STYRENE PARK OFFSITE

Document Title:

NDT Procedure (RT, UT, PT, MT)

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RADIOGRAPHY EXAMINATION PROCEDURE

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1) SCOPE

This article contains methods and requirements for Radiographic Examination of Heat Exchanger applicable when specified by NDT/Welding map.

2) REFERENCE

- ASME Sec. V, Article 2 & Article 22 (2019 Edition)
- ASME Sec. VIII Div.1 & Div.2 (2019 Edition)
- ASME Sec. IX (2019 Edition)

3) EXTENT OF PROCEDURE

- Examination of all Butt-weld Joints According to regarding Welding Map & ITP.
- Evaluation by contractor or Third Party Inspector shall be done according to the relevant Project Specification requirements / Approved ITP.

4) SURFACE PREPARATION

All welded joint shall be visually inspected before commencement of any non-destructive examination also the requirement of ASME Sec. V, Para. T.222 for surface preparation shall be met. Any irregularities that can mask or be confused with discontinuities shall be removed by any suitable process to a degree that the applicable material Spec. the referencing code and the other requirements.

5) DENSITOMETER

5.1) Densitometers shall be calibrated at least every 90 days during use as follows:

a) A national standard step tablet or a step wedge calibration film, traceable to a national standard step tablet and having at least 5 steps with neutral densities from at least 1.0 through 4.0, shall be used.

The step wedge calibration film shall have been verified within the last year by comparison with a national standard step tablet.

b) The densitometer manufacturer’s step-by-step instruction for the operation of the densitometer shall be followed.

c) The density steps closest to 1.0, 2.0, 3.0, and 4.0 on the national standard step tablet or step wedge calibration film shall be read.

d)The densitometer is acceptable if the density readings do not vary by more than ±0.05 density units from the actual density stated on the national standard step tablet or step wedge calibration film.

5.2) Periodic Verification

Periodic calibration verification checks shall be performed as described in 5.1 at the beginning of each shift, after 8 hr of continuous use, or after change of apertures, whichever comes first.

5.3) Documentation

Densitometer calibrations required by 5.1 shall be documented, but the actual readings for each step do not have to be recorded. Periodic densitometer verification checks required by 5.2 do not have to be documented.

5.4) Traceability

All film shall be traceable

6) FACILITIES FOR VIEWING FILM

(a) Viewing facilities shall provide subdued background lighting of an intensity that will not cause reflections, shadows, or glare on the radiographs that interfere with the interpretation process. Equipment used to view radiographs for interpretation shall provide a variable light source sufficient for the essential IQI 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 do not interfere with interpretation.

(b) To provision of best viewing condition, the illuminator must provide sufficient light of an intensity that will illuminate the average density. (1.8 minimum for single film viewing for radiographs made with an X-ray source and 2.0 minimum for radiographs made with a gamma ray source).

Viewing conditions shall be such that the light transmitted from the outer edges of the film or low-density region does not interfere with the interpretation of the radiograph. Subdued lighting rather than total darkness is preferable in the viewing room. The brightness of the surrounding should be about the same as the area of interest in the radiograph. Room illumination must be so arranged that there are no reflections from the surface of the film under examination.

(c) Identification markers:

-The permanent identification (see attachment) shall be produced on the radiograph traceable to the contract, component, weld seam, or part number, as appropriate. In any case this information shall not obscure the area of interest. Repair or reshoot radiographs shall be identified by R1, R2, R/S, as applicable.

-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. A tolerance of 0.05 in density is allowed for variations between densitometer readings.

-The identification marks will be appeared on the radiographs and will not interfere with the image. It will include, project identification equipment Tag No., Weld line, welder stamp and date of testing as a minimum.

7) GEOMETRIC UNSHARPNESS

7.1) GEOMETRIC UNSHARPNESS DETERMINATION

Geometric un sharpness of the radiograph shall be determined in accordance

with: $Ug = Fd/D$

Where

Ug= geometric unsharpness

F= source size: maximum projected dimension of the radiating source (or effective focal spot) in the plane perpendicular to the distance D from the weld or object radiation, in.

D= distance from source of the radiation to weld or object being radiographed, in.

d= distance from source side of weld or object being radiographed to the film D and d shall be measured to the approximate center of the area of interest.

7.2) The actual or maximum source size (effective focal spot size) and source to film distance shall be recorded in the report, and the geometric unsharpness shall meet the requirements of 7.3.

7.3) GEOMETRIC UNSHARPNESS LIMITATIONS

Recommended maximum values for geometric un-sharpness are as follows:

Material Thickness, mm	Ug Maximum, mm
Under 50	0.51
50 through 75	0.76
Over 75 through 100	1.02
Greater than 100	1.78

Note: Material thickness is the thickness on which the IQI is based.

8) RADIATION SOURCE

Radiation source is Iridium 192 and maximum source size is 2x3 mm.

9) TECHNIQUE

SWSI source-weld-film arrangement shall be indicated as per ASME Sec. V. Double wall exposure shall be used just when single wall exposure is not applicable. Care should be exercised to ensure that the required geometric un-sharpness is not exceeded. If the geometric un-sharpness requirement cannot be met for double wall viewing technique, then single wall viewing shall be used (If applicable).

10) EQUIPMENT

Gamma-ray apparatus (sentinel) with remote control or equivalent.

Note: The minimum and maximum thickness for the use of radioactive isotopes is primarily dictated by exposure time that the required radiographic sensitivity has been obtained.

11) FILM TYPE

- Radiographic inspection performed using Fine grain film, D7, D4 (Type 1 and 2) or equivalent. Radiographic film length shall be 250 mm (10 inches) minimum. Film width shall be minimum 100 mm where accessible.

-The film treatment shall be in accordance with the film supplier recommendation.

12) INTENSIFYING SCREEN

- Back & front lead screens 0.13 mm thick
- Fluorescent intensifying screen shall not be used
- Lead intensifying screen shall be in direct contact with the film
- Prepakced films may be used

13) EXPOSURE CONDITION

Depending on diameter & wall thickness, minimum source to film distance shall be 200 mm. For using of radioactive isotopes the recommendation of ASME Sec. V Article II, part T-272 shall be considered.

14) NUMBER OF EXPOSURE

Minimum 3 Exposures takan120°, to each other shall be made. For welds on nozzles with nominal diameter 3" or less, may be performed by the elliptical projection technique. At least two separate exposures are required at location 90° apart.

15) OVER LAP

30 mm on each side of film may be used.

16) PENETRAMETER

Wire type and material according to ASTM E747. The Penetrometer shall be set at the end of film location. The Penetrometer shall be placed on the welds (on film side) so that the wire is perpendicular to the welds.

17) BACK SCATTER RADIATION

A lead symbol “B,” with minimum dimensions of 13 mm in height and 1.5 mm in thickness, shall be attached to the back of each film holder during each exposure to determine if backscatter radiation is exposing the film.

18) SENSITIVITY

Radiography shall be performed with a technique and radiographic set up which ensures achievement of the required Quality level and shall be calculated as per related standard or Project specification.

Calculation of Equivalent Pentameters sensitivity (EPS)

18.1) For set up hole type IQI

EPS = 100 x Square root of (T x h/2) / X

X = thickness to be radio graphed

T = thickness of the designated IQI

H = diameter of visible hole

18.2) Wire type IQI

EPS = D x 100 / X

Where X = thickness to be radio graphed

D = diameter of thinnest wire visible as a radiographic image.

19) FILM DENSITY

The calibration of densitometer is considered valid as long as the unit is not switched off during a series of measurement. Film density shall be according to ASME Sec. V, Article II-Part-T-282. & shall be limited to viewer capacity 2 to 3.5

20) FILM PROCESSING

- Type: Manual Agfa gravity G 127 or equivalent.
- Developing bath
- Developing temperature around 20ºC (approximately 5 minutes).
- Agfa gravity G 335 or equivalent.
- Fixing bath: Fixing time 10 minutes (approximately 20ºC).
- Washing: In running water + melting agent.
- Drying: Using suitable drier.
-Viewing: Light intensity adjustable viewer suitable to view 1.8 to 4.

21) LOCATION MARKS

Location markers,(Fig.T-275 of ASME Sec V Article 2) ,which are to appear as radiographic images on the film, shall be placed on the part, not on the exposure holder /cassette ,Their locations shall be permanently marked on the surface of the part being radio graphed when permitted, or on a map, in a manner permitting the area of interest on a radiograph to be accurately traceable to its location on the part, for the required retention period of the radiograph .Evidence shall also be provided on the radiograph that the required coverage of the region being examined has been obtained.

22) IDENTIFICATION AND MARKING OF RADIOGRAPHS

Each film shall be identified as per following items to avoid any confusion and mismatching in the reports and relevant films. Marking shall clear the outer edges of the weld.

1) Project identifier manufacture name
2) Column No.
3) Joint No.
4) Welder Stamp
5) Weld Thick
6) Location Mark
7) Pentameter
8) Date of Shooting

9) XR No.

10) Weld number

11) Identification of Shooting Status (Repair: R1, Retake: RT, Reshoot: RS...)

12) After P.W.H.T with "AP"

23) ACCEPTANCE CRITERIA

For acceptance interpretation of weld the requirements of ASME Sec. VIII Div.1, Appendix 4, UW-51 & UW-52 shall be followed. Imperfections listed in above criteria are unacceptable shall be repaired as provided in UW-38 and the repair re-examined.

