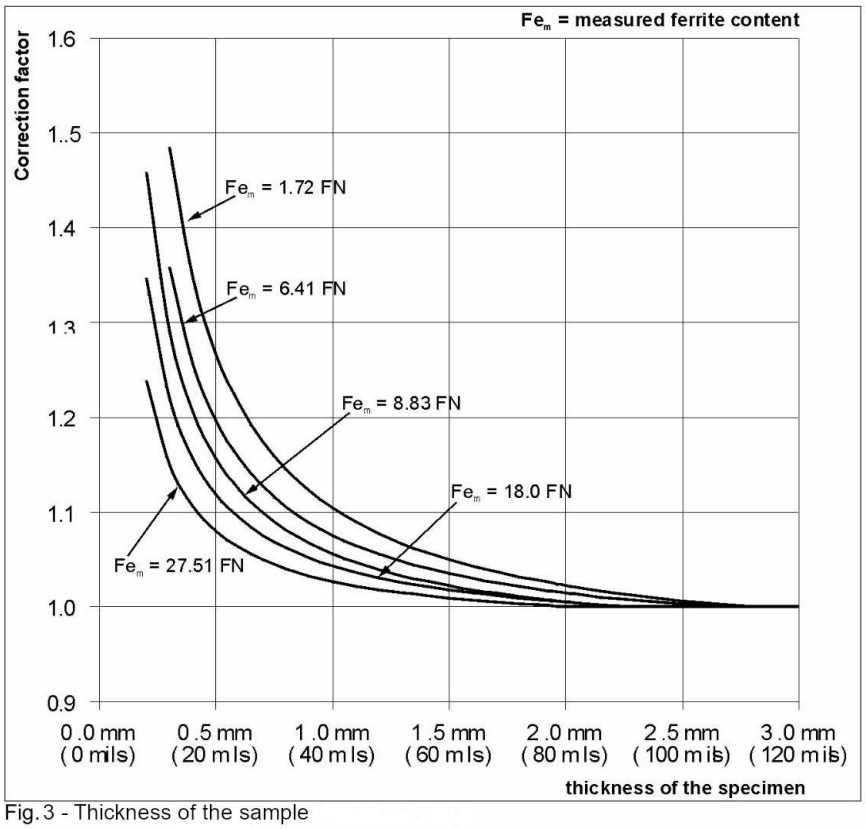


Fig.3 - Thickness of the sample

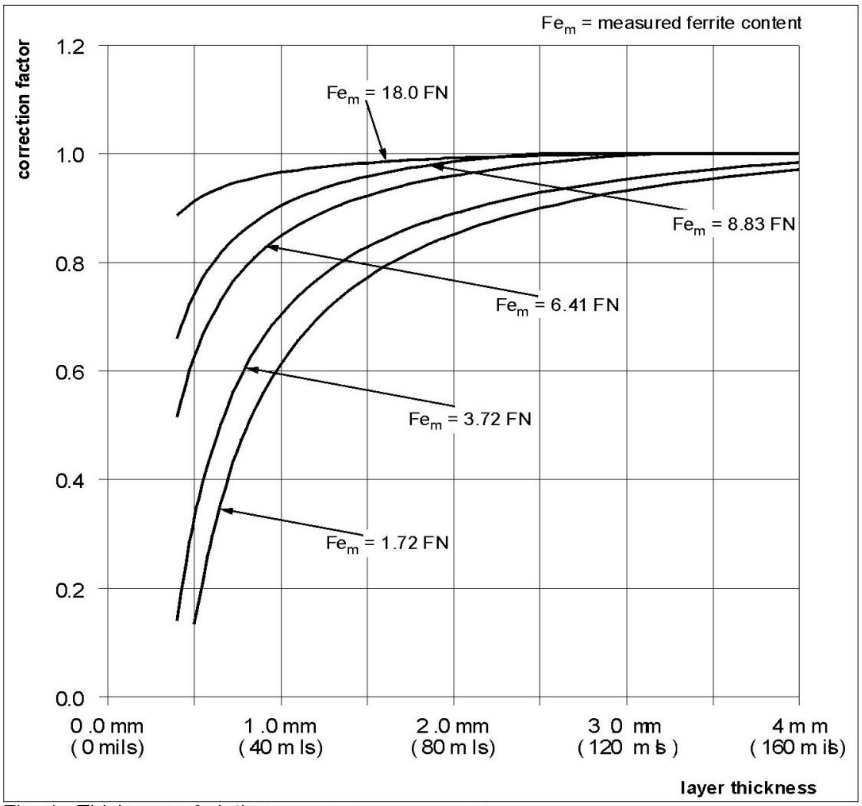


Fig. 4 - Thickness of plating

DELTA FERRITE CHECK
AUSTENITIC AND DUPLEX MATERIALS

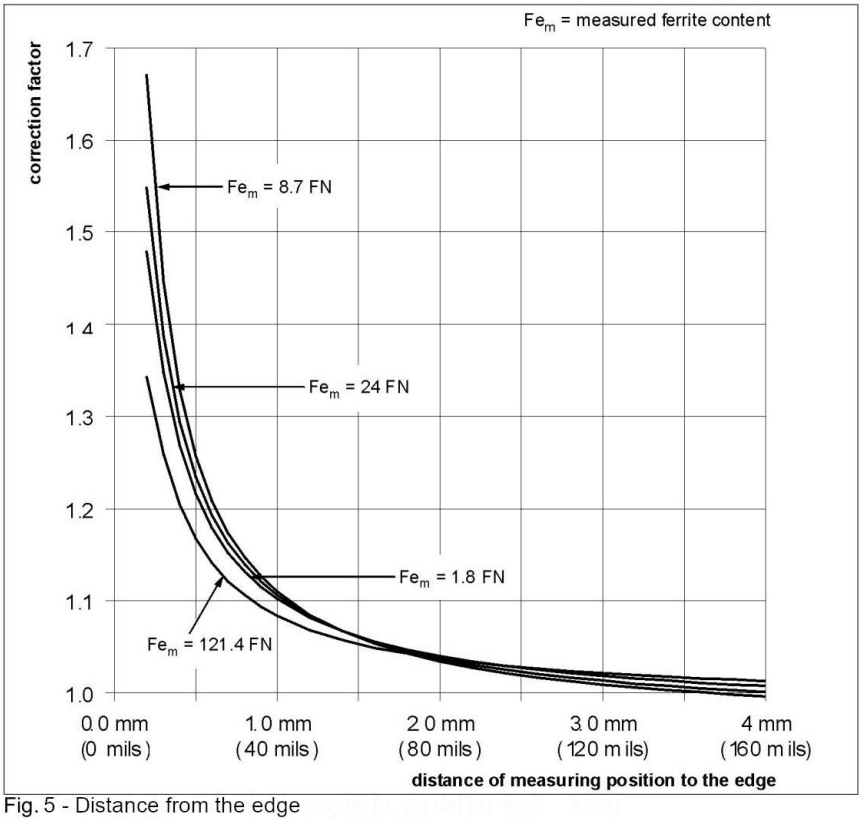
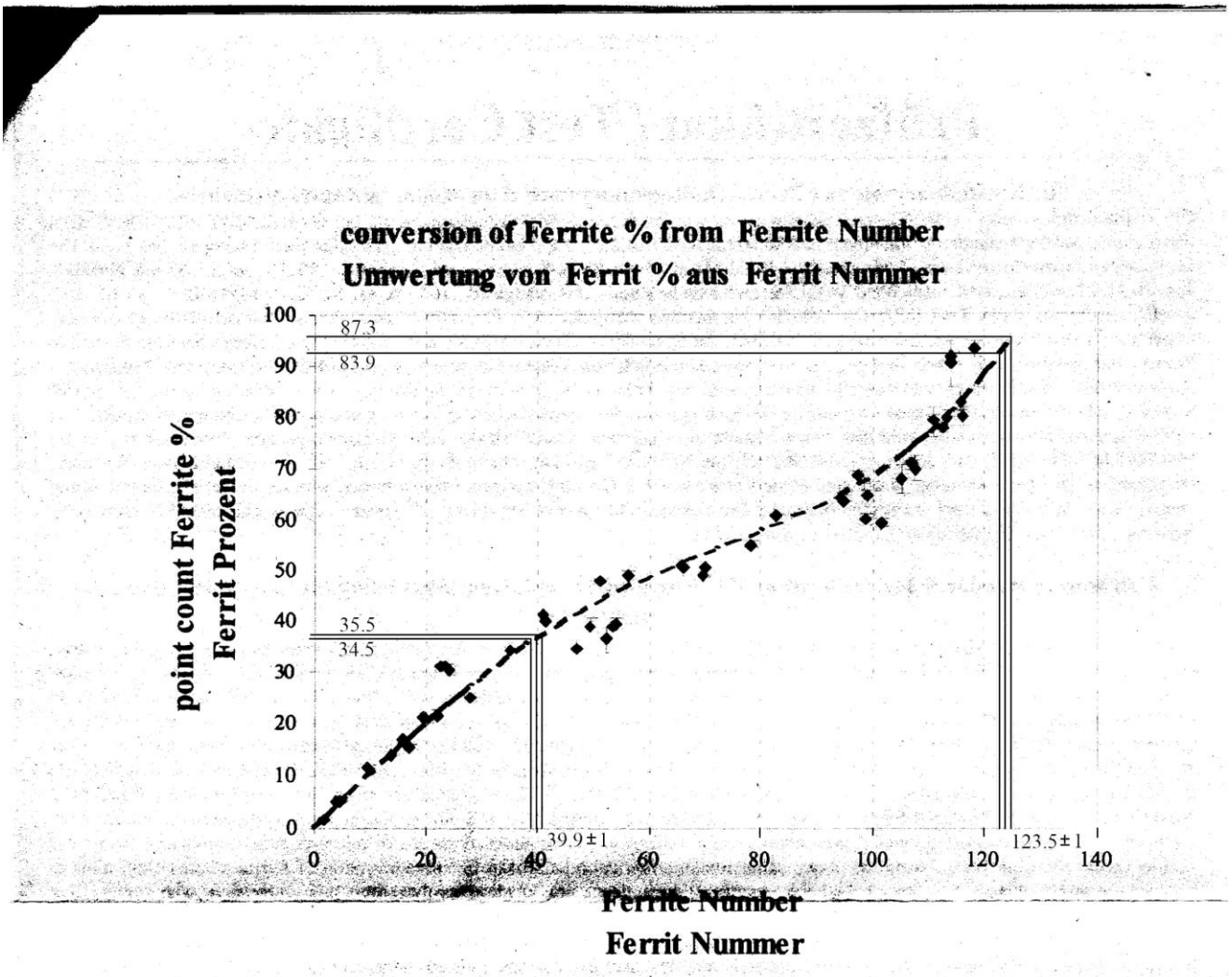


Fig. 5 - Distance from the edge

DELTA FERRITE CHECK
AUSTENITIC AND DUPLEX MATERIALS



Gewährleistung: Unsere Garantie für die gelieferten Kalibriernormale bezüglich herstellungsbedingter Mängel gilt für einen Zeitraum von 12 Monaten, gerechnet ab dem Datum der Lieferung bzw. Rechnungsdatum.
Unsere Gewährleistung umfasst nur den kostenlosen Umtausch beanstandeter Einstellnormale.
Prüfmittelüberwachung: die Festlegung des Überprüfungsintervalls hängt ab von der Häufigkeit und der Art und Weise der Benutzung des Einstellnormales und obliegt daher dem Anwender.
Hinweis: Vor jeder Benutzung sollten die Einstellnormale visuell auf äußerlich erkennbare mechanische Beschädigungen wie Eindrücke, Korrosion oder Oberflächenverschmutzung überprüft werden. Einstellnormale sollten ersetzt werden, sobald diese sichtbare Gebrauchspuren aufweisen.