(a) Image Density. Density within the image of the indication may vary and is not a criterion for acceptance or rejection.

(b) Relevant indications. Only those rounded indications which exceed the following dimensions shall be considered relevant.

(1) 1/10 t for t less than 3 mm.

(2) 1/64 in. for t from 3 mm to 6 mm

(3) 1/32 in. for t greater than 6 mm to 50 mm

(4) 1/16 in. for t greater than 50 mm

(c) Maximum Size of Rounded Indication. The maximum permissible size of any indication shall be 1/4 t, or 4mm,whichever is smaller; except than an isolated indication separated from an adjacent indication by 25mm or more may be 1/3 t, or 6 mm, whichever is less.

For t greater than 50mm the maximum permissible size of an isolated indication shall be increased to 10mm.

(d) Aligned Rounded Indications. Aligned indications are acceptable when the summation of the diameters of the indications is less than t in a length of 12t. See Fig.1-1. The length of groups of aligned rounded indications and the spacing between the groups shall meet the requirements of Fig.1-2.

(e) Spacing. The distance between adjacent rounded indications is not a factor in determining acceptance or rejections, except as required for isolated indications or groups of aligned indications.

(f) Rounded Indication Charts. The rounded indications characterized as imperfections shall not exceed that shown in the charts. The charts in Figs.1-3 through 1-8 illustrate various types of assorted. Randomly dispersed and clustered rounded indications for different weld thicknesses greater than 3mm. These charts represent the maximum acceptable concentration limits for rounded indications.

The charts for each thickness range represent full-scale 150mm radiographs, and shall not be enlarged or reduced. The distributions shown are not necessarily the patterns that may appear on the radiograph, but are typical of the concentration and size of indication permitted.

(g) Weld Thickness t less than 3mm. For t less than 3mm the maximum number of rounded indications shall not exceed 12 in a 150mm length of weld. A proportionally fewer number of indications shall be permitted in welds less than 150mm in length.

(h) Clustered Indications. The illustrations for clustered indications show up to four items as many indications in a local area, as that shown in the illustrations for random indications. The length of an acceptable cluster shall not exceed the lesser of 25mm or 2t, where more than one cluster is present. The sum of the lengths of the clusters shall not exceed 25mm in a 150mm length weld.

(I) Elongated indication:

a) any indication characterized as a crack or zone of incomplete fusion or penetration is unacceptable

(1) Any other elongated indication on the radiograph which has length greater than: (a)1/4 in.(6mm) for t up to 3/4 in.(19mm)

(b)1/3 t for t from 3/4 in.(19mm) to 2 1/4 in. (57mm)

(c)3/4 in.(19mm) for t over 2 1/4 in.(57mm)

Where

t = the thickness of the weld excluding any allowable reinforcement. For a butt weld joining two members having different thicknesses at the weld.t is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld. the thickness of the throat of the fillet shall be included in t.

(2) Any group of aligned indications that have an aggregate length greater than t in a length of 12 t, except when the distance between the successive imperfections exceeds 6L where L is the length of the longest imperfection in the group.

Table 1: Acceptable Indication

SI Units

Thickness t, *mm*	Maximum Size of Acceptable Indication ,mm		Maximum Size of Non-relevant Indication ,mm
	Random	Isolated	
Less than 3	1/4 t	1/3 t	1/10 t
3	0.79	1.07	0.38
5	1.19	1.60	0.38
6	1.60	2.11	0.38
8	1.98	2.64	0.79
10	2.31	3.18	0.79
11	2.77	3.71	0.79
13	3.18	4.27	0.79
14	3.61	4.78	0.79
16	3.96	5.33	0.79
17	3.96	5.84	0.79
19.0 to 50 ,incl.	3.96	6.35	0.79
Over 50	3.96	9.53	1.60

J)Acceptance Criteria of Spot Radiography

b) The acceptability of welds examined by spot radiography shall be judged by the following standards:

(1) Welds in which indications are characterized as cracks or zones of incomplete fusion or penetration shall be unacceptable.

(2) Welds having indications characterized as slag inclusions or cavities are unacceptable when the indication length exceeds 2/3*t* .

c) For all thicknesses, indications less than 1/4 in. (6 mm) are acceptable, and indications greater than 3/4 in. (19 mm) are unacceptable. Multiple aligned indications meeting these acceptance criteria are acceptable when the sum of their longest dimensions indications does not exceed *t* within a length of 6*t* (or proportionally for radiographs shorter than 6*t*), and when the longest length *L* for each indication is separated by a distance not less than 3*L* from adjacent indications.

(3) Rounded indications are not a factor in the acceptability of welds not required to be fully radiographed.

24) EXAMINATION REPORT

Attached form will be used to record examination results.

25) PERSONNEL QUALIFICATION

All operators, must be qualified to SNT-TC-1A level I, European norm: EN 473 entitled "Qualification and Certification of NDT Personnel" As a minimum, Interpretation must be carried-out by inspectors holding at least Valid Certificate to SNT-TC-1A level II, European norm: EN 473 entitled "Qualification and Certification of NDT Personnel" or CSWIP.

General Note:

All welded joint shall be visually inspected before commencement of any Non Destructive examination.

26) REPORTING

Operator/Interpreter shall provide a test report (attachment No. 1) after test Performing and film interpretation and give it to client authorized inspector for review &Approval.

All related document/ instruments shall be available to inspectors to be peer reviewed as their request. Also, they are allowed to challenge the interpretation and request additional/repeat NDE at their

discretion.

27) FILM STORAGE

Exposed films shall be stored in accordance with ASME SEC V article2 Appendix3 standard.

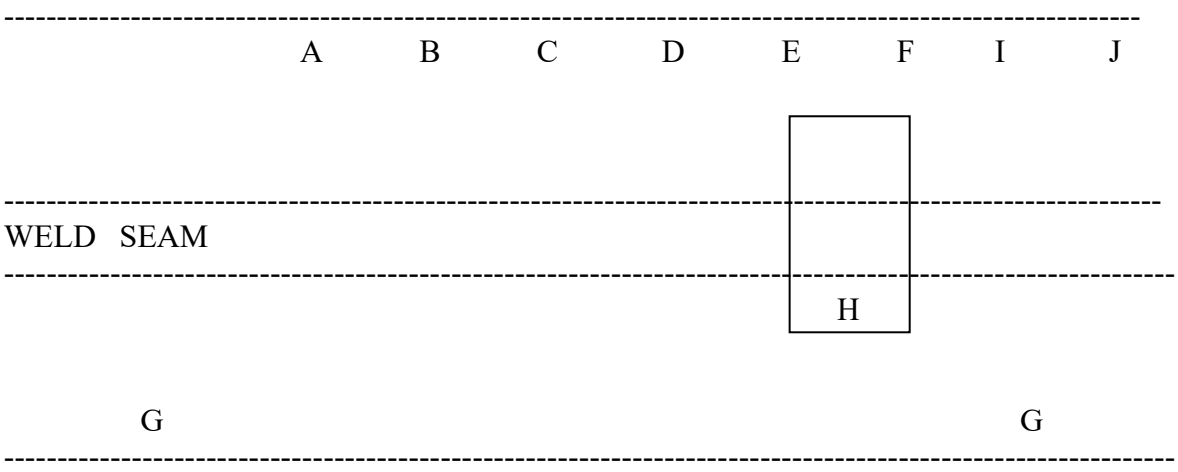
28) SAFETY SYSTEM

All safety items shall be performed according to Company rules by RT operators.

29) DOCUMENTATION

Vendor shall prepare and document the radiographic technique details and a radiograph review form. Each radiograph shall be documented on the radiographic examination report. As a minimum, the report shall include required information, described in Article 2, T- 291, ASME sec. V. The report shall be prepared and dated by the qualified and certified Level II who examined the evaluation and disposition of the radiographs and approved by the qualified and certified Level II or Level III who performed the final acceptance of the radiographs.

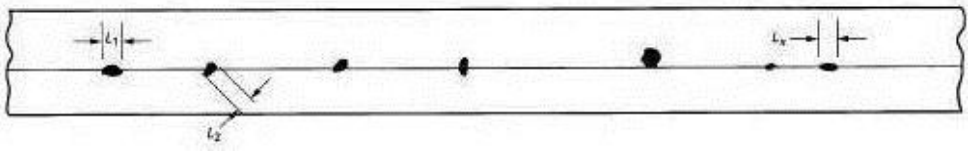
DENTIFICATION SYSTEM



A: Project identifier manufacture name
B: Item No.
C: Joint No.
D: Welder Stamp
E: Weld Thick
F: Date of Shooting
G: Location Mark
H: Penetrameter
I: Identification of Shooting
J: After PWHT

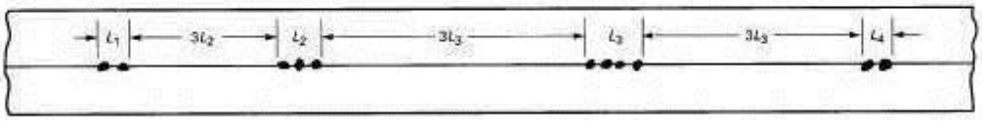
Note:
Arrangements of identification markers above are not necessarily in order.

Fig.1-1 Aligned Rounded Indications



Note: Sum of L_1 to L_X shall be less than *t* in a length of 12*t*.

Fig.1-2 Groups of Aligned Rounded Indications



Note: Sum of the group lengths shall be less than *t* in a length of 12*t*.

Maximum Group Length
L = ¼ in. (6mm) for t less than ¾ in. (19mm)
L = 1/3t for t3/4 in. (19mm) to 2 ¼ in. (57mm)
L = ¾ in. (19mm) for t greater than 2 ¼ in. (57mm)

Maximum Group Spacing
3L where L is the length of the longest adjacent group being evaluated.

Fig 1-3 Charts for t equal to 1/8 in. to 1/4 in. (3 mm to 6 mm), Inclusive

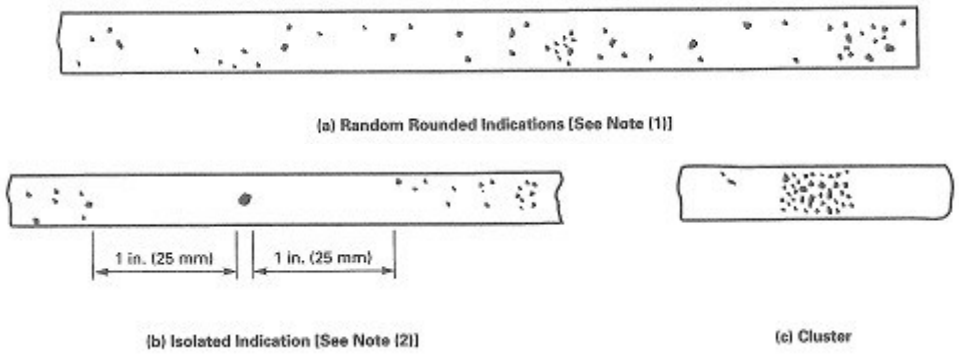


Fig 1-4 Charts for t over to 1/4 in. to 3/8 in. (6 mm to 10 mm), Inclusive

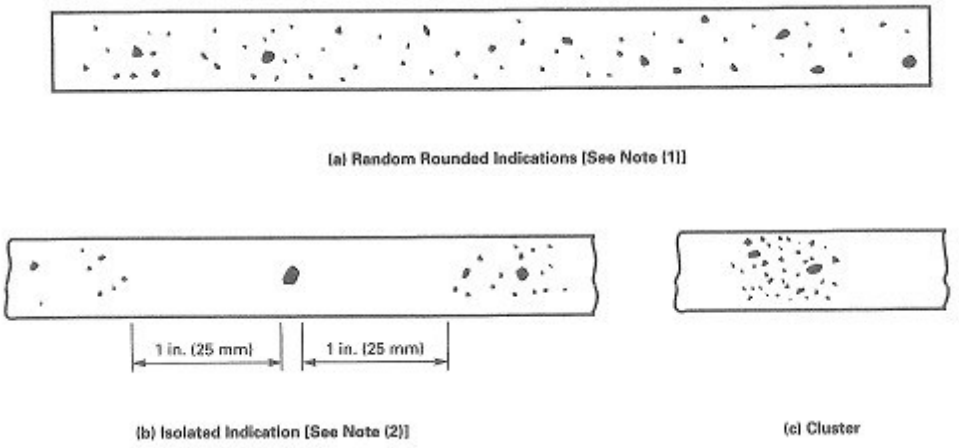


Fig 1-5 Charts for t over 3/8 in. to 3/4 in. (10 mm to 19 mm), Inclusive

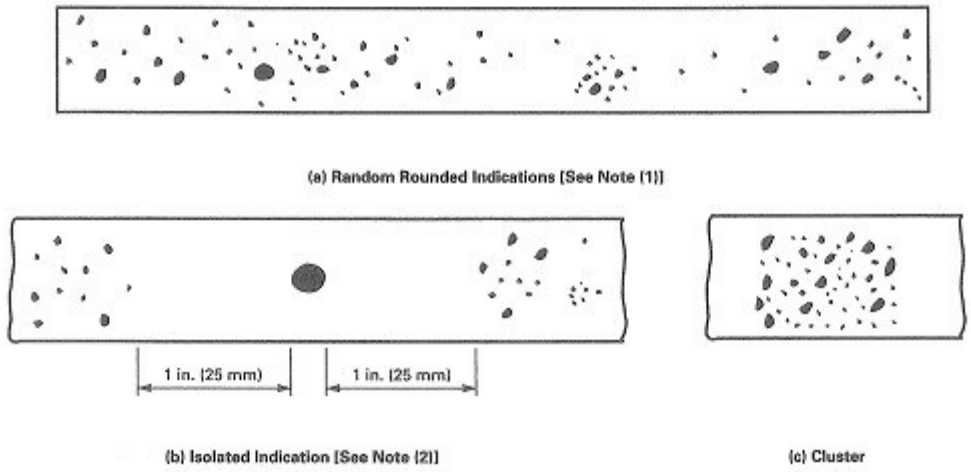
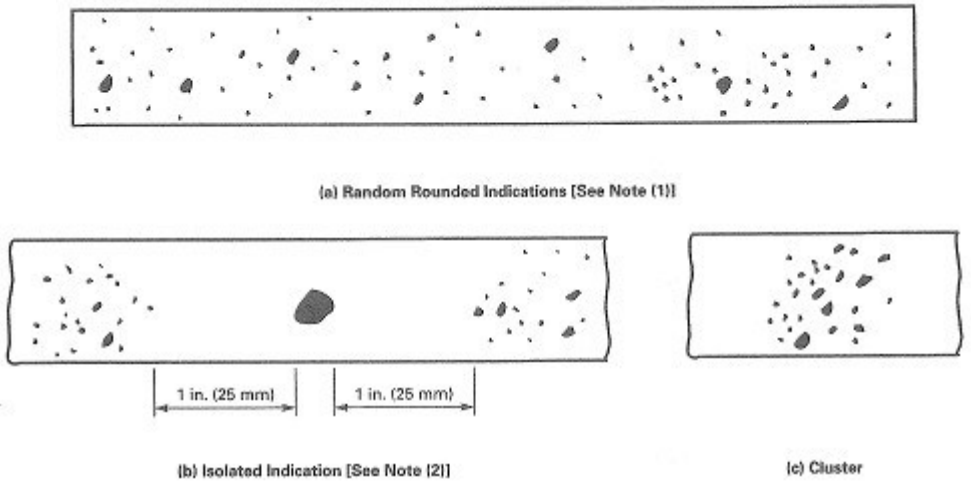


Fig.1-6 Charts for t over 3/4 in. to 2 in.(19 mm to 50 mm),Inclusive



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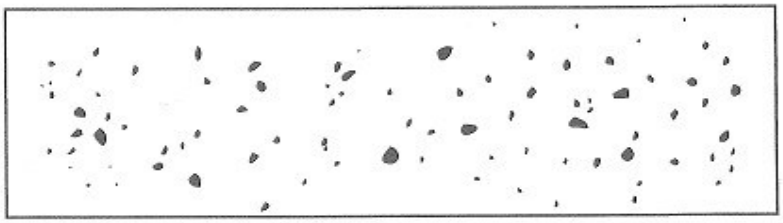
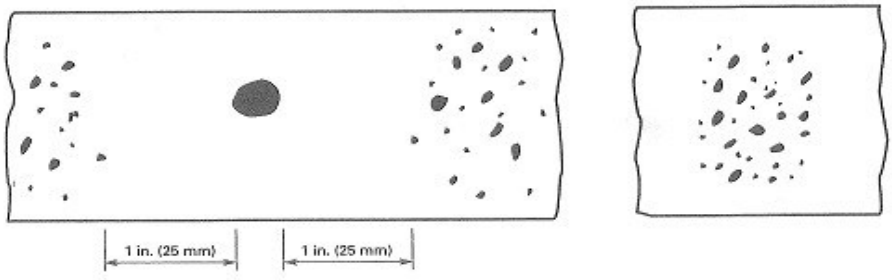
ig.1-8 Charts for t over 4 in. (100 mm)



(a) Random Rounded Indications [See Note (1)]

Fig.1-8 Charts for t over 4 in.(100 mm)



(b) Isolated Indication [See Note (2)]

(c) Cluster

NOTES:
(1)Typical concentration and size permitted in any 6 in. (150 mm) length of weld.
(2) Maximum size per Table 1

LIQUID PENETRANT

EXAMINATION PROCEDURE

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1) SCOPE

This article contains methods and requirements for Liquid Penetrant Examination of Heat Exchanger applicable when specified by NDT map.

2) REFERENCE

- ASME V, Article 6 (2019 Edition)
- ASME VIII Div.1, App. 8 (2019 Edition)
- ASNT-TC-1A (Latest Edition)

3) TECHNIQUE

The technique used in this procedure is Color Contrast Penetrant, using solvent removable penetrant.

4) RAW MATERIAL

Brand name of PT set is BYCO TEST or equivalent. Penetrant, developer and cleaner shall have same brand name. Comparison block for each batch of liquid penetrant test, and also ARB block should be prepared.

5) SURFACE PREPARATION

Surface preparation by grinding, machining or other methods may be necessary where surface irregularities could mask indication. The surface to be examined (within at least 25 mm) shall be clean and free of grease, flux spatter, rust oil that might interfere with the penetration of liquid. Also the surface must be dried by proper method such as heating or using clean clothes in case of moisture or wet surface. The proper solvent for degreasing is BYCO TEST or equivalent.