Note:

Warranty: The guarantee for the stated accuracy of the standards in respect to productional defects lasts 12 months from the time of shipment or invoice.
Our warranty only covers the even exchange of faulty calibration standards free of charge.
Verification of measuring: the frequency of verification of this standard is determined by the user, based upon the number of uses and the severity of use.
Remark: Prior to each use inspect the standards for obvious mechanical defects, such as deep scratches, gouges, corrosion, contamination or other defects. Any standards showing mechanical defects should be replaced promptly.

As regards the NDT-VT-01 E1 R0h procedure – Delta ferrite check Austenitic and Duplex Materials, we confirm that it can also be applied to welding overlays as in point 2.1.3.

Thickness of the overlay ≥ 2 mm

End of document

PROVE ESEGUITE DA Test conducted by	PER IL LABORATORIO For the laboratory	L'ISPETTORE DEL CLIENTE Customer inspector	IL COLLAUDATORE The inspector
	dott. Ing. G. GROSSI		

I.R.T.E.C. s.r.l.

LIQUID PENETRANT TESTING PROCEDURE

IR TEC SRL
SISTEMA DI QUALITA'
CERTIFICATO ISO 9001:2008

LIQUID PENETRANT EXAMINATION OF WELDS ACCORDING TO EN ISO

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9. DOCUMENTATION/RECORDS
10. REPAIR REQUIREMENTS
11. PERSONNEL

By signature and date on the front sheet of this Procedure by the relevant persons, the signature on each page of this Procedure are waived

2	2	2024/03/06	Verified according with EN ISO 3452-1:2021
2	1	2015/11/26	Revised according to comments
2	0	2014/10/14	First issue
Em.	**Rev.**	**Data - Date**	**Descrizione - Description**

REVISIONS

Issued by :

IRTEC srl ISTITUTO DI RICERCHE TECNOLOGIE E COLLAUDI

Checked/Approved by :
NDE LEVEL 3 ISO 9712
dott. Ing. G. GROSSI

LIQUID PENETRANT EXAMINATION OF WELDS ACCORDING TO EN ISO

1. SCOPE

1.1. This procedure describes the method to be followed for water washable visible and solvent removable liquid penetrant examination of welds.

2. REFERENCE DOCUMENTS

2.1. This procedure satisfies the requirements of the following specifications :

2.2. UNI EN ISO 3452-1:2021

2.3. UNI EN ISO 23277:2015

3. APPLICABILITY

3.1. This procedure is applicable to :

3.2. Butt and fillet welds

3.3. Weld overlays

3.4. This procedure is applicable to parts of any size.

4. EQUIPMENT

4.1. Penetrant materials
The term “penetrant materials” is intended to include all penetrants, solvents or cleaning agents, developers, etc., used in the examination process.

5. MISCELLANEOUS REQUIREMENTS

5.1. **Control of Contaminants** - All the penetrant materials shall be certified to satisfy the control of contaminants. These certifications shall include the penetrant manufacturers’ batch numbers and the test results obtained in accordance with the requirements of table B.

5.2. **Expiration date** - Make sure to use the penetrant materials before the expiration date

5.3. **Surface preparation**

5.3.1. In general, satisfactory results may be obtained when the surfaces of the part is in the as-welded, as-rolled, as-cast or as-forged condition. Surface preparation by grinding, machining, or other methods may be necessary where surface irregularities could mask indications.

5.3.2. Prior to each liquid penetrant examination, the surface to be examined and all adjacent areas within at least 25 mm shall be dry and free of all dirt, grease, lint, scale, welding flux, weld spatter, paint, oil and other extraneous matter that could obscure surface openings or otherwise interfere with the examination.

5.3.3. Typical cleaning agents which may be used are organic solvents.

5.3.4. Cleaning solvents shall meet the requirements of 5.1. The cleaning method employed is an important part of the examination process.

5.3.5. Solvent cleaning after machining is a correct method of cleaning.

5.3.6. Grinding is a correct method of cleaning.

5.3.7. Is also correct perform examination after welding (it is only necessary to remove the slag and grind where necessary).

5.4. **Drying After Preparation**

5.4.1. After cleaning, drying of the surface to be examined shall be accomplished in the following way :

5.4.1.1. Solvent cleaning – dry cloths and/or normal evaporation

5.4.1.2. Minimum evaporation time shall be 2 minutes.

6. TECHNIQUE

6.1. **Techniques**

6.1.1. A color contrast (daylight visible) penetrant shall be used (the penetrant materials to be used are listed in Table A).
The penetrant shall be used with one of the following penetrant processes :

6.1.1.1. Water washable

6.1.1.2. Solvent Removable

6.1.2. The materials to be used is listed in Table A.

6.1.3. When solvent cleaning or excess penetrant removal is required, the solvents in Table A shall be used.

6.2. **Techniques for Standard Temperatures**

6.2.1. As a standard technique, the ambient temperature and the surface of the part to be processed shall not be below 10°C nor above 50°C throughout the examination period.

6.2.2. Where is not practical to comply with these temperature limitations, other temperatures and times may be used, provided the procedures are qualified as specified in UNI EN ISO 3452-5 or 3452-6 as applicable.

7. EXAMINATION

7.1. **Penetrant Application**

7.1.1. The penetrant will be applied by a pressurized spray can, by brushing or by dipping.

7.2. **Penetration time**

7.2.1. Penetration time is critical. The minimum penetration time shall be 15 minutes.

7.3. **Excess penetrant removal**

7.3.1. **Water-Washable Penetrants** – Excess water-washable penetrant shall be removed by wiping with a dry cloth repeating the operation until most traces of penetrant have been removed. The remaining traces shall be removed by lightly wiping the surface with a water spry and/or wet cloths. The water pressure shall not exceed 3.5 bar. The water temperature shall not exceed 43°C.

7.3.2. **Solvent removable penetrants** - Excess solvent removable penetrants shall be removed by wiping with a dry cloth, repeating the operation until most traces of penetrant have been removed. The remaining traces shall be removed by lightly wiping the surface with cloth moistened with solvent. To minimize removal of penetrant from discontinuities, care shall be taken to avoid the use of excess solvent.
Flushing the surface with solvent, following the application of the penetrant and prior to developing, is prohibited.

7.3.3. **Excess penetrant removal check –** The final cleaning shall be performed with a clear cloth that shall remain clean.

7.4. **Drying After Excess Penetrant Removal**

7.4.1. For the water washable technique, the surfaces may be dried by blotting with clean cloths and/or by using circulating air, provided the temperature of the surface is not raised above 52°C.

7.4.2. For the solvent removable technique, the surfaces may be dried by normal evaporation (minimum 2 minutes), blotting, wiping, or forced air.

7.5. **Developing**

7.5.1. The developer shall be applied by spraying as soon as possible after penetrant removal. In every case the time interval after drying shall not exceed 10 minutes.

7.5.2. Wet Developer Application – Prior to applying solvent suspension type wet developer to the surface, the developer must be thoroughly agitated to ensure adequate dispersion of suspended particles.

7.5.3. Developer shall be applied only to a dry surface. It shall be applied by a pressurized spry can. Drying shall be by normal evaporation.

7.5.4. The developer shall be applied only to a dry surface in a thin and uniform layer.

7.5.5. The developer shall not be applied over a dry layer of developer.

7.5.6. Developing time begins when the developer coating is dry.

7.6. **Interpretation**

7.6.1. **Final interpretation** - Final interpretation shall be made within 10 to 30 minutes of developing time (see 7.5.6). If bleed out does not alter the examination results, longer periods are permitted. If the surface to be examined is large enough to preclude complete examination within the prescribed or established time, the examination shall be performed in increments.

7.6.2. **Characterizing indication(s)** – The type of discontinuities are difficult to evaluate if the penetrant diffuses excessively into the developer. If this condition occurs, close observation of the formation of indication(s) during application of the developer may assist in characterizing and determining the extent of the indication(s).
The type and size of the indication is the basis for acceptance evaluation.

7.6.2.1. A linear indication is one having a length greater than three times the width

7.6.2.2. A rounded indication is one of circular or elliptical shape with the length equal to or less than three times the width

7.6.3. **Color Contrast Penetrants** – With a color contrast penetrant, the developer forms a reasonably uniform white coating. Surface discontinuities are indicated by bleed-out of penetrant which is normally a deep red color that stains the developer. Indications with a light pink color may indicate excessive cleaning. Inadequate cleaning may leave an excessive background making interpretation difficult.

7.6.3.1. A minimum light intensity of 500 lx is required on the surface to be examined to ensure adequate sensitivity during the examination and evaluation of indications. This light intensity may be obtained by an incandescence bulb lamp 220V 100W transparent glass at a distance not greater than 400 mm

7.6.3.2. Lighting has been actually measured by means of a calibrated luxmeter.

7.6.4. **Post-Examination Cleaning** – When post-examination cleaning is required, it should be conducted as soon as practical after examination and documentation. Cleaning shall be performed by brushing and dry cloths.

8. EVALUATION

8.1. All indications shall be evaluated in term of the acceptance standards of the referencing Code Section.

8.1.1. Acceptance criteria for welds (all materials), if not otherwise specified, shall be in accordance with Tables D and E of this procedure.

8.2. Broad areas of pigmentation which could mask indications of discontinuities are unacceptable. Such areas shall be cleaned and reexamined using the same type of penetrant.

8.3. Discontinuities at the surface will be indicated by bleed-out of penetrant; however, localized surface irregularities due to machining marks or other surface conditions may produce false indications.

8.4. Any indication which is believed non relevant shall be regarded as an imperfection unless it is shown by reexamination by the same method or by the use of other nondestructive methods or by surface conditioning that no unacceptable imperfection is present.

9. DOCUMENTATION/RECORDS

9.1. **Recording of Indications**

9.1.1. **Nonrejectable Indications** – Nonrejectable indications shall be recorded as specified by the referencing Code Section.

9.1.2. **Rejectable Indications** - Rejectable indications shall be recorded. As minimum, the type of indications (linear or rounded), location and extent (length or diameter or aligned) shall be recorded.

9.1.3. **Examination Records**

9.1.4. For each examination, the following information shall be recorded (see Annex) :

9.1.4.1. Information on the part tested :

a) Identification of part/weld (part number/weld seam number)

b) Dimensions

c) Material

d) Surface conditions

e) Production stage

9.1.4.2. procedure identification and revision

9.1.4.3. Designation of the penetrant system used

a) RED WW : II-a-e-Level 1

b) AVIO B : II-c Class 2-e-Level 2

9.1.4.4. map or record of indications per 9.1

9.1.4.5. lighting equipment

9.1.4.6. examination personnel identity, qualification level and signature

9.1.4.7. date of examination

10. REPAIR REQUIREMENTS

10.1. Whenever a defect is removed and subsequent welding is not required because the removed material does not reduce the wall thickness below the drawing requirements, the affected area shall be blended into the surrounding surface so as to avoid sharp notches, crevices or corners.

10.2. If the welding is required, prior to weld repair the excavated area shall be examined again by this specification. The weld repair shall be performed, if necessary, by applicable welding specification and shall be authorized, if necessary, by Quality Control Department. In any case, after repair, the surface shall be examined by the methods required by this procedure with the same acceptance criteria.

11. PERSONNEL

11.1. Personnel performing liquid penetrant examination shall be qualified to NDE Level 2 according to EN ISO 9712.

LIQUID PENETRANT EXAMINATION OF WELDS ACCORDING TO EN ISO

TABLE A	
PENETRANT MATERIALS	**NDT ITALIANA**
SOLVENT (For cleaning and penetrant removal)	Elite BC1
PENETRANT	Elite K71B2p (sensitivity level 2
DEVELOPER	Elite D112A

TABLE B		
CONTROL OF CONTAMINANTS		
TEST	METHOD	RESULT
Corrosive properties	UNI EN ISO 3452-2	According to standard
Halogens (Cl+F)	SE 165-02	≤ 1%
Sulfur	SE 165-02	≤ 1%

TABLE C			
MINIMUM DWELL TIMES (minutes)			
Material	Form	Type of discontinuity	Penetrant
Aluminum, Magnesium, Steel, Brass, Bronze, Titanium, High temperature alloys	Castings and welds	Cold shuts, porosity, lack of fusion, cracks	5
	Wrought materials, extrusions, forgings, plates	Laps, cracks	10

TABLE D			
Type of indicationj	Acceptance level (a)		
	1	2	3
Linear indication	L ≤ 2	L ≤ 4	L ≤ 8
Non linear indication	d ≤ 4	d ≤ 6	d ≤ 8
(a) Acceptance levels 2 and 3 may be specified with suffix “X” which denotes that all linear indications detected shall be evaluated to level 1.			

TABLE E	
ACCEPTANCE STANDARDS FOR WELDS (All materials)	
Quality level according to EN ISO 5817 EN ISO 10042	Acceptance levels According to EN ISO 23277
B	2X
C	2X
D	3X

MAGNETIC PARTICLE EXAMINATION OF WELDS ACCORDING TO EN ISO STANDARD
(Yoke technique, Black wet particles)

I.R.T.E.C. S.R.L.

MAGNETIC PARTICLE TESTING PROCEDURE

IR TEC SRL
SISTEMA DI QUALITA'
CERTIFICATO ISO 9001:2008

MAGNETIC PARTICLE EXAMINATION OF WELDS ACCORDING TO EN ISO STANDARD
(Yoke technique, Black wet particles)

SUMMARY

1. SCOPE
2. GENERAL
2.2. This procedure is applicable to welds and parts with any dimensions compatibly with the characteristics of the equipment and the technique of magnetization
3. REFERENCE DOCUMENTS
4. EQUIPMENT
5. MISCELLANEOUS REQUIREMENTS
6. TECHNIQUE
7. CALIBRATION
8. EXAMINATION
9. EVALUATION
10. DOCUMENTATION
11. ACCEPTANCE CRITERIA
12. REPAIR
13. PERSONNEL

Non è stata trovata alcuna voce d'indice.

2	2i	2024/10/04	Revised according with comments
2	1	2017/07/23	Verified according to EN ISO 17638:2016
2	0	2014/10/14	First Issue
Em.	**Rev.**	**Data**	**Descrizione - Description**

REVISIONI - REVISIONS

By signature and date on the front sheet of this Procedure by the relevant persons, the signature on each page of this Procedure are waived

Emessa da:

IRTEC S.R.L. ISTITUTO DI RICERCHE TECNOLOGIE E COLLAUDI

Verificata/Approvata da:
NDE Level 3 ISO 9712

dott. Ing. G. GROSSI

MAGNETIC PARTICLE EXAMINATION OF WELDS ACCORDING TO EN ISO STANDARD (Yoke technique, Black wet particles)

1. SCOPE

1.1. When specified by the referencing Code Section, the magnetic particle examination techniques described in this procedure shall be used. This procedure is in conformance with ISO 17638 Non-destructive testing of welds — Magnetic particle testing. This document provides details that have been considered in this procedure.

1.2. This procedure is applicable for magnetic particle examination of the following :

1.2.1. Ferromagnetic groove and fillet welds

1.2.2. This procedure is applicable to parts of any dimension.

2. GENERAL

2.1. The magnetic particle examination method may be applied to detect cracks and other discontinuities on or near the surfaces of ferromagnetic materials. The sensitivity is greatest for surface discontinuities and diminishes rapidly with increasing depth of subsurface discontinuities below the surface.
Typical types of discontinuities that can be detected by this method are cracks, laps, seams, cold shuts, and laminations.
In principle, this method involves magnetizing an area to be examined, and applying ferromagnetic particles (the examination's medium) to the surface. The particles will form patterns on the surface where cracks and other discontinuities cause distortions in the normal magnetic field. These patterns are usually characteristic of the type of discontinuity that is detected.
Whichever technique is used to produce the magnetic flux in the part, maximum sensitivity will be to linear discontinuities oriented perpendicular to the lines of flux. For optimum effectiveness in detecting all types of discontinuities, each area is to be examined at least twice, with the lines of flux during one examination approximately perpendicular to the lines of flux during the other.

2.2. This procedure is applicable to welds and parts with any dimensions compatibly with the characteristics of the equipment and the technique of magnetization

2.3. The test shall be conducted in the operative steps as specified by the contract.

3. REFERENCE DOCUMENTS

3.1. EN ISO 17638

3.2. EN ISO 23278

4. EQUIPMENT

AC yokes shall be used for producing the necessary magnetic flux in the weldt.

4.1. Examination Medium

4.1.1. **Particle Types**. - Black wet ferromagnetic particles in water or oil suspension shall be used. The materials listed in table 1 shall be used.

4.1.2. **Particles**. - Wet particles concentration shall be in accordance with the recommendation in table 1.

4.1.3. **Temperature Limitations**. - Particles shall be used within the following temperature range: 5 ÷ 50°C

5. MISCELLANEOUS REQUIREMENTS

5.1. Surface Conditioning

5.1.1. Satisfactory results are usually obtained when the surfaces are in the as-welded, as-rolled, as-cast, or as forged conditions. However, surface preparation by grinding or machining may be necessary where surface irregularities could mask indications due to discontinuities.

5.1.2. Prior to magnetic particle examination, the surface to be examined and all adjacent areas within at least 25 mm shall be dry and free of all dirt, grease, lint, scale, welding flux and spatter, oil, or other extraneous matter that could interfere with the examination.

5.1.3. Cleaning may be accomplished using, organic solvents, paint removers, sand or grit blasting, grinding.

5.2. Nonmagnetic Surface Contrast Enhancement

5.2.1. Non magnetic surface contrasts may be applied by the examiner to uncoated surfaces, only in amounts sufficient to enhance particle contrast. Demonstration by means of the pie-shaped field indicator of the field strength shows the adequacy of the technique used.
The field indicator shall be coated with the same amount of contrast.

MAGNETIC PARTICLE EXAMINATION OF WELDS ACCORDING TO EN ISO STANDARD
(Yoke technique, Black wet particles)

6. TECHNIQUE

6.1. The AC magnetizing technique shall be used.

6.1.1. AC yoke method shall only be applied to detect discontinuities that are open to the surface of the part.

6.1.2. Permanent magnet yoke magnetizing technique shall be used only if explicitly requested

7. CALIBRATION

7.1. Frequency of Calibration

7.1.1. **Light Meters** – Visible light meters shall be calibrated at least once a year or whenever the meter has been repaired. If meters have not been in use for one year or more, calibration shall be done before being used.

7.1.2. **Lifting Power of Yokes**

Prior to use, the magnetizing power of electromagnetic yokes shall have been checked within the past year. The magnetizing power of all yokes shall be checked whenever the yoke has been damaged or re paired.

Each alternating current electromagnetic yoke shall have a lifting power of at least 4.5 kg at the maximum pole spacing that will be used.

Each weight shall be weighed with a scale from a reputable manufacturer or measured with a calibrated calliper and the weight calculated using a density for steel of 7.8 kg/dm3 and stenciled with the applicable nominal weight prior to first use. A weight need only be verified again if damaged in a manner that could have caused potential loss of material.

7.2. Magnetic Field Adequacy and Direction

7.2.1. **Magnetic Field Adequacy** - The applied magnetic field shall have sufficient strength to produce satisfactory indications, but shall not be so strong that it causes masking of relevant indications by nonrelevant accumulations of magnetic particles.

Factors that influence the required field strength include the size, shape, and material permeability of the part; the technique of magnetization; coatings; the method of particle application; and the type and location of discontinuities to be detected.

When it is necessary to verify the adequacy of magnetic field strength, it shall be verified by using the following method.

7.2.1.1. **Pie-Shaped Magnetic Particle Field Indicator-** The indicator, shown in Fig. 1, shall be positioned on the surface to be examined, such that the copper-plated side is away from the inspected surface. A suitable field strength is indicated when a clearly defined line (or lines) of magnetic particles form(s) across the copper face of the indicator when the magnetic particles are applied simultaneously with the magnetizing force. When a clearly defined line of particles is not formed, the magnetizing technique shall be changed as needed.

8. EXAMINATION

8.1. Preliminary Examination

Before the magnetic particle examination is conducted, a check of the examination surface shall be conducted to locate any discontinuity surface openings which may not attract and hold magnetic particles because of their width.

8.2. Direction of Magnetization

At least two separate examinations shall be performed on each area. During the second examination, the lines of magnetic flux shall be approximately perpendicular to those used during the first examination.

8.3. Method of Examination

The ferromagnetic particles used in an examination medium shall be wet and visible. Examination(s) shall be done by the continuous method.

The magnetizing current shall be turned on after the particles have been applied by flowing or spraying with a pressurized can. Flow of particles shall stop with the application of current. Wet particles applied from aerosol spray cans may be applied before and/or after magnetizing current is applied. Wet particles may be applied during the application of magnetizing current if they are not applied directly to the examination area and are allowed to flow over the examination area or are applied directly to the examination area with low velocities insufficient to remove accumulated particles.

8.4. Examination Coverage

All examinations shall be conducted with sufficient field overlap to ensure 100% coverage at the required sensitivity.

See in the figure 2 the effective testing area (shaded) for magnetizing with yokes..

8.5. Interpretation

The interpretation shall identify if an indication as false, nonrelevant, or relevant. False and nonrelevant indications shall be proven as false or nonrelevant. Interpretation shall be carried out to identify the locations of indications and the character of the indication.

8.5.1. **Visible (Color Contrast) Magnetic Particles** - Surface discontinuities are indicated by accumulations of magnetic particles which should contrast with the examination surface. The color of the magnetic particles shall be sufficiently different than the color of the examination surface. A minimum light intensity of 1000 Lx is required on the surface to be examined to ensure adequate sensitivity during the examination and evaluation of indications. The calibration of the lux-meter shall be verified every 12 months.

8.5.2. Demagnetization

When residual magnetism in the part could interfere with subsequent processing or usage, the part shall be demagnetized any time after completion of the examination.

8.5.3. Post-examination Cleaning

When post-examination cleaning is required, it should be conducted as soon as practical using a process that does not adversely affect the part.

9. EVALUATION

9.1. All indications shall be evaluated in terms of the acceptance standards of EN ISO 23278

9.2. When using a contrast enhancement coating; if an indication greater than 50% of the maximum allowable flaw size is detected, the coating in the area of the indication shall be removed and the examination repeated.

9.3. Discontinuities on or near the surface are indicated by retention of the examination medium. However, localized surface irregularities due to machining marks or other surface conditions may produce false indications.

9.4. Broad areas of particle accumulation, which might mask indications from discontinuities, are prohibited, and such areas shall be cleaned and reexamined.