6) LIQUID PENETRANT APPLICATION

- Type of dye penetrates is visible penetrant examination method.
- Apply by thoroughly and uniformly spraying on the part to be examined.
- The temperature of the penetrant and the surface of the part to be processed shall not be below 5°C not above 52°C throughout the examination period and when it is not practical to conduct a liquid penetrant examination within the temperature range of 5°C to 52°C, the examination procedure at the

proposed lower or higher temperature range requires qualification of the penetrant materials and processing in accordance with Mandatory Appendix III of Article 6 of ASME Sec V.

- The maximum penetration time according to table 672 of ASME Sec V. for temperature range from 10°C to 52°C for penetrant is 5 min and for developer is 10 min.

7) METHOD OF REMOVING EXCESS PENETRANT

Removing will be performing by special solvent and clean clothes (Magna flux SKC-S or equivalent). Solvent shall not be spray directly to the weld. Residual total chlorine (hydrogen, fluorine) sulfur shall not exceed 0.1 percent by weight. Method of drying surface after excess penetrant removal is commonly normal evaporation. The drying time shall be minimum 2 minutes and not be greater than 5 minutes. After the specified penetration (dwell) has elapsed, any penetrant remaining on the surface shall be removed, taking care to minimize removal of penetrant from discontinuities. Flushing the surface with solvent, following the application of the penetrant and prior to developing, is prohibited

8) DEVELOPING

The developer shall be applied as soon as possible after penetrate removal. The time interval shall not exceed that established in this procedure. Insufficient coating thickness may not draw the penetrant out of discontinuities; converse, excessive coating thickness may mask indications. With color contrast penetrates, only wet developer shall be used. With fluorescent penetrates, a wet or dry developer may be used.

8.1) WET DEVELOPER APPLICATION

Prior to applying suspension type wet developer to the surface, the developer must be thoroughly agitated to ensure adequate dispersion of suspended particles.

(a) Aqueous Developer Application. Aqueous developer may be applied to either a wet or dry surface. It shall be applied by dipping, brushing, spraying, or other means, provided a thin coating is obtained over the entire surface being examined. Drying time may be decreased by using warm air, provided the surface temperature of the part is not raised above 125˚F. Blotting is not permitted.

(b) Non aqueous Developer Application. Non aqueous developer shall be applied only to a dry surface. It shall be applied by spraying, except where safety or restricted accesses preclude it. Under such conditions, developer may be applied by brushing. Drying shall be by normal evaporation.

8.2) Developing time for final interpretation begins immediately after the application of a dry developer as soon as a wet developer coating is dry. The minimum developing time shall be 10 min.

9) EVALUATION OF EXAMINATION

Final interpretation shall be made within 10 to 60 min after the requirements of procedure are satisfied. The light intensity shall be 1000 lux light. All relevant indications shall be recorded and evaluated as per ASME sec. VIII Div. 1 appendix 8, Repair shall perform under supervision of inspector. Attached form will be used for examination report.

All related document/ instruments shall be available to inspectors to be peer reviewed as their request. Also, they are allowed to challenge the interpretation and request additional/repeat NDE at their discretion.

10) POST CLEANING

Post-examination cleaning shall be performed as soon as possible after the examination. Solvent or water, as applicable, shall be used to remove the residual penetrant and developer by spraying, wiping with cloths, or brushing.

11) PERSONNEL QUALIFICATION

All operators (Assistants) must be qualified to SNT-TC1A level I or level II. As a minimum, interpretation must be carried-out by inspectors holding at least valid certificate to ASNT-TC-1A level II.

12) PROCEDURE QUALIFICATION

When procedure qualification is specified, a change of requirement in an essential variable from the specified value, or range of values, shall require re-qualification of the written procedure

13) ACCEPTANCE CRITERIA

The acceptance criteria for above mentioned method will be according to ASME Sec. VIII Appendix 8 (Edition2019), are as below:

All surfaces to be examined shall be free of:

a) relevant linear indications
b) relevant rounded indications greater than 5 mm

c) four or more relevant rounded indications in a line separated by 1.5 mm or less (edge to edge).

d) Under cut of welds shall not exceed 0.3 mm

ULTRASONIC EXAMINATION PROCEDURE

Contents

1. SCOPE
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10. EXAMINATION & RECORDS REPORTING
11. PROCEDURE QUALIFICATION
12. POST EXAMINATION CLEANING

1) SCOPE

1.1. This article contains methods and requirements for Ultrasonic Examination of Heat Exchanger applicable in materials whose section is 6 mm thick or greater when specified by NDT map. Technique details for specific contracts are given on the relevant procedure/Technique sheets and may not be subsequently revised with this document.

1.2. The examination of 'T,' 'Y,' 'K' welds, nozzle and node welds may be subject to severe restrictions to the extent of the ultrasonic scanning which is possible, as a result of the shape, position or angle of the joining members.

1.3. Such areas of restricted scanning, or restricted weld coverage must be recorded on the Inspection report.

2) REFERENCES

- ASME Sec. V, Article 4 (2019 Edition)
- ASME Sec. VIII Div.1 & Div.2 (2019 Edition)
- ASNT-TC-1A (Latest edition)
- BS EN 12223. 2000, NDT: Ultrasonic Examination - Specification for Calibration Block No. 1
- BS EN 27963: 1992, Specification for Calibration Block No. 2 for Ultrasonic Examination of welds.

3) QUALIFICATION OF PERSONNEL

All operators (assistants), must be qualified to SNT-TC1A level II, European norm: EN473 entitled "Qualification and Certification of NDT Personnel" As a minimum, Interpretation must be carried- out by inspectors holding at least Valid Certificate to SNT-TC-1A level II, European norm: EN 473 entitled "Qualification and Certification of NDT Personnel" or CSWIP. Utilization of other approval schemes is permitted by prior agreement between contracting parties and the scheme agreed upon shall be defined in the specific Technique/Procedure Sheets.

4) EQUIPMENT AND MATERIALS

4.1. Flaw Detector

The flaw detector shall be the Krautkramer USK6, USK7, USM35, Sonatest, Sitescan 110, Sitescan 130, Masterscan 330 or equivalent Company Approved equipment (by an appropriately qualified Member of Senior Management), calibrated accordance with the requirements of ASME V Article 5, T-530.

The equipment used must be calibrated at least each 3 mouths for linear vertical presentation (screen high linearity) and also for amplitude control linearity.

4.2) Probes

The probes to be used shall be selected from to the following. All probes shall be ESI rated.

Normal probes (Compression) 5.0MHz

10mm dia. Twin crystal. 4 MHz 24mm

dia. Single crystal 4 MHz 10mm dia.

Single crystal

d) Angle Probes (Shear)

AP4MHz 20mm Dia.	45°, 60°, 70°	38° (where applicable)
MAPS 4MHz 10mm Dia.	45°, 60°, 70°	38° (where applicable)
TMAPF 4MHz 10mm Dia.	45°, 60°, 70°	38° (where applicable)

4.3 Calibration Blocks

4.3.1. The appropriate Calibration Block with thicknesses and holes sizes in accordance with Article 5 Figures T-542-2.1 where side drilled holes are used. The calibration block shall be selected for the material thickness under examination.

4.3.2. IIW-V1 Calibration Block

IIW-V2 Calibration Block

4.3.3 Reflectors.

Specified reflectors (i.e., side-drilled holes, flat bottom holes, notches, etc.) shall be used to establish primary reference responses of the equipment. An alternative reflector(s) may be used provided that the alternative reflector(s) produces a sensitivity equal to or greater than the specified reflector(s) (e.g., side-drilled holes in lieu of notches, flat bottom holes in lieu of side- drilled holes).

4.3.4 Material

(a) Similar Metal Welds. The material from which the block is fabricated shall be of the same product form and material specification or equivalent P-Number grouping as one of the materials being examined. For the purposes of this paragraph, P-Nos. 1, 3, 4, 5A through 5C, and 15A through 15F materials are considered equivalent.

*(b)*Dissimilar Metal Welds. The material selection shall be based on the material on the side of the weldfrom which the examination will be conducted. If the examination will be conducted from both sides,calibration reflectors shall be provided in both materials.

4.3.4 Quality. Prior to fabrication, the block material shall be completely examined with a straight beam search unit. Areas that contain an indication exceeding the remaining back-wall reflection shall be excluded from the beam paths required to reach the various calibration reflectors.

4.3.5. Surface Finish. The finish on the scanning surfaces of the block shall be representative of the scanning surface finishes on the component to be examined.

4.4. Couplant

4.4.1. Conventional Couplant

The couplant shall be a proprietary ultrasonic couplant, a suitable cellulose based wallpaper adhesive, e.g. Polycell, oil or water as appropriate.

4.4.2. Halogen Free Couplant

Certain high alloy materials intended for use at elevated temperatures demand the use of halogen free couplants. In such circumstances only couplants certified as being Sulphur and Halogen free, (i.e. less than 50 ppm) shall be used.

"Couplants used on austenitic stainless steel or titanium shall not contain more than 250 ppm of halides (chlorides plus fluorides)."

5) SURFACE CONDITION

5.1. Weld Surface

The weld surface shall be prepared as needed to present a smooth contour, avoiding sharp changes in section. Where such changes in section occur, it is possible that some difficulty in the ultrasonic interpretation may occur. Such difficulties must be recorded on the report.

5.2. Parent Material

The parent material shall be free from weld spatter, surface irregularities or foreign matter that might interfere with the examination, giving a smooth contour for a distance of at least 2 ½ t on each side of the weld on each of the testing surfaces (where t is the thickness of the material under test). Where 70˚ angle probes are employed, the distance shall be increased to 3 ½ t.