10. DOCUMENTATION

10.1. Recording of Indications

10.1.1. **Rejectable Indications** - Rejectable indications shall be recorded. As a minimum, the type of indications (linear or rounded), location and extent (length or diameter or aligned) shall be recorded.

10.1.2. A complete set of records for each part shall be retained by the Manufacturer until the Manufacturer's Data report has been signed By the Inspector

10.2. Examination Records

For each examination, the following information shall be recorded :

a) procedure identification and revision
b) magnetic particle equipment and type of current
c) magnetic particles (visible or fluorescent, wet or dry)
d) examination personnel identity and qualification level
e) map or record of indications per 10.1
f) material and thickness
g) lighting equipment
h) date and time examinations were performed

11. ACCEPTANCE CRITERIA

11.1. Acceptance criteria shall be in accordance with EN ISO 23278. See appendix A.

12. REPAIR

12.1. Whenever a defect is removed and subsequent welding is not required because the removed material does not reduce the wall thickness below the drawing requirements, the affected area shall be blended into the surrounding surface so as to avoid sharp notches, crevices or corners.

12.2. If the welding is required, prior to weld repair the excavated area shall be examined again by this specification. The weld repair shall be performed by applicable welding specification and shall be authorized by Quality Control Department. In any case, after repair, the surface shall be examined by the methods required by this specification for the item involved.

MAGNETIC PARTICLE EXAMINATION OF WELDS ACCORDING TO EN ISO STANDARD (Yoke technique, Black wet particles)

13. PERSONNEL

13.1. Personnel performing magnetic particle examination shall be qualified to NDT Level 2 according to ISO 9712 standard.

TABLE 1	
MATERIALS	**NDT ITALIANA**
Solvent (for cleaning)	BIO REMOVE5R
Black magnetic particles in oil suspension (spray can)	BW2 SP
Contrast lacquer	WBL5 SP

MAGNETIC PARTICLE EXAMINATION OF WELDS ACCORDING TO EN ISO STANDARD
(Yoke technique, Black wet particles)

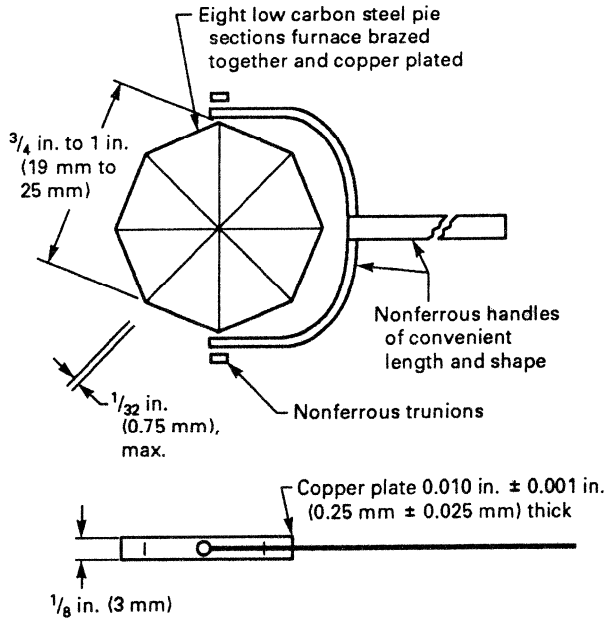


FIG. 1 - PIE-SHAPED MAGNETIC PARTICLE FIELD INDICATOR

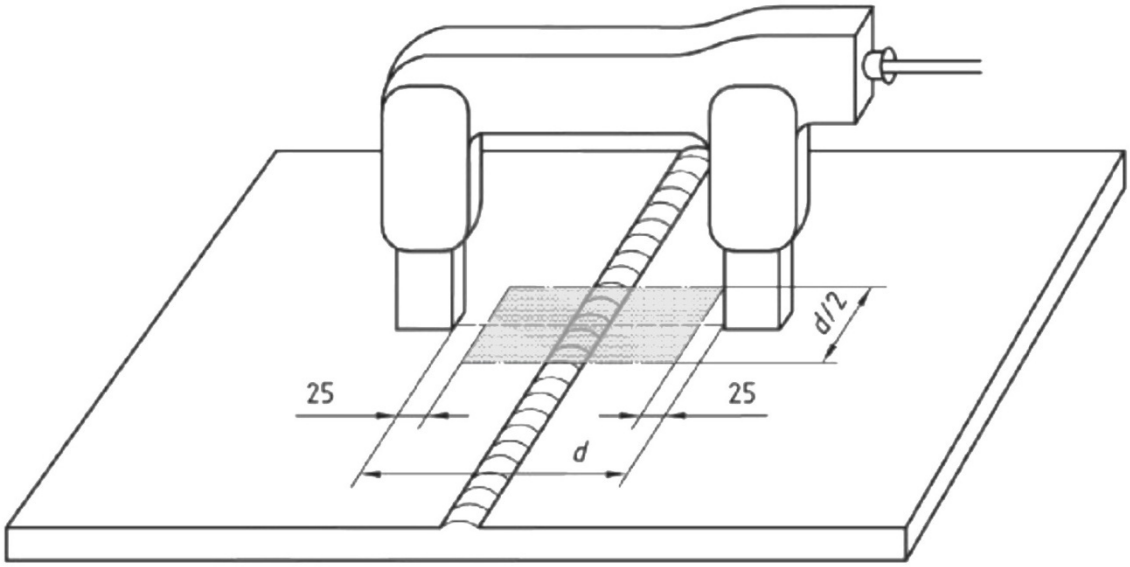


FIGURE 2

MAGNETIC PARTICLE EXAMINATION OF WELDS ACCORDING TO EN ISO STANDARD (Yoke technique, Black wet particles)

APPENDIX A

EVALUATION OF INDICATIONS REVEALED BY MAGNETIC PARTICLE EXAMINATION (ACCORDING TO EN ISO 23278

1. EVALUATION OF INDICATIONS

1.1. Indications will be revealed by retention of magnetic particles. All such indications are not necessarily imperfections, however, since excessive surface roughness, magnetic permeability variations (such at the edge of heat affected zone), etc., may produce similar indications.

1.2. An indication is the evidence of a mechanical imperfection.

1.3. A linear indication is one having a length greater than three times its width.

1.4. A rounded indication is one of circular or elliptical shape with a length equal to or less than three times its width.

1.5. Any questionable or doubtful indications shall be reexamined to determine whether or not they are relevant.

2. ACCEPTANCE STANDARDS

2.1. Acceptance criteria for welds (all materials), if not otherwise specified, shall be in accordance with Table A1. Table A2 connects the acceptance level with the quality level of the weld according withEN ISO 5817.

TABLE A1

Type of indicationj	Acceptance level (a)		
	1	2	3
Linear indication	$L \leq 1.5$	$L \leq 3$	$L \leq 6$
Non linear indication	$d \leq 2$	$d \leq 3$	$d \leq 4$

(a) Acceptance levels 2 and 3 may be specified with suffix “X” which denotes that all linear indications detected shall be evaluated to level 1.

TABLE A2

ACCEPTANCE STANDARDS FOR WELDS

Quality level according to EN ISO 5817	Acceptance levels According to EN ISO 23278
B	2X
C	2X
D	3X

ULTRASONIC TESTING OF WELDS
ISO 17640

APPENDIX A
APPENDIX B
APPENDIX C
APPENDIX D

1	0	2024/10/01	First issue
Em.	**Rev.**	**Data**	**Descrizione**

1.1 INDICE DELLE REVISIONI

Emessa da:

ISTITUTO DI RICERCHE TECNOLOGIE E COLLAUDI

Verificata/Approvata da:
NDT LEVEL 3 ISO 9712

ULTRASONIC TESTING OF WELDS
ISO 17640

1. SCOPE

1.1. This document specifies techniques for the manual ultrasonic testing of fusion-welded joints in metallic materials of thickness ≥ 8 mm which exhibit low ultrasonic attenuation.
It is intended for use on full penetration welded joints where both the welded and parent material are ferritic.

1.2. This document specifies two testing levels, each corresponding to a different probability of detection of imperfections. Guidance on the selection of testing levels A, B is given in the following table.

Quality Level of the Weld UNI EN ISO 5817	Testing Level UNI EN ISO 17640	Acceptance Level UNI EN ISO 11666
C	A	3
B	B	2

1.3. This document can be used for the assessment of discontinuities, for acceptance purposes, the following technique:

- Evaluation based on length and echo amplitude of the discontinuity;

2. NORMATIVE REFERENCES

ISO 9712, Non-destructive testing — Qualification and certification of NDT personnel
ISO 11666, Non-destructive testing of welds — Ultrasonic testing— Acceptance levels
ISO 16811, Non-destructive testing — Ultrasonic testing — Sensitivity and range setting
IS0 17635, Non-destructive testing of welds — General rules for metallic materials
EN 12668 (all parts), Non-destructive testing — Characterization and verification of ultrasonic examination equipment

3. Terms and definitions

3.1. For the purposes of this document, the terms and definitions given in ISO 5577 and ISO 17635 apply.

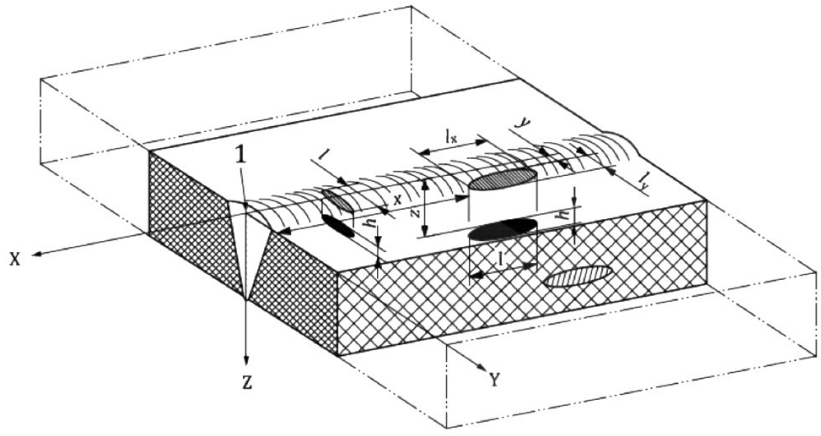
4. Symbols

4.1. The symbols in Table 1 apply.

Table 1 — Symbols

Symbol	Definition	Unit
AL	acceptance level	—
D_{DSR}	diameter of the disk-shaped reflector (flat-bottomed hole)	mm
h	extension of the discontinuity in depth direction	mm
l	length of the discontinuity	mm
l_x	projected length of the discontinuity in the x-direction	mm
l_y	projected length of the discontinuity in the y-direction	mm
p	full skip distance	mm
t	thickness of parent material[a]	mm
x	position of the discontinuity in the longitudinal direction	mm
y	position of the discontinuity in the transverse direction	mm
z	position of the discontinuity in the depth direction	mm
[a] If the joined parts are not of equal thickness, t represents the smallest thickness.		

4.2. Indications shall be considered to be originating from either longitudinal or transverse discontinuities, depending on the direction of their major dimension with respect to the weld axis x, in accordance with figure 1.



Key
1 origin

Figure 1 — Coordinate system for defining the location of discontinuities

5. General

5.1. The purpose of this document is to describe general techniques of ultrasonic weld testing, using standard criteria, for the most commonly used welded joints.
The specific requirements of this document cover the test equipment, preparation, performance of testing, and reporting. The parameters specified, in particular those for the probes, are compatible with the requirements of 1SO 11666 and 1SO 23279.