6 .EXAMINATION

6.1.1 The scanning requirements of this procedure are based on the use of at least two probes of differing angles from each side of the weld.

SENSITIVITY

The scanning sensitivity should be set to twice the primary reference level(+6dB). All indications in excess of 20% of the DAC should be evaluated when assessed at the primary reference level. A DAC curve is required for all welds. For examination of a full wall thickness, the notches shall be used as calibration reflectors. A side-drilled hole may be used for initial acceptance of a weld, provided that it can be demonstrated that the hole calibration produces a sensitivity equal to or greater than the notch calibration.

Distance amplitude correction:

a) DAC curves will be constructed for every search unit to be utilized at each particular range used, for reference during all weldments examination. Block used for DAC construction will be selected as appropriate from those as specified in ASME Section, Article4, figure T-434.2.1, T-434.3 DAC curves will be constructed as follow:

b) Place the probe on the calibration block to obtain a reflection from the hole, which produces the greatest response.

c) Maximize the indication by manipulation and adjusted to approx.75% screen height using the calibration gain control. Make a mark on the CRT at the peak of the indication using an indelible fine tipped felt maker.

d) Points representing 20% and 50% of the primary gain are also to be constructed. Repeat b) and c) using reflections from every reflect or than can be obtained within the beam length of the test range to be used, including those reflections obtained from skip.

Connect all points marked with a smooth curving line, this line will be referenced to as the DAC curve the respective probe used and will apply for that particular search unit.

Note: DAC curves will be directly marked as the CRT time base screen cover with an indelible ink marker or superimposed using clear plastic, Polyester or Perspex overlap.

Should the DAC curve fail to search a level of at least 20% of full screen height at the limit of its range, as represented on the time base, sufficient supplementary gain will be added to attain this level and the DAC adjusted accordingly.

6.2 Calibration

6.2.1 Straight Beam Examination (0° Probe)

a) The equipment is calibrated using a straight beam probe for a suitable range for the thickness of material being examined. A minimum of two back wall echoes from the material under test shall be noted during the examination.

b) A Distance Amplitude Correction curve (DAC curve) shall be produced using the appropriate calibration block selected in accordance with paragraph 4.3

The attenuator control is adjusted to produce a response of 80% full screen height and the screen is marked. The probe is then re-positioned to give the maximized response for each of the remaining holes on ASMW block (basic calibration block) without changing the attenuator settings. At each maximized position, mark the position of maximum response on the screen. Connect the screen marks to produce the DAC curve. This gain setting is the primary reference level.

6.2.2 Angle Beam Calibration

(a) The equipment is calibrated for a suitable range for the beam path length required to satisfactorily complete the examination, i.e. Full Skip Distance by calibration ASME block (basic calibration block)

(b) Produce a DAC curve in accordance with paragraph 6.1.3.

System calibration confirmation shall be carried out at the commencement of, and at 4 hourly intervals during the examination after any break where the equipment has been switched off, and on completion of an examination.

If during the calibration confirmation the sweep range of the DAC curve has changed by the following tolerances: (i) Sweep Range - if a point of the DAC curve has moved on the time base by more than 10% of its original time base position, or (ii) DAC Curve - if a point on the DAC curve has changed by ± 20% or 2 dB from its original amplitude; then the following action shall be taken:

6.3.1 Sweep Range

The calibration shall be corrected with a note of the correction being made on the report. If any signals have been recorded, all recorded indications shall be re-examined with the corrected calibration and their values corrected accordingly on the report.

6.3.2 DAC Curve

If any point on the DAC curve has decreased by 20% or 2dB all recorded data since the last valid calibration shall be marked void. A new DAC curve shall be produced with a note to this effect on the report and the voided areas shall be re-examined. If any point on the DAC Curve has increased

by 20% or 2dB all recorded data since the last valid calibration shall be reassessed following the production of the new DAC curve. A note - of this shall be made on the report.

7) CALIBRATION

7. 1 General Calibration Requirements

7.1.1. Ultrasonic System. Calibrations shall include the complete ultrasonic system and shall be performed prior to use of the system in the thickness range under examination.

7.1.2. Calibration Surface. Calibrations shall be performed from the surface (clad or unclad; convex or concave) corresponding to the surface of the component from which the examination will be performed.

7.1.3. Couplant. The same couplant to be used during the examination shall be used for calibration.

7.1.4. Contact Wedges. The same contact wedges to be used during the examination shall be used for calibration.

7.1.5. Instrument Controls. Any control which affects instrument linearity (e.g., filters, reject, or clipping) shall be in the same position for calibration, calibration checks, instrument linearity checks, and examination.

7.1.6. Temperature. For contact examination, the temperature differential between the calibration block and examination surfaces shall be within 14°C. For immersion examination, the couplant temperature for calibration shall be within 14°C of the couplant temperature for examination.

8) EXAMINATION TECHNIQUE

All scans shall be carried out with a minimum overlap of 10% of the transducer diameter.

8.8.1. Parent Metal Examination

Prior to any examination of the weldment, the parent material shall be examined. A compression waves 0˚ examination will be carried out for a minimum of 75mm either side of the weld to locate any flaws in the parent material and to determine its thickness. For thicknesses up to 30mm, a twin crystal probe shall be used. For thicknesses over 30 mm, a single crystal probe shall be used.

8.8.2. Weld Material - “Pipe & Welds”

8.8.2.1 If the weld cap has been removed the center line of the weld shall be determined by locating the position of maximum response from the weld root. Weld Material T, K, Y, Nozzle or Node Configurations.

Where the back of a weld is accessible, a normal probe should be used to outline projected weld limits on to the testing surface.

The probe should be placed on the parent material and the first return echo from the remote surface should be set to 80% full screen height. The probe should then be scanned across the weld zone until the echo amplitude is reduced by 6 dB as it crosses the projected weld edge and its position should be marked on the surface. This scan is to be repeated behind each weld edge until a series of marks are produced which when joined represent the projected weld profile.

8.8.3 Weld Examination. Plate & Pipe Welds

8.8.3.1 A critical root scan shall be carried out from both sides of the weld, with at least one angle probe directed essentially perpendicular to the weld axis so as to distinguish between root variations and the existence of root cracks or crack-like defects. This shall be done where practicable with the aid of a magnetic strip placed so that the distance from the probe index to the root will be constant. The body and fusion faces of the weld shall then be examined using a continuous scanning raster from both sides of the weld between the weld center line or the cap edge whichever is appropriate and full skip plus the cap width using at least two probes of differing angles.

8.8.3.2 T, K & Y Configurations

(a) Scanning from the 'flange'

Using 45° and 60° probes, the weld zone should be examined in two directions with the probe directed essentially perpendicular to the weld edge, examining the flange and weld material between the two weld toes.

(b) Scanning of Perpendicular 'T' butt welds

Using any two angle probes, where angles differ by at least 10° the weld area should be searched from the 'web'. Where full coverage of the complete weld zone is not possible when scanning from one side of the 'web' then scanning from two sides of the web must be carried out whenever possible.

The selected probe angle should be selected to be as nearly perpendicular to the fusion face as possible whilst maintaining the search distance to the most practicable minimum.

(c) Scanning of inclined or circular cross section 'T' butt-welds

The examination of inclined and circular 'T' butt configurations may introduce geometric difficulties. In such cases then a series of cross-sectional drawings must be prepared for each significant change in the geometry. Selection of the appropriate probe angle will depend upon the specific geometric configurations at particular locations.

8.8.3.3 Set on Branch Welds

A characteristic of these welds is the severe change in weld cross-section around the circumference, which makes coverage of the 'B' side wall particularly difficult and calls for a combination of scans. For this reason, unless there is adequate access for examination from the bores of both welded components, the weld cap/fillet surface shall be dressed if required to allow probes to be scanned on this surface.

The following scans are required (See figure 1 for Scan Position).

Root		Scan Q1
'A' Fusion Face	(i)	When bore access allows: scan P1 and Q2.
	(ii)	In other cases: Scan Q2.
'B' Fusion Face	(i)	When bore access allows: scans P3 and S2.
	(ii)	In other cases: select from scans Q1, Q2, Fl and R1 as applicable.
Weld Body	(i)	When bore access allows: scan P2.

8.8.3.4 Set on Nozzle Welds

The following scans are required (See figure 1 for scan position).

Root		Scan Q1
'A' Fusion Face	(i)	When bore access allows: scan P1 and Q2.
	(ii)	In other cases: scan Q2.
'B' Fusion Face	(i)	When bore access allows: scan S2, supplemented by scan P3, particularly for sizing defects.
	(ii)	In other cases: scans Q1 and Q2 supplemented if required by scan Fl to give full coverage.
Weld Body	(i)	When bore access allows: scan P2.
	(ii)	In other cases no further scans are practicable.

Transverse Defects not normally a requirement on this type of weld, and of limited effectiveness due to unfavorable joint geometry.

8.8.3.5 Set on Stub Welds

The following scans are required: (See figure 1 for scan positions).

Root	Scan Q1
'A' Fusion Face	Scan Q2

'B' Fusion Face	Scan Q2
Weld Body	No additional scans are practicable. Transverse

Defects Scanning for transverse defects is not applicable.

8.8.3.6 Set through Connections and T Butt Welds

The following scans are required: (See figure 1 for scan position).