5.2. If the joined parts are not of equal thickness, the smallest thickness shall be considered.

6. Information required prior to testing

6.1. Items to be specified:
- a) method for setting the reference level;
- b) method to be used for the evaluation of discontinuities;
- c) acceptance levels;
- d) testing level;
- e) manufacturing and operation stage(s) at which the testing is to be carried out;
- f) qualification of personnel;
- g) type(s) of parent material and product form (i.e. cast, forged, rolled);
- h) manufacturing or operation stage at which testing is to be made, including heat treatment, if any;
- i) time and extent of any post-weld heat treatment;
- j) joint preparation and dimensions;
- k) requirements for surface conditions;
- l) welding procedure or relevant information on the welding process;
- m) extent of testing;

7. Requirements for personnel and equipment

7.1. Personnel qualifications

7.1.1. Personnel performing testing in accordance with this document shall be qualified to an appropriate level in ultrasonic testing in accordance with ISO 9712 or equivalent in the relevant industrial sector.

7.2. Test equipment

7.2.1. Any equipment used for testing in conjunction with this document shall comply with the requirements of EN 12668.

7.3. Probe parameters

7.3.1. Test frequency

7.3.1.1. The frequency shall be within the range 2 MHz to 5 MHz.

7.3.2. Angles of incidence

7.3.2.1. When testing is carried out with transverse waves and techniques that require the ultrasonic beam to be reflected from an opposite surface, care shall be taken to ensure that the angle between the beam and the normal to the opposite reflecting surface is between 35° and 70°.

7.3.2.2. Where more than one beam angle is used, at least one of the angle-beam probes used shall conform to this requirement. incidence.

7.3.2.3. When the use of two or more beam angles is specified, the difference between the nominal beam angles shall be 10° or greater.

7.3.3. Transducer size

7.3.3.1. The transducer size shall be chosen according to the ultrasonic path to be used and the frequency. The smaller the transducer, the smaller the length and width of the near field, and the larger the beam spread in the far field at a given frequency.
Small probes having 8x9 mm crystal dimensions are therefore most useful when working at short sound paths.
For longer sound paths, i.e. greater than 100 mm 14x14 mm crystal dimensions may be used and 20x 22 mm crystal dimensions are more suitable for greater than 200 mm sound paths.

7.3.4. Adaptation of probes to curved scanning surfaces

7.3.4.1. The gap, g, between test surface and bottom of the probe shall not be greater than 0,5 mm. If a value for g larger than 0,5 mm results, the probe shall be adapted to the surface and the sensitivity shall be set accordingly.

7.3.5. Coupling media

7.3.5.1. As coupling medium shall be used the NDT FYP gel. The coupling medium used for range and sensitivity setting and for the test shall be the same.

8. Testing volume

8.1. The testing volume is defined as the zone which includes weld and the width of the heat-affected zone on each side of the weld or at least 10 mm if the width of the heat-affected zone is not known.
In all cases, scanning shall cover the whole testing volume. If individual sections of this volume cannot be covered in at least one scanning direction, or if the angles of incidence with the opposite surface do not meet the requirements of 7.3.2, alternative or supplementary ultrasonic techniques shall be agreed upon. This may, in some cases, require removal of the weld reinforcement.

9. Preparation of scanning surfaces

9.1. Scanning surfaces shall be wide enough to permit the testing volume (see Figure 2) to be fully covered. Alternatively, the width of the scanning surfaces may be smaller if equivalent coverage of the testing volume can be achieved by scanning from both the upper and the lower surface of the joint.

9.2. Scanning surfaces shall be even and free from foreign matter likely to interfere with probe coupling (e.g. rust, loose scale, weld spatter, notches, grooves). Waviness of the test surface shall not result in a gap between the probe and test surfaces greater than 0,5 mm. These requirements shall be ensured by dressing, if necessary.

10. Parent metal testing

10.1. The parent metal, in the scanning zone area (see Figure 2), shall be tested with straight-beam probes prior to or after welding.
Where imperfections are found, their influence on the proposed angle-beam testing shall be assessed and, if necessary, the techniques adjusted correspondingly

11. Range and sensitivity setting

11.1. General

11.1.1. Setting of range and sensitivity shall be carried out prior to each testing in accordance with this document. The temperature difference during range and sensitivity setting and during the test shall be within +15 °C.

11.1.2. Checks to confirm these settings shall be performed at least every 4 h and upon completion of the testing.

11.1.3. Checks shall also be carried out whenever a system parameter is changed or changes in the equivalent settings are suspected.

11.2. Reference for sensitivity setting

11.2.1. One of the following techniques for setting the reference shall be used.

11.2.1.1. Technique 1: the reference is a distance-amplitude curve (DAC) for side-drilled holes of diameter
3 mm
11.2.1.2. Technique 3: the reference notch shall be rectangular, 1 mm wide with a depth of 1 mm. This technique applies only for the thickness range 8 mm < t < 15 mm and only for beam angles ≥ 70°.
11.2.1.3. See in appendix D the block to be used for various weld thicknesses. See also the minimum calculated depth of the side drilled hole for various transducers and path lengths.
11.2.2. The length of the side-drilled holes and notches shall be at least 38 mm.

11.3. Evaluation levels

11.3.1. All indications equal to or exceeding the levels in Appendix C of this document (1SO 11666:2018).shall be evaluated.

11.4. Transfer correction

11.4.1. When separate blocks are used for establishing reference levels, a measurement shall be made of the transfer differences, between test object and reference block, at a representative number of locations.
11.4.2. Suitable techniques are described in Appendix B of this document (ISO 16811).
11.4.3. If the differences are less than or equal to 2 dB, correction is not required.
If the differences are greater than 2 dB but smaller than or equal to 12 dB, they shall be compensated for.
If transfer losses exceed 12 dB, the reason shall be considered and further preparation of the scanning surfaces shall be carried out.

11.5. Signal-to-noise ratio

11.5.1. During testing of the weld, the noise level, excluding spurious surface indications, shall remain at least 12 dB below the evaluation level. This requirement may be relaxed subject to specification.

12. Testing levels

12.1. This document specifies two testing levels (A, B) related to quality levels of welds.

Testing Level	Quality Level UNI EN ISO 5817
A	C
B	B

13. Testing techniques

13.1. General

13.1.1. Ultrasonic testing of welds shall be performed by contact manual pulse-echo scanning to find longitudinal indications.
Transversal indications will also be sought if required.
See in appendix A the scanning positions.

13.2. Manual scanning

13.2.1. During angle-beam scanning, a slight swivelling movement up to an angle of approximately 10° on either side of the nominal beam direction shall be applied to the probe.

13.3. The tandem technique will only be used if expressly requested.

13.4. **Location of discontinuities**

13.4.1. The location of discontinuities shall be defined by reference to a coordinate system, e.g. as shown in Figure 1. A point on the testing surface shall be selected as the origin for these measurements.

13.5. Evaluation of indications

13.5.1. **General**
13.5.1.1. All relevant indications above the evaluation level shall be assessed in accordance with 13.5.2 to 13.5.4.

13.5.2. **Maximum echo amplitude.**
13.5.2.1. The echo amplitude shall be maximized by probe movement and recorded in relation to the reference level.

13.5.3. **Discontinuity length**
13.5.3.1. The length of a discontinuity, shall, be determined by the drop of the echo to the evaluation level. See the Appendix B of this document

13.5.4. **Discontinuity height**

13.5.4.1. The height of a discontinuity shall be determined only if required.

13.5.5. **Characterization of discontinuities**

13.5.5.1. Discontinuities are characterized by the height of the echo and their length (13.5.3.1).

14. ACCEPTANCE STANDARD

14.1. See in appendix C the acceptance standard for isolated indications.

15. Test report

15.1. The test report shall include at least the following information:

a) an identification of the object under test:
b) the material and product form;
c) the dimensions;
d) the location of tested weld/welded joint, sketch showing geometrical configuration (if necessary);
e) a reference to the welding procedure, specification and heat treatment;
f) the state of manufacture;
g) the surface conditions;
h) contract requirements, e.g. specifications, guidelines, special agreements;
i) the place and date of testing;
j) an identification of test organizations and identification and certification of operator;
k) the maker and type of the ultrasonic instrument with identification number;
l) the maker, type, nominal frequency, size of transducer and actual angle of incidence of probes used
m) an identification of reference blocks used with a sketch, if necessary;
n) the coupling medium;
o) the testing level(s) and reference to this procedure
p) the extent of testing;
q) the location of the scanning areas;
r) the reference points and details of the coordinate system used as specified in 13.4
s) an identification of probe positions, by use of a sketch;
t) the range setting;
u) the method and values used for sensitivity setting (gain setting for reference levels and values used for transfer corrections);
v) the reference levels;
w) the result of the parent material test;
x) the standards for acceptance levels;
y) the deviations from this document or contract requirements;
z) the coordinates of the discontinuities, as specified in 13.4, with details of associated probes and corresponding probe positions;
aa) the maximum echo amplitudes as specified in 13.5.2
bb) the lengths of discontinuities as specified in 13.5.3;
cc) the results of evaluation according to specified acceptance levels;

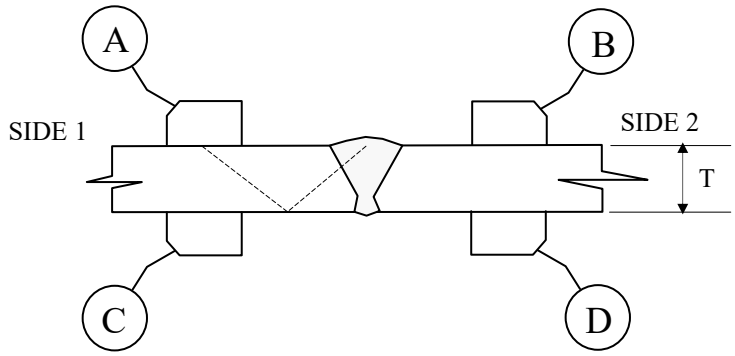
ULTRASONIC TESTING OF WELDS
ISO 17640

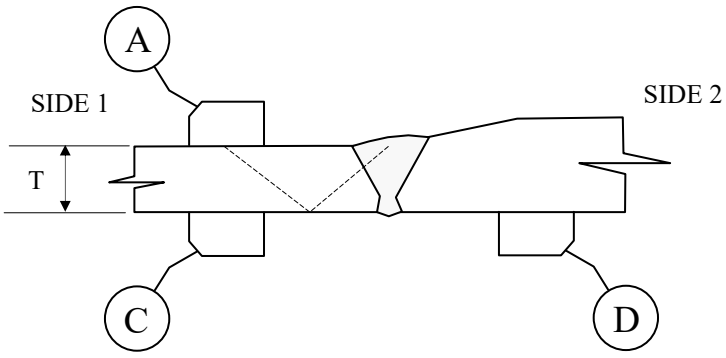
APPENDIX A

BUTT WELDS OF PLATES AND TUBES

Testing Level	THICKNESS (mm)	ANGLES OF BEAM	SCANNING POSITIONS	BEAM TYPE	No. OF SCANS	NOTE
A	8 ≤ T< 15	1	A or B	reflected	2	/
	15 ≤ T< 40	1	A or B	reflected	2	/
B	8 ≤ T< 15	70°	A e B oppure C e D	reflected	2	2
	15 ≤ T< 40	60 e 70°	A e B oppure C e D	reflected	4	1, 2
	40 ≤ T< 60	45 e 60°	A e B oppure C e D	reflected	4	/
	60 ≤ T< 100	45 e 60°	A e B oppure C e D	reflected	4	/
	100 ≤ T< 300	45 e 60°	A e B e C e D	direct	8	3