Root	(i) When bore 'A' access allows: scan P2 or P1 in both directions.
	(ii) In other cases: scans R1 and either R2 or S1. 'A'
Fusion Face	(i) When bore 'A' access allows: scan P2.
	(ii) In other cases: Scans Fl, R1 and either R2 or S1.
'B' Fusion Face	(i) When bore 'A' access allows: scans R1 and S1, or P1 in both directions.
	(ii) In other cases: scans R1 and either R2 or S1.
Weld Body	No specific extra scans required.
Transverse Defects	Scans for transverse defects are not normally a requirement on this type of weld; a limited standard of examination only may be achieved by scanning from the weld cap or from the bore of component 'A'.

8.9 Defect Evaluation and Sizing

8.9.1. Any signals having amplitude in excess of 20% DAC, observed during the examination shall be further investigated to:

i. Confirm its existence

ii. Determine its location with reference to the established datum points.

iii. Determine its size.

iv. Determine its nature.

8.9.2. This investigation may require scanning from other positions and with different probe angles and is highly subjective in its nature and should be carried out with extreme care.

The recommended sizing techniques are as follows:

8.9.3. Defect Length

Use the -6dB drop technique - marking the probe center at the defect end points. Subsidiary maximum at the ends of the defect should be treated independently of the major defect for overall assessment of length.

8.9.4. Through Thickness Dimension

Use the maximum amplitude technique or -20dB drop technique in conjunction with adjustable flaw

location aids.

8.9.5. Recording Indications

The recording levels and rejection levels shall be in accordance with the referencing code (T-591.1, T-591.2 of ASME sec V article5) & project specification.

9) ACCEPTANCE CRITERIA

The levels of acceptance shall be accordance to ASME Sec. VIII Appendix 12 (Edition 2019) as below:

Imperfections which produce a response greater than 20% of the reference level shall be investigated to the extent that the operator can determine the shape, identity, and location of all such imperfections and evaluate them in terms of the acceptance standards given in (a) and (b) below.

(a) Indications characterized as cracks, lack of fusion, or incomplete penetrations are unacceptable regardless of length.

(b) Other imperfections are unacceptable if the indications exceed the reference level amplitude and have lengths which exceed:

1. 1/4 in.(6mm) for *t* up to 19 mm;
2. 1/3 *t* for *t* from 19 mm to 57 mm;
3. 3/4 in. (19mm) for *t* over 57 mm.

Where *t* is the thickness of the weld excluding any allowable reinforcement.

For a butt weld joining two members having different thicknesses at the weld, *t* is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld, the thicknesses of the throat of the fillet shall be included in *t*.

10) EXAMINATION & RECORDS REPORTING

The reports of each weld examined must include all the relevant calibration data, to permit a duplicate examination at a later date. The reports may omit certain criteria providing the information is readily available by cross reference to a Contract specific Technique / Procedure sheet.

The report must also include all the data relevant to the work-piece together with a sketch, where appropriate, of the work piece or the defects detected.

The method of completion of the report should ensure all boxes are completed; where not applicable, the abbreviation 'N/A' inserted, or where not known the abbreviation 'N/K' inserted.

The examination standard, acceptance standard and referenced NDT

Inspection/Technique/Procedure sheet must be clearly stated on the report.

Where necessary these shall be accompanied by a sketch or drawing.

All test restrictions and or deviations from the specific Technique sheet must be entered on the report and the client informed if the test result may be affected.

The report should include, factually or by cross referral, the following as a minimum: -

(a) Manufacture name
(b) Project name
(c) Item no
(d) Weld no
(e) Acceptance standards
(f) Material type & thickness
(g) Specific Technique reference
(h) Equipment Used
(i) Operator's name & Qualifications
(j) Calibration details
(k) I.D & location of weld and area tested
(l) Surface(s) from which test is conducted
(m) Map or sketch of location of defects found
(n) Date of test
(o) Couplant used
(p) Basic calibration block identification
(q) Surface condition
(r) Probes & Frequency
(s) Special Equipment
(t) Client details and location and/or clear areas
(u) "All related document/ instruments shall be available to inspectors to be peer reviewed as their request. Also, they are allowed to challenge the interpretation and request additional/repeat NDE at their discretion."

11) PROCEDURE QUALIFICATION

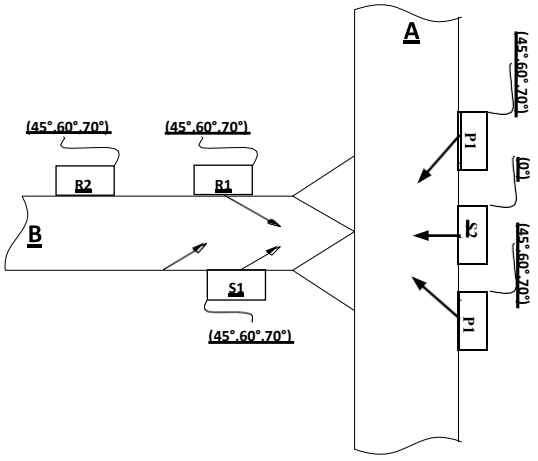
When procedure qualification is specified, a change of a requirement identified as an essential variable shall require requalification of the written procedure by demonstration. A change of a requirement identified as a nonessential variable does not require requalification of the written procedure. All changes of essential or

nonessential variables from those specified within the written procedure shall require revision of, or an addendum to, the written procedure.

FIGURE 1 (Typical)

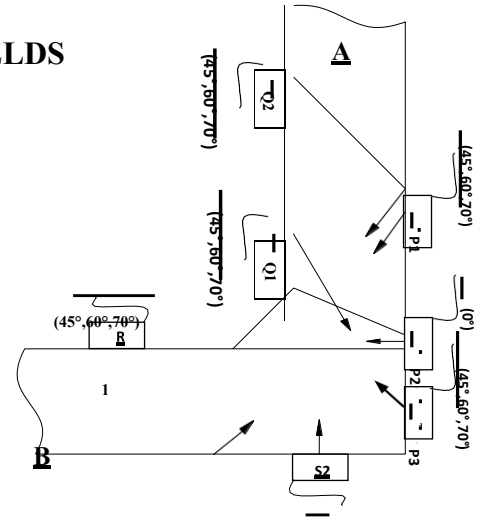
(a) SET - ON CONNECTIONS

1) BRANCH WELDS: - BORE A > 0.5 BORE B
2) NOZZLE WELDS: - BORE A < 0.5 BORE B
3) STUB WELDS: THICKNESS A < 12.5mm



(b) SET THROUGH CONNECTIONS AND T' BUTT WELDS

1) SET THRO. CONNECTION. FULL PENETRATION
2) SET THRO. CONNECTION. PARTIAL PENETRATION
3) 'T' BUTT WELD. FULL PENETRATION
4) 'T' BUTT WELD. PARTIAL PENETRATION



(0°)

12- POST EXAMINATION CLEANING

Post cleaning shall be performed immediately after examination and evaluation by proper process

that does not adversely effect on related part.

MAGNETIC PARTICLE EXAMINATION

PROCEDURE

Contents

1. SCOPE
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14. PERSONNEL QUALIFICATION
15. CALIBRATION

1)Scope

This article contains methods and requirements for Magnetic Particle Examination of Heat Exchanger.

2)Reference

- ASME Sec. V, Article 7, (Edition 2019)
- ASME Sec. VIII, Div. 1, (Edition 2019)
- ASNT-TC-1A (Latest Edition)

3)Surface Preparation

3.1. Satisfactory results are usually obtained when the surfaces are as welded conditions. however, surface preparation by grinding or machining may be necessary where surface irregularities could make indication due to discontinuities.

3.2. Prior to magnetic particle examination, the surface to be examined and all adjacent area within at least 25.4 mm shall be dry and free of all dirt, grease, welding flux and spatter, oil or other extraneous matter that could interfere with the examination.

3.3. Cleaning may be accomplished using detergents, organic solvents, paint remover, vapor degreasing, grit blasting, or ultrasonic cleaning methods.

3.4. If coatings are left on the part in the area being examined, it must be demonstrated that indication can be detected through the existing maximum coating thickness applied.

4)Magnetic Particles

4.1. The magnetic particles used for finding discontinuities will be wet method. Powders for wet test are non- fluorescent. The powders used will be as liquid suspension, they shall have a high permeability and a low capacity of keeping magnetization. Particles shall be visible under normal light. The following powders and / or similar will be used:

- Natural light black (magnaflux or equivalent)
- Red (magnaflux or equivalent)

4.2. Two types of Liquid Carriers may be used:

4.2.1. Oil - bath

The oil used in preparing the bath shall be light oil or refined oil having a low Sulphur and chloride limits content: Further it shall completely with the requirement of the ASME regulations.

When using oil as carrier of fluorescent particles, it shall be controlled by black light so that is gets only minimum quantity of natural fluorescence.

4.2.2. Water - bath

The water shall contain wetting substances and corrosion inhibitors. Bath concentration shall be in compliance with the applicable standard.

4.3. The temperature of the wet particle suspension and the surfaces of the part shall not exceed 52

°C.

- The following powders and / or similar

will be used: Natural light black

(magnaflux or equivalent) Red

(magnaflux or equivalent)

5)Magnetization Method

5.1. The Electromagnetic Yoke Technique shall be used. This method shall be performed only to surface and sub-surface discontinuities.