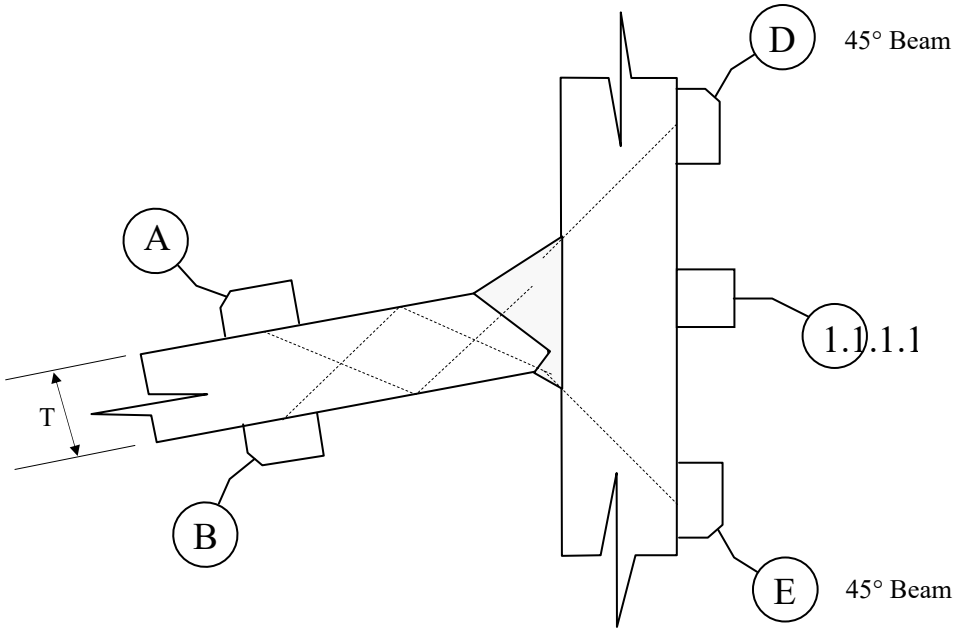
NOTE 1) In the thickness range 15 < T ≤ 25 mm if the probe frequency is < 3 MHz one beam angle is sufficient
2) If the weld is only accessible from one side 1 or 2, two beam angles shall be used
3) The 60° beam will be used to reach the root of the weld





WELD OF SET-IN NOZZLES

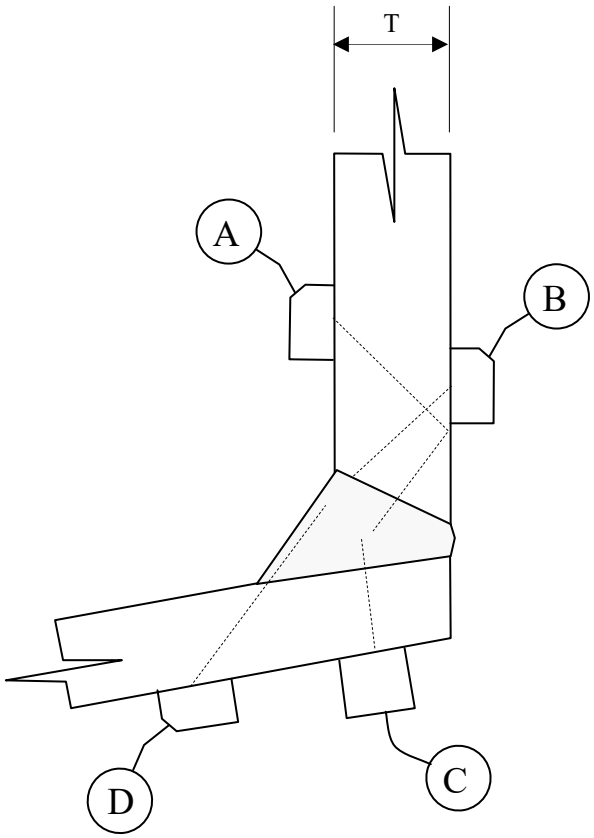
Testing Level	THICKNESS (mm)	Angles of beam	SCANNING POSITIONS	BEAM TYPE	No. OF SCANS
A	8 ≤ T< 15	1 (70° for A – 45° for D)	A or D or C	reflectedfor A direct for D and C	1
	15 ≤ T< 40	1 (60° for A – 45° for D)	A+C or A+D	reflectedfor A direct for D and C	2
B	8 ≤ T< 15	1 (70° for A – 45° for D)	A o D + C	reflectedfor A	2
	15 ≤ T< 40	1 (60° for A – 45° for D e E)	A o (D+E) + C	Reflected for A	2 o 3
	40 ≤ T< 60	1 (60° for A – 45° for D e E)	(A o B)+(D+E)+C	Reflected for A and B	4
	60 ≤ T≤ 300	2 for A and B (45° and 60°) 1 for D and E (45°)	A+B+D+E+C	direct	7



NOTA If the nozzle has a reinforcing plate, the test will be carried out before welding the reinforcing plate.

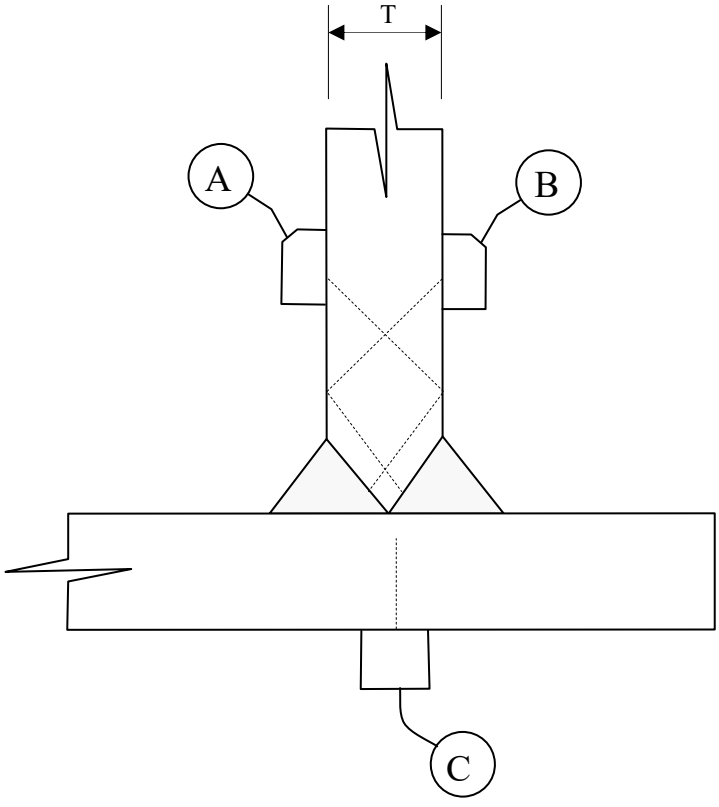
WELD OF SET-ON NOZZLES

Testing Level	THICKNESS (mm)	BEAM ANGLES	SCANNING POSITIONS		BEAM TYPE	No. of SCANS
A	8 ≤ T< 15	70°	A or B		Reflected for A, direct for B	1
	15 ≤ T< 40	60°	A or B	C	Reflected for A, direct for B	2
B	8 ≤ T< 15	2 (60° e 70°) per A o B	A o B	/	Reflected for A, direct for B	2
	15 ≤ T< 40	2 (60° e 70°) per A o B	A o B	C	Reflected for A, direct for B	3
	40 ≤ T< 60	2 (45° e 60°) per A e B	A e (B o D)	C	Reflected for A, direct for B and D	5
	60 ≤ T< 100	2 per A e B (45° e 60°), 1 per D (45°)	A e (B o D)	C	Reflected for A, direct for B and D	5
	100 ≤ 300	2 per A e B (45° e 60°), 1 per D (45°)	A e (B o D)	C	Direct for A, B, e D	4 o 5



TEE WELDS

Testing level	THICKNESS (mm)	BEAM ANGLES	POSIZIONI DI SCANSIONE		FASCIO UTILIZZATO	No. DI SCANSIONI
A	8 ≤ T< 15	70°	A or B		Reflected for A e B	1
	15 ≤ T< 40	60°			Reflected for A e B	2
B	8 ≤ T< 15	1 (70°) for A or B	A or B	C	Reflected for A e B, direct for C	2
	15 ≤ T< 40	1 (70°) for A and B	A and B	C	Reflected for A e B, direct for C	3
	40 ≤ T< 300	2 (45° e 60°) for A and B	A and B	C	Direct for A and B and C	5



APPENDIX B

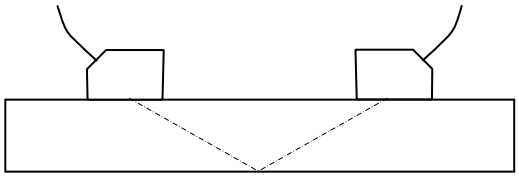
EVALUATION OF THE TRANSFER LOSS

Straight beam
Place the probe on block V1 and bring the background echo to 80% of the screen. Note the amplification (Vt,t).
Rest the probe on the work piece base material and bring the background echo to 80% of the screen. Note down the amplification (Vt,r).
Note on the DGS diagram of the probe used, on the curve of the large reflector (∞), the theoretical difference in amplification for the paths in the calibration block and the test piece (ΔVS).
Calculate ΔVt = Vt,r - Vtr - ΔVS.
This is the correction to be applied to the amplification to account for transfer losses.
This correction will only be applied if positive and > 2 dB

Angle beam
Calibration block V1 is used.
Use 2 (identical) probes of the type to be used for control; one will be used as a transmitter and the other as a receiver.

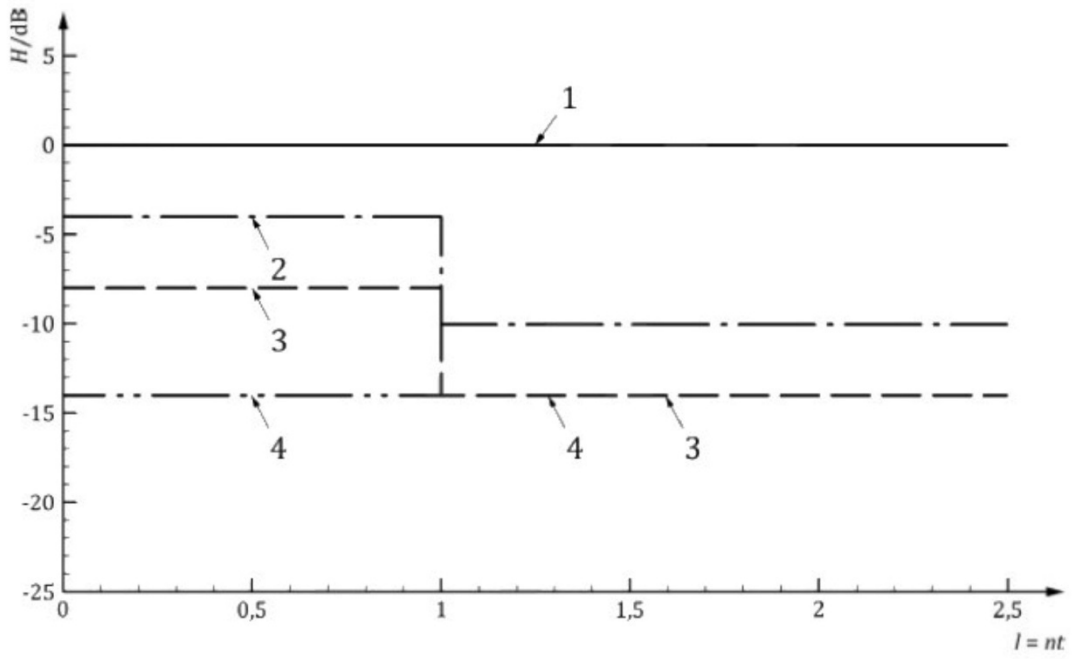
Place the two probes on the same face of the V1 block (see sketch at the bottom of the page) and bring the signal to 80% of the screen.
Note the amplification of the instrument (Vt,t).
Note down the ultrasonic path in the calibration block (ST)
Note on the DGS diagram of the probe used, on the curve of the large reflector (∞), the theoretical difference in amplification for the paths in the calibration block and in the work piece (ΔVS).
Place the two probes in the same way on the work piece base material.
Record the amplification of the instrument (Vt,r).
Note down the ultrasonic path in the work piece to be checked (SR)