5.2. The AC magnetizing technique will be used provided that it has a 4.5 kg lifting that weighed with a scale from a reputable manufacturer. This test shall be performed before use; recording of this test is not required.

5.3. The DC technique will be used provided that it has 18 kg lifting capacity at the maximum Pole spacing. This test shall be performed before use; recording of this test is not required.

5.4. Two examinations at least shall be carried out in every area where the prods are placed so that the flux lines result approximately perpendicular.

5.5. Two examination at least shall be carried out with a sufficient overlapping (MIN. 15% overlapped) so as to ensure the 100% covering of the surface to be tested.

5.6. The following equipment and /or similar can

be used: MAGNAFLUX – Y6

TIDE – GWM 220

6)Demagnetization

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

7)Magnetic Field Checking

Whenever starting or completing an MT examination, direction and suitability of the magnetic field shall be checked by using the field indicator.

8) Method of Examination

Examination shall be done by continuous method: that is the magnetizing current remains on while the examination medium in being applied and while excess of the examination medium is being removed.

9) Interpretation

9.1 Non – fluorescent particles:

For Non–fluorescent particles examination is performed using visible light. A minimum light intensity of 50 FC (500 Lx) is required to ensure adequate sensitivity during the examination and evaluation of indication.

9.2 Fluorescent particles:

For this method the examination is performed using an ultraviolet lamp.

a) The examination shall be performed in a darkened area.

b) The examiner shall be in the darkened area at 5 min prior to performing the examination to enable his eyes to adapt to dark viewing. If the examiner wears glasses or lenses, they shall not to be photosensitive.

c) The ultraviolet light shall be allowed to warm up for a minimum of 5 minute prior to use or measurement of the intensity of the ultraviolet light emitted.

d) The ultraviolet light intensity shall be measured with an ultraviolet light meter. A minimum of 1000 uw/cm 2 the surface of the part to be examined shall be required. The black light intensity shall be measured at least once

10) Procedure Qualification

10.1. Procedure Requirements: Magnetic particle examination shall be performed in accordance with a written procedure which shall as a minimum, contain the requirements listed in Table T-721, ASME Sec. VIII, Div.1. The written procedure shall establish a single value, or range of values, for

each requirement.

10.2. Procedure Qualification: When procedure qualification is specified, a change of requirement identified as an essential variable from the specified value, or range of values, shall require requalification of the written procedure. A change of a requirement identified as a nonessential variable from the specified value, or range of values, does not require re qualification of the written procedure. All changes of essential or nonessential variables from the value, or range of values, specified by the written procedure shall require revision of, or an addendum to, the written procedure.

11) Indications Evaluation

11.1. All indication shall be evaluated in terms of the acceptance of the referencing code section.

11.2. Discontinuities on or near the surface indicated by retention of the examination medium.

11.3. Broad areas of particle accumulation, which might mask indication from discontinuities, are prohibited, and such areas shall be cleaned and re-examined.

11.4. Only indications, which have any dimensions greater than 1/16in, shall be considered relevant. A linear indication is one having a length greater than three times the width. A rounded indication is one of circular or elliptical shape with a length equal to or less than three times the width. Any questionable or doubtful indication shall be re-examined to determine whether or not they are relevant.

11.5. "All related document/ instruments shall be available to inspectors to be peer reviewed as their request. Also, they are allowed to challenge the interpretation and request additional/repeat NDE at their discretion."

12) Acceptance Criteria

e) In any case all surfaces to be examined shall be free of:

f) Relevant linear indications.

g) Relevant rounded indication greater than 5 mm.

h) Four or more relevant rounded indication in a line separated by 1.5 mm or less, edge to edge.

i) Under cut of welds shall not exceed 0.3 mm

13) Post 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. The techniques employed are:

- Drying of wet particles and subsequent removal by brushing or compressed air.
- Removal of wet particles by flushing with proper solvent.

Other suitable techniques may be used if they will not interfere with subsequent requirements.

14) Personnel Qualification

Personnel involving in this examination in compliance with this procedure shall be qualified according to SNT-TC-1A, Level I as operator and Level II as examiner.

15) Calibration of Equipment

15.1. Frequency:

Magnetizing equipment with an ammeter shall be calibrated at least once a year, or whenever the equipment has been subjected to major electric repair, periodic overhaul, or damage. If equipment has not been in use for a year or more, calibration shall be done prior to first use.

15.2. Procedure:

The accuracy of the unit's meter shall be verified annually by equipment traceable to a national standard. Comparative readings shall be taken for at least three different current output levels encompassing the usable range.

15.3. Tolerance:

The unit’s meter reading shall not deviate by more than ±10% of full scale, relative to the actual current value as shown by the test meter.

15.4. Light Meters:

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.

VISUAL INSPECTION PROCEDURE

Contents:

1. SCOPE
2. REFERENCE
3. PROCEDURE QUALIFICATION
4. PERSONNEL REQUIREMENTS
5. PHYSICAL REQUIREMENTS
6. EQUIPMENT
7. TECHNIQUE
8. EVALUATION
9. DOCUMENTATION
10. ACCEPTANCE CRITERIA

1) Scope

This Article contains methods and requirements for visual examination applicable when specified by a referencing Code Section. Specific visual examination procedures required for every type of examination are not included in this Article, because there are many applications where visual examinations are required.

2) Reference

- ASME Sec. V, Article 9 (2019 edition)
- ASME Sec. VIII (2019 edition)
- ASME Sec. IX (2019 edition)
- ASTM-E94- Nondestructive testing
- ASTM -E149- Control quality of radiography testing
- ASNT-TC-1A (Latest Edition)
- NIOEC-SP-41-03, NIOEC-SP-44-03
- 3034-00-ED-SE-JSP-44003-A2
- 3034-00-ED-SE-JSP-42001-A3.
- TEMA –Standard Class “R” - 8th edition
- 3034-MT-JSP-AA350

-04/EB-ME/OTH-R-0005 Rev. A Unfired pressure vessels (Based on HTAS Standard No. 4-1361/E).

3) Procedure Qualification

When procedure qualification is specified by the referencing Code Section, a change of a requirement listed in Table T-921 ASME Sec.V identified as an essential variable shall require requalification of the written procedure by demonstration. A change of a requirement identified as a nonessential variable does not require requalification of the written procedure. All changes of essential variables from those specified within the written procedure shall require revision of, or an addendum to, the written procedure.

4) Personnel Requirement

The user of this Article shall be responsible for assigning qualified personnel to perform visual

examinations to the requirements of this Article. As a minimum, interpretation must be carried-out by inspectors holding at least valid certificate to ASNT-TC-1A level II.

5) Physical Requirements

Personnel shall have an annual vision test to assure natural or corrected near distance acuity such that they capable of reading standard J-1 letters on standard Jaeger test type charts for near vision.

6) Equipment

Equipment used for visual examination techniques, for example, direct visual examination, shall have the proper capabilities. Capabilities include, but are not limited to viewing, magnifying, identifying, measuring, and/or recording observations in accordance with requirements of the referencing Code Section.

7) Technique

7.1) Applications

Visual examination is generally used to determine such things as the surface condition of the part, alignment of mating surfaces, shape, or evidence of leaking. In addition, visual examination is used to determine a composite material's (translucent laminate) subsurface conditions.

7.2) Direct Visual Examination

Direct visual examination may usually be made when access is sufficient to place the eye within 24 in. (600 mm) of the surface to be examined and at an angle not less than 30 deg to the surface to be examined. Mirrors may be used to improve the angle of vision, and aids such as a magnifying lens may be used to assist examinations. Illumination (natural or supplemental white light) for the specific part, component, vessel, or section thereof being examined is required. The minimum light intensity at the examination surface/site shall be 100 foot candles (1000 lux).

8) Evaluation

All examinations shall be evaluated in terms of the acceptance standards of the referencing Code Section.

9) Documentation

9.1) A written report of the examination shall contain the following information:

(a) the date of the examination

(b) procedure identification and revision used

(c) technique used

(d) results of the examination

(e) examination personnel identity, and, when required

by the referencing Code Section, qualification level

(f) identification of the part or component examined

9.2) Even though dimensions, etc., were recorded in the process of visual examination to aid in the evaluation, there need not be documentation of each viewing or each dimensional check.

10) Acceptance Criteria

10.1) Relevant Defects

The accessible surfaces of the welds shall be examined visually with no magnification required. The welds shall show complete fusion and no evidence of burning through the weld, and shall be free from cracking or porosity.

In addition, all surfaces to be examined shall be free of:

(a) relevant linear indications

(b) relevant rounded indications greater than 5 mm

(c) four or more relevant rounded indications in a line separated by 1.5 mm or less (edge to edge)

10.2) Alignment Tolerances

(a) Alignment of sections at edges to be butt welded shall be such that the maximum offset is not greater than the applicable amount for the welded joint category under consideration, as listed in Table 1. The section thickness t is the nominal thickness of the thinner section at the joint.

(b) Any offset within the allowable tolerance provided above 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 what would otherwise be the edge of the weld. Such additional weld metal buildup shall be subject to the

requirements of UW-42.

Table 1 (UW-33)

Section thickness (mm)	Joint Categories	
	A	B, C & D
Up to 13, incl.	1/4 t	1/4 t
Over 13 to 19, incl.	3 mm	1/4 t
Over 19 to 38, incl.	3 mm	5 mm
Over 38 to 51, incl.	3 mm	1/8 t
Over 51	Lesser of 1/16 t or 10mm	Lesser of 1/8 t or 19 mm

10.3) Finished Longitudinal & Circumferential Joints

(a) Butt welded joints shall have complete penetration and full fusion. As welded surfaces are permitted, However the surface of welds shall be sufficiently free from coarse ripples, grooves, Overlaps, and abrupt ridges and valleys to permit proper interpretation of radiographic and other required NDT.