Calculate ΔVt = Vt,t - Vt,r - ΔVS.
This is the correction to be applied to the amplification to account for transfer losses.
This correction will only be applied if positive and > 2 dB



Determination of transfer loss for control by angle probe

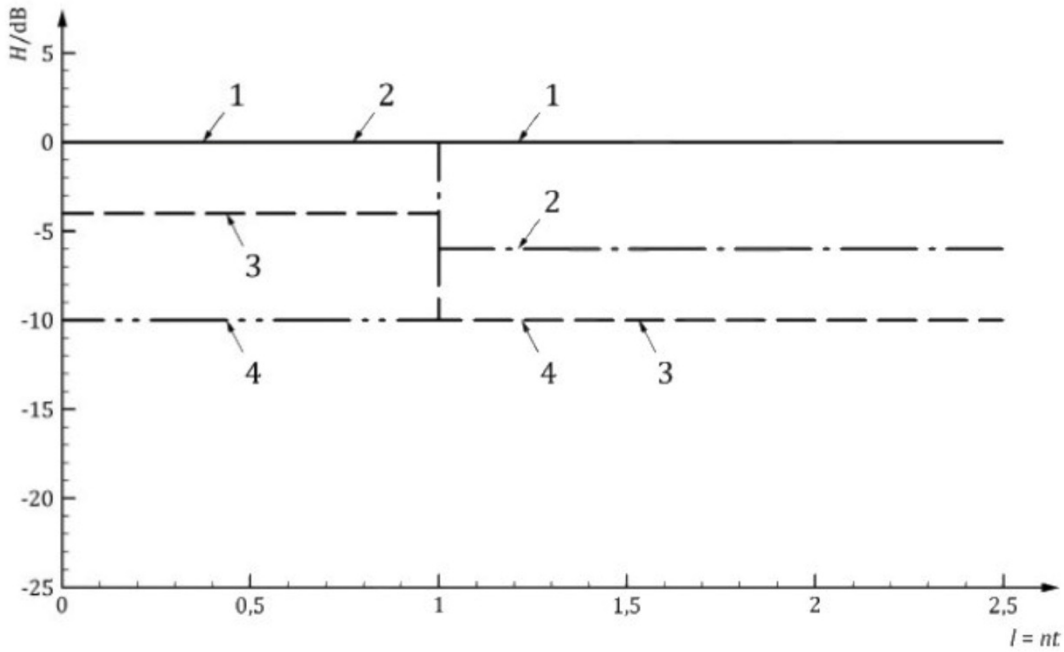
APPENDIX C



Key

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

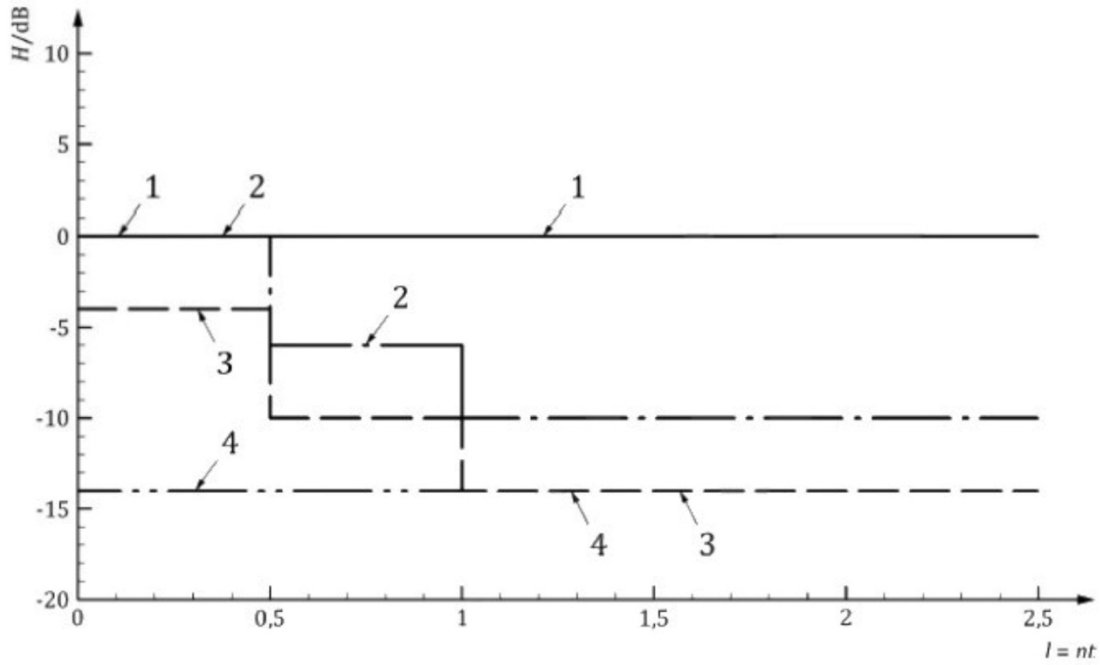
Figure A.1 — Levels for techniques 1 and 3 for thicknesses 8 mm to 15 mm — Acceptance level 2



Key

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

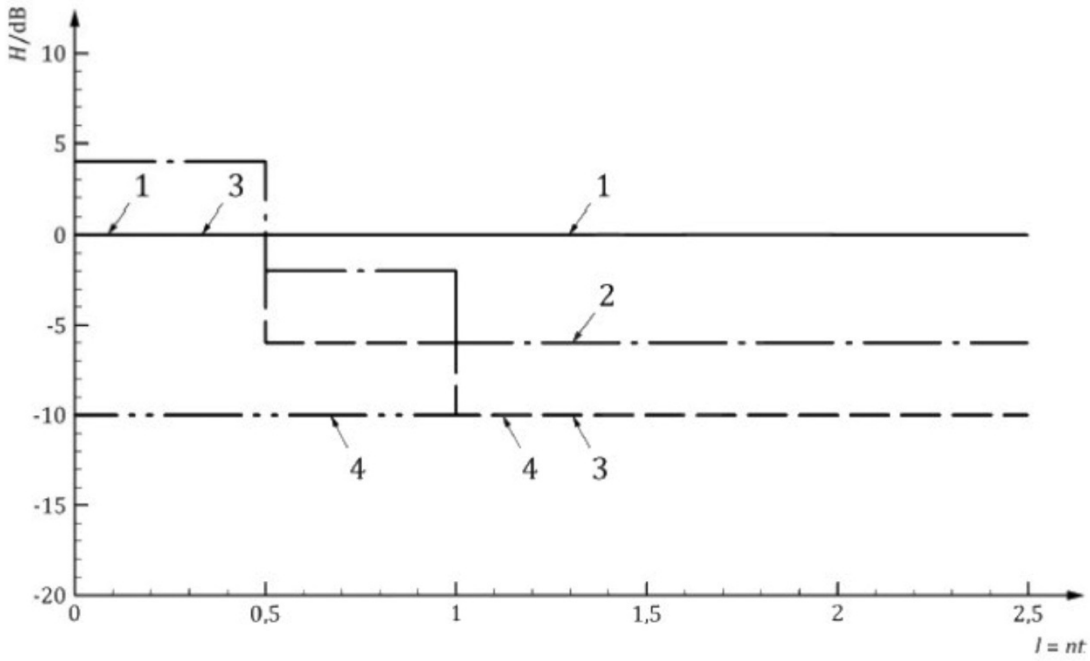
Figure A.2 — Levels for techniques 1 and 3 for thicknesses 8 mm to 15 mm — Acceptance level 3



Key

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

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



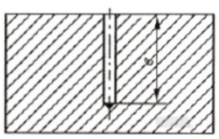
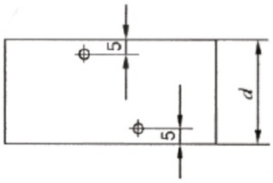
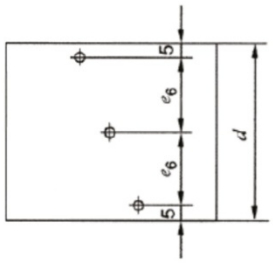
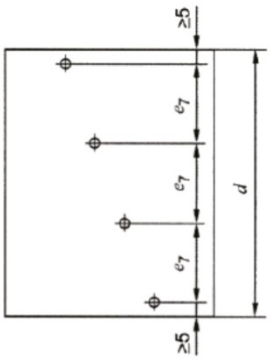
Key

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

Figure A.4 — Levels for technique 1 for thicknesses 15 mm to 100 mm — Acceptance level 3

ULTRASONIC TESTING OF WELDS
ISO 17640

APPENDIX D

Spessore della parete, *d*, in mm	Blocchi di riferimento e riflettori di riferimento	Condizioni
		
$10 \le d \le 15$		
$15 < d \le 20$		$e > \frac{2\lambda s}{D_{eff}}$
$20 < d \le 40$		$D_{SDH} \ge 1{,}5\ \lambda$ $e_6 = \frac{d-10}{2}$
$d > 40$		$e_7 \le \frac{d-10}{2}$

Probe	Frequency	Path length	e ≥	
8x9	4 MHz	100	32 mm	
14x14	2 MHz	150	31 mm	
20x22	2 Mhz	200	27 mm	

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CERTIFICATO DI LIVELLO 3
LEVEL 3 CERTIFICATE

N° 34832/PND/C

Si certifica la qualificazione per esami in Prove Non Distruttive al **LIVELLO 3**

*This is to certify qualification by examinations in Non-Destructive Testing at the **LEVEL 3***

di / of

Grossi Giuseppe

nato a / *born in* **Domodossola (VB)**

il / *on* **10 novembre 1941**

per i metodi seguenti / *for the following methods:*

RT (Radiografia) - UT (Ultrasuoni) - MT (Magnetoscopia) - PT (Liquidi Penetranti)

Il presente certificato viene rilasciato in conformità alla Norma UNI EN ISO 9712.
This certificate is issued according to UNI EN ISO 9712.

Il Presidente del Comitato Tecnico
The President of Technical Committee
P. I. E. Tuberosa

L'Amministratore Unico
The Administrator
Dr. Ing. M. Crepaldi

Data Delibera: 23/12/2020
Approval Date

Data Scadenza: 23/12/2025 C
Expiry Date

AIPnD



PRS N°0076

PROVE NON DISTRUTTIVE: Certificato di Qualifica Operatore

NON-DESTRUCTIVE TESTING: Operator Qualification Certificate

N° IND-24-02015-C

Si certifica la qualifica in Prove Non Distruttive al Livello 3

It certifies the qualification for Non-Destructive Testing at the level 3

Titolare del certificato / *Certificate holder*

Vincenzo Santarcangelo (ID # 4044)

Nato a / *born in*: Matera (MT) Italy

Il / *on*: 25 Apr 1960

Per il metodo-tecnica / F*or the method-tecnique:*

Radiographic Testing / Film interpretation (RT/F-I)

APPROVAZIONE PER ESECUZIONE DI PROVE NON DISTRUTTIVE secondo l'Allegato I paragrafo 3.1.3 della direttiva attrezzature a pressione 2014/68/UE PED (CEN/TR 15589 Route A)

APPROVAL FOR EXECUTION OF NON-DESTRUCTIVE TESTING as per Annex I paragraph 3.1.3 of pressure equipment directive 2014/68/UE PED (CEN/TR 15589 Route A)

Per i settori / F*or the sectors*:

Pre- and in-service testing which includes manufacturing (s)

(composed by product sector c-f-w-t-wp-m)

Il presente certificato viene rilasciato in conformità alla Norma UNI EN ISO 9712:2022 e Regolamento Bureau Veritas IT-IND-REG-01_NDT.IND

This certificate is issued according to UNI EN ISO 9712:2022 and Bureau Veritas Rule IT-IND-REG-01_NDT.IND

Emesso / *Issued:* 5 Jun 2024

Valido dal / *Validity start date*: 6 Jun 2024

Data ultima revisione / *Date last revision:* ----------

Scadenza / *Expiry date*: 5 Jun 2029

Responsabile Tecnico di Schema

NDT Scheme Chief

Luca Rossi

to check the certificate: https://bvchecker.revo.network

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NON-DESTRUCTIVE TESTING: Operator Qualification Certificate

N° IND-24-02014-C

Si certifica la qualifica in Prove Non Distruttive al Livello 3

It certifies the qualification for Non-Destructive Testing at the level 3

Titolare del certificato / *Certificate holder*

Vincenzo Santarcangelo (ID # 4044)

Nato a / *born in*: Matera (MT) Italy

Il / *on*: 25 Apr 1960

Per il metodo-tecnica / F*or the method-tecnique:*

Penetrant Testing (PT)

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APPROVAL FOR EXECUTION OF NON-DESTRUCTIVE TESTING as per Annex I paragraph 3.1.3 of pressure equipment directive 2014/68/UE PED (CEN/TR 15589 Route A)

Per i settori / F*or the sectors*:

Pre- and in-service testing which includes manufacturing (s)

(composed by product sector c-f-w-t-wp-m)

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Emesso / *Issued:* 5 Jun 2024

Valido dal / *Validity start date*: 6 Jun 2024

Data ultima revisione / *Date last revision:* ----------

Scadenza / *Expiry date*: 5 Jun 2029

Responsabile Tecnico di Schema

NDT Scheme Chief

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NON-DESTRUCTIVE TESTING: Operator Qualification Certificate

N° IND-21-02198-C

Si certifica la qualifica in Prove Non Distruttive al Livello 2
It certifies the qualification for Non Destructive Testing at the level 2

Titolare del certificato / *Certificate holder*
Lorefice Nicolò (ID # 7066)

Nato a / *born in*: Gela (CL) Il / *on*: 11 Nov 1993

Per il metodo / *for the method:*
Penetrant Testing (PT)

APPROVAZIONE PER ESECUZIONE DI PROVE NON DISTRUTTIVE secondo l'Allegato I paragrafo 3.1.3 della direttiva attrezzature a pressione 2014/68/UE PED (CEN/TR 15589 Route A)
APPROVAL FOR EXECUTION OF NON-DESTRUCTIVE TESTING as per Annex I paragraph 3.1.3 of pressure equipment directive 2014/68/UE PED (CEN/TR 15589 Route A)

Per i settori / *for the sectors*:
Pre- and in-service testing which includes manufacturing

Il presente certificato viene rilasciato in conformità alla Norma UNI EN ISO 9712:2012 e Regolamento Bureau Veritas IT-IND-REG-01_NDT.IND
This certificate is issued according to UNI EN ISO 9712:2012 and Bureau Veritas Rule IT-IND-REG-01_NDT.IND

Data ultima revisione / *Date last revision*: ----------

Emesso / *issued*: 28 Jul 2021 Scadenza / *Expiry date*: 27 Jul 2026

Autorizzazione del datore di lavoro
Employer authorizing

Responsabile Tecnico di Schema
NDT Scheme Chief
Luca Rossi

Firma titolare del certificato
Signature of certificate holder

NDT OPERATOR QUALIFICATION CERTIFICATE

No. **20VE00144PN1**

Operator	**CAVALLO ANDREA**		
Born in	**GROTTAGLIE (TA)**	on	**02/04/1995**
Employed by	**CAVALLO ANDREA**		
Located in	**Fragagnano (TA)**		

THIS IS TO CERTIFY that the non destructive test operator is qualified by examinations at the LEVEL 2 according to UNI EN ISO 9712:2012 standard and to RINA Rule RC/C 14

in the method:

MAGNETIC PARTICLE

for the sectors:

Pre-service and in service testing of equipment, plants and structures

This certificate is valid from	**14 February 2020**	to	**13 February 2025**
Issued at	**GENOVA**	on	**14 February 2020**

Filippo Lago
(Italy Welding & Pressure Equipment Certification Head)

Operator

RINA Services S.p.A.
Via Corsica 12 - 16128 Genova

This certificate consist of 1 page

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO

PRS N° 066 C

Membro degli Accordi di Mutuo Riconoscimento EA, IAF e ILAC
Signatory of EA, IAF and ILAC Mutual Recognition Agreements

BUREAU VERITAS

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO
PRS N° 076C
Membro degli Accordi di Mutuo Riconoscimento EA, IAF e ILAC
Signatory of EA, IAF and ILAC mutual Recognition Agreements

PROVE NON DISTRUTTIVE: Certificato di Qualifica Operatore
NON-DESTRUCTIVE TESTING: Operator Qualification Certificate

N° IND-20-01877-C

Si certifica la qualifica in Prove Non Distruttive al Livello 2
It certifies the qualification for Non Destructive Testing at the level 2

Titolare del certificato / *Certificate holder*
Cavallo Andrea (ID # 6449)

Nato a / *born in*: Grottaglie (TA) Il / *on*: 2 Apr 1995

Per il metodo / *for the method:*
Penetrant Testing (PT)

APPROVAZIONE PER ESECUZIONE DI PROVE NON DISTRUTTIVE secondo l'Allegato I paragrafo 3.1.3 della direttiva attrezzature a pressione 2014/68/UE PED (CEN/TR 15589 Route A)
APPROVAL FOR EXECUTION OF NON-DESTRUCTIVE TESTING as per Annex I paragraph 3.1.3 of pressure equipment directive 2014/68/UE PED (CEN/TR 15589 Route A)

Per i settori / *for the sectors*:
Pre- and in-service testing which includes manufacturing

Il presente certificato viene rilasciato in conformità alla Norma UNI EN ISO 9712:2012 e Regolamento Bureau Veritas IT-IND-REG-01_NDT.IND
This certificate is issued according to UNI EN ISO 9712:2012 and Bureau Veritas Rule IT-IND-REG-01_NDT.IND

Data ultima revisione / *Date last revision*: ----------

Emesso / *issued*: 21 Sep 2020 Scadenza / *Expiry date*: 20 Sep 2025

Autorizzazione del datore di lavoro
Employer authorizing

CONTROL S.R.L.

Firma titolare del certificato
Signature of certificate holder

Responsabile Tecnico di Schema
NDT Scheme Chief
Luca Rossi

BUREAU VERITAS

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO
PRS N° 076C
Membro degli Accordi di Mutuo Riconoscimento EA, IAF e ILAC
Signatory of EA, IAF and ILAC mutual Recognition Agreements

PROVE NON DISTRUTTIVE: Certificato di Qualifica Operatore
NON-DESTRUCTIVE TESTING: Operator Qualification Certificate

N° IND-22-00184-C

Si certifica la qualifica in Prove Non Distruttive al Livello 2
It certifies the qualification for Non Destructive Testing at the level 2

Titolare del certificato / *Certificate holder*
Cavallo Andrea (ID # 6449)

Nato a / *born in*: Grottaglie (TA) Il / *on*: 2 Apr 1995

Per il metodo / *for the method:*
Radiographic Testing / Radiographic Interpretation (RT/RI)

APPROVAZIONE PER ESECUZIONE DI PROVE NON DISTRUTTIVE secondo l'Allegato I paragrafo 3.1.3 della direttiva attrezzature a pressione 2014/68/UE PED (CEN/TR 15589 Route A)
APPROVAL FOR EXECUTION OF NON-DESTRUCTIVE TESTING as per Annex I paragraph 3.1.3 of pressure equipment directive 2014/68/UE PED (CEN/TR 15589 Route A)

Per i settori / *for the sectors*:
Pre- and in-service testing which includes manufacturing

Il presente certificato viene rilasciato in conformità alla Norma UNI EN ISO 9712:2012 e Regolamento Bureau Veritas IT-IND-REG-01_NDT.IND
This certificate is issued according to UNI EN ISO 9712:2012 and Bureau Veritas Rule IT-IND-REG-01_NDT.IND

Data ultima revisione / *Date last revision*: ----------

Emesso / *issued*: 2 Feb 2022 Scadenza / *Expiry date*: 1 Feb 2027

Autorizzazione del datore di lavoro
Employer authorizing

CONTROL S.N.C.
di Mercatali L. & F.
Via Attilio Mo[illegible] - 48100 RAVENNA
Partita I.V.A. 01 203 960 396
Codice Fiscale 00 174 550 400

Responsabile Tecnico di Schema
NDT Scheme Chief
Luca Rossi

Firma titolare del certificato
Signature of certificate holder



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ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO
PRS N° 076C
Membro degli Accordi di Mutuo Riconoscimento EA, IAF e ILAC
Signatory of EA, IAF and ILAC mutual Recognition Agreements

PROVE NON DISTRUTTIVE: Certificato di Qualifica Operatore
NON-DESTRUCTIVE TESTING: Operator Qualification Certificate

N° IND-23-02424-C

Si certifica la qualifica in Prove Non Distruttive al Livello 2
It certifies the qualification for Non-Destructive Testing at the level 2

Titolare del certificato / *Certificate holder*
Nicolò Lorefice (ID # 7066)

Nato a / *born in*: Gela (CL) Italy

Il / *on*: 11 Nov 1993

Per il metodo / *For the method*
Magnetic Testing (MT)

APPROVAZIONE PER ESECUZIONE DI PROVE NON DISTRUTTIVE secondo l'Allegato I paragrafo 3.1.3 della direttiva attrezzature a pressione 2014/68/UE PED (CEN/TR 15589 Route A)
APPROVAL FOR EXECUTION OF NON-DESTRUCTIVE TESTING as per Annex I paragraph 3.1.3 of pressure equipment directive 2014/68/UE PED (CEN/TR 15589 Route A)

Per i settori / *For the sectors*
Pre- and in-service testing which includes manufacturing

Il presente certificato viene rilasciato in conformità alla Norma UNI EN ISO 9712:2012 e Regolamento Bureau Veritas IT-IND-REG-01_NDT.IND
This certificate is issued according to UNI EN ISO 9712:2012 and Bureau Veritas Rule IT-IND-REG-01_NDT.IND

Data ultima revisione / *Date last revision*: ----------

Emesso / *Issued*: 23 Jul 2023

Valido dal / *Valid from*: 23 Jul 2023

Scadenza / *Expiry date*: 22 Jul 2028

Firma titolare del certificato
Signature of certificate holder

Responsabile Tecnico di Schema
NDT Scheme Chief
Luca Rossi

to check the certificate: https://bvchecker.revo.network

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