(b) A reduction in thickness (under cut) due to the welding process is acceptable provided all of the following conditions are met.

(c) The reduction in thickness shall not reduce the material of the adjoining surfaces below the minimum required thickness at any point.

(d) The reduction in thickness shall not exceeded 1/32 in (0.8 mm) or 10% of nominal thickness of the adjoining surface whichever in less.

(e) To assure that the weld grooves are completely filled. So that the surface of the weld metal at any point does not fall below the surface of the adjoining base materials weld metal may be added as reinforcement on each face of the weld. The thickness of the weld reinforcement on each face shall not exceed in table (2).

(e) Concavity due to the welding process on the root side of a single welded circumferential Butt weld is permitted when the resulting thickness of the weld is at least equal to the thickness of the thinner member of the two sections being joined and the contour of the concavity is smooth.

Table 2 (UW-35)

Material nominal thickness (mm)	Maximum reinforcement(mm)	
	Category B & C Butt welds	Other welds
Less than 2.4	2.4	0.8
2.4 to 4.8 incl.	3.2	1.6
Over 4.8 to 13 incl.	4.0	2.4
Over 13 to 25 incl.	4.8	2.4
Over 25 to 51 incl.	5	3.2
Over 51 to 76 incl.	6	4
Over 76 to 102 incl.	6	6
Over 102 to 127 incl.	6	6
Over 127	8	8

MAGNATIC PARTICLE TESTING REPORT

EQUIPMENT NO.:	
DATE:	
REPORT NO.:	

Equipment Name:	REPORT NO.:	SHEET : OF	DATE:
DRAWING NO.:		STANDARD:	
TESTING SUBJECT:	BASE METAL:		

MAGNETIZING FORCE:

CURRENT TYPE AC ☐ DC HWR ☐ FWR ☐

TYPE OF MAGNETIC FIELD LONGITUDINA CIRCULAR ☐

MAGNETIZING METHOD:

COIL ☐ PROD ☐ HEAD SHOT ☐ FLEXIBLE CABLE ☐ CENTERAL CONDUCTOR ☐ YOKE

MEDIUMS: WET DRY ☐ FLUORESCENT ☐ VISIBLE ☐

MAGNETIC PARIIED: COLOR ☐ DRY ☐ WET ☐ HUORESCENT ☐ OTHER ☐

SURFACE CONDITION: AS WELD AS FORGED ☐ BRUSH ☐ AS MACHINED ☐ OTHER ☐

ROW	WELD NO.	MT NO.	MATERIAL	RESULT 1		RESULT 2		REMARK
				ACC.	REJ	ACC.	REJ	

INTERPRETER	VENDOR	OWNER/TPI
NAME:	NAME:	NAME:
SIGN:	SIGN:	SIGN:
DATE:	DATE:	DATE:

Vendor:	**LIQUID PENETRANT TEST REPORT**		EQUIPMENT NO.:
			Date:
			REPORT NO.:
			Page: **OF**

Applicable code :	**Stage of Examination**
Procedure ID:	
Material:	**Prepared Edge:** **After P.W.H.T** ☐ **As welded** ☐ **After Hydro .test** ☐ **Others** ☐

Surface preparation : **Grinding** ☐ **Machining** ☐ **Power Brush** ☐ **Others** ☐

Penetrant	**Type**	☐ Color Contrast	☐ Fluorescent
	Application	☐ Brushing	☐ Spraying
	Temperature : Ambient temp.	**Penetrate time:** 10 Minutes	**Penetrant Designation:**
Removal	☐ Water Washable Penetrant		**Removal Designation:**
	☐ Post Emulsifying Penetrant		
	☐ Solvent Removable Penetrant		
Developing	☐ Dry developer		**Developing Designation:**
	☐ Wet developer		

Row	**Item**	**Joint NO.**	**THK (mm)**	**Defect Type**	**Location**	**Dimension (mm)**	**Result**		**Remark**
							Repair	**Accept**	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

NOTE :

Judgment : Satisfactory ☐ unsatisfactory ☐

Interpretar	**VENDOR**	**OWNER/TPA**
NAME:	NAME:	NAME:
DATE:	DATE:	DATE:
SIGNATURE:	SIGNATURE:	SIGNATURE:

RADIOGRAPHY EXAMINATION REPORT

Project: **Item No.:** **Procedure:** **Code/Standard: ASME Sec VIII**	**Technique :** ☑ SWSI ☐ DWSI ☐ DWDI ☐ Pano **Film Type :** ☑ AA400 ☐ AGFA D4 ☑ MX125 ☑ R 4 **IQI:** ☐ 13~19 ☑ 10~16 ☐ 6~12 ☐ 1~7 **Density:** ☑ 2~2.5 ☑ 2.5~3 ☑ 3~3.5 ☐ 3.5~4	**Source Type:** γ ☑ x ☐ **Source Size :2X3mm** **Source Strength:56**	**Report No:** **Sensitivity:2% Max**	**Date:**	**Page: 1 of 1** **UG:0.5 Max**

Row	RT No :	JOINT.NO	SFD	THK(mm)	Welder Stamp	Req No	Weld Length (mm)	Film Length (cm)	Result 1				Result 2				Result 3				Defects Type & Location(cm)
									Acc	Rep	RS	RT	Acc	Rep	RS	RT	Acc	Rep	RS	RT	

Legend							
LC: Longitudinal Crack	**LOF**: Lack of Fusion	**CP**: Cluster Porosity	**PP**: Pipe Porosity	**SI**: Slag Inclusion	**RC**: Root Concavity	**Acc:**Accept
TC: Transverse Crack	**LOP**: Lack of Penetration	**PO**: Spherical Porosity	**CV:**Cavities	**TI**: Tungsten Inclusion	**EP**: Excess Penetration	**RS:**Reshoot
SC: Star Crack	**RU**: Root Undercut	**RPO**: Random Porosity	**WH**: Worm Hole	**OI:** Oxid Inclusion	**UF**: Under Fill	**Rep:**Repair
CC: Crater Crack	**CU**: Cap Undercut	**LP:** Linear Porosity	**PH**: Pin Hole	**BT**: Burn Through	**HB**: Hollow Bead	**RT:**Retake

INTERPRETER	VENDOR	OWNER/TPI
DATE:	**DATE:**	**DATE:**
NAME:	**NAME:**	**NAME:**
SIGN:	**SIGN:**	**SIGN:**

ULTRASONIC EXAMINATION REPORT

EQUIPMENT NO.:
Date:
REPORT NO.:
PAGE NO.:

PROCEDURE ID:	**THICKNESS:**	**SEARCH UNIT:**	**COUPLANT:**
ACCEPTANCE CRITERIA:	mm	MAKER: FREQUENCY:	OIL ☐ GREASE ☐ GLYCERIN ☐
GROOVE TYPE:	Inch	TYPE & SIZE:	SCA ☐ WATER ☐ CELLULOSE PASTE ☐
V ☐ U ☐ X ☐	**WELDING PROCESS:**	**SEARCH UNIT CABLE(S):**	**EQUIPMENT FUNCTION:**
K ☐ Y ☐ OTHER ☐	SMAW ☐ GMAW ☐ GTAW ☐	TYPE: Lenght:	TOLERANCE OF SCREEN HIGH LINEARITY:
SURFACE CONDITION:	FCAW ☐ SAW ☐ OTHER ☐	**TEST BLOCKS:**	TOLERANCE OF AMPLITUDE CONTROL LINEARITY:
AS WELD ☐ AS FORGED ☐	**EQUIPMENT**	CALIBRATION :	**EXAMINATION METHOD**
AS MACHINED ☐ AS CAST ☐	MAKER:	BASIC MATERIAL:	PULSE-ECHO ☐ STRAIGHT BEAM ☐ ANGLE BEAM ☐
AS GRINDED ☐ OTHER ☐	MODEL:	CALIBRATION dB: SCANNING dB:	IMMERSION ☐ CONTACT ☐ ROUGH TRANSMISSION ☐

NO.	ITEM	JOINT	Weld Length (mm)	SCAN AREA (mm)	DEFECT LOCATION			INTERPRETATION	RESULT		REMARKS
					X	L	D		ACCEPT	REJECT	

Judgment : Satisfactory ☐ Unsatisfactory ☐

INTERPRETER	**VENDOR**	**OWNER/TPI**
NAME	**NAME**	**NAME**
SIGN	**SIGN**	**SIGN**
DATE	**DATE**	**DATE**

WELDING VISUAL INSPECTION REPORT

OWNER REQ. NO.:	PROJECT NO.:	ITEM NO.:	REPORT NO.:	PAGE:	DATE:
KAS-0206-07	HX126	ALL ITEM	FPA-HX126-VT-001	1 of 1	

Row No.	Weld Identification	WPS NO.	MATERIAL (TYPE 1/ TYPE 2)	WELDER STAMP			RESULT
				ROOT	FILLING	CAP	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

INTERPRETAR	VENDOR	OWNER/TPI
NAME:	NAME:	NAME:
DATE:	DATE:	DATE:
SIGN.:	SIGN.:	SIGN.: