

 NISOC	<p>نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض</p> <p>خرید مخازن ذخیره ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0026_00)</p>																									
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طرح نگهداشت و افزایش تولید ۲۷ مخزن

NDT PROCEDURE

نگهداشت و افزایش تولید میدان نفتی بینک

V00	Nov.2024	IFA	IDrill M.E.	M.Fakharian	M.Sadeghian	
Rev.	Date	Purpose of Issue/Status	Prepared by:	Checked by:	Approved by:	CLIENT Approval

Status:

IFA: Issued For Approval
IFI: Issued For Information
AFC: Approved For Construction

 <p>NISOC</p>	<p>نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنيه تحت الارض</p> <p>خرید مخازن ذخیره ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0026_00)</p>																	
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1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also, PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

GENERAL DEFINITION

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields Company (NISOC)
PROJECT:	Binak Oilfield Development – Supply Storage Tank
EPD/EPC CONTRACTOR (GC):	Petro Iran Development Company (PEDCO)
EPC CONTRACTOR/PURCAHSER:	Joint Venture of: Hirgan Energy – Design & Inspection Companies (HE/DI)
VENDOR:	iDrill Middle East (iDrill M.E)
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
TPI:	Third-Party Inspector
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
MAY:	Is used where a provision is completely discretionary.

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2.0 SCOPE

This procedure shall be applied for Non-Destructive examination of welding related to the Elevated Potable tank(Tag No.TK-2209), Lean Glycol Storage Tank (TK-2102) and Fire Water Tank (TK-2301A/B).

3.0 REFERENCES CODE AND STANDARD

API 650;	Welded Steel Tank for Oil Storage
ASME Sec. V	Boiler & Pressure Vessel Code (NDT)
ASME Sec. VIII, Div.1	Boiler & Pressure Vessel Code
Project Specification	

4.0 PERSONNEL QUALIFICATION

Non-destructive examination shall be performed by operators qualified according to API650 Sec. 6 or SNT-TC-1A / ISO 9712 / EN 473.

5.0 REPORTING

Non-destructive examination results will be reported on the attached typical forms.

6.0 RADIOGRAPHIC TEST PROCEDURE

6.1. EQUIPMENT

This specification covers the requirement the radiographic examination of butt weld joints by X-Ray or Gamma-Ray.

X-Ray Source: The maximum voltage or energy of the source used in the examination equipment shall be in accordance with following table. The following X-Raymay be used:

TYPE	MAX. KV	Focal Spot Size (MAX.)	TKH
Portable Directional	150	1 X 2	6~30

GAMMA-Ray Source: The following Gamma-Ray source may be used:

Source	Source Size
Ir192	2 X 3
Selenium	3 X 4

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The radiographic technique shall demonstrate that the required radiographic sensitivity has been obtained. For this purpose, the radiographic technique shall be qualified on the minimum thickness of the material radiographed.

Film: Radiographic films shall be type II as described in ASTM E1815.

Brand: Care stream AA400 / AGFA D7 / Kodak MX-125

Penetrometer: Wire type I.Q.I. shall be used to judge the radiographic sensitivity.

Number and Placement of "I.Q.I.": As per Art. 2-T277 of ASME Sec. V (see Fig.1).

I.Q.I Selection: The designated wire diameter shall be as specified in Art.2-T276 of ASME Sec.V.

6.2. TECHNIQUE

6.2.1. Prior to radiographic examination the concerned welds will be visually acceptable

6.2.2. Weld will be prepared by any suitable manner to ensure a suitable radiographic contact.

6.2.3. The films shall be:

Centered on the weld and of sufficient width to permit insertion of identification markers and penetrometer (see Fig.1).

As close to the surface of the welds as practical

6.3. QUALITY

6.3.1.Sensitivity: As per code (Better than 2%)

6.3.2.Density: 2 to 4

6.3.3.Radiographs: All radiographs shall be free mechanical, chemical or other blemishes that would interfere with the image in the area of interest in the radiograph.

6.4. IDENTIFICATION AND LOCATION MARKERS ON RADIOGRAPHS

The type of identification and method by which identification is achieved shall be as agreed between Purchaser and Erector.

The minimum identification should at least include the following: The project name, The weld No., The welder No., Part thickness, Date. The letter "R" shall be used to designate a radiograph of a repair and shall include -1, -2, etc. for the number of repairs.

Location markers should be placed on the part being examined, whenever practical. Their exact locations should also be marked on the surface of the part being radiographed.

6.5. STORAGE AND PROTECTION OF FILM

6.5.1. Unexposed films shall be stored in clean and dry place.

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6.5.2. Radiographs will be bonded by the NDT Sub-contractor/Vendor for the duration of the works and field in suitable boxes with appropriate reports and paper works.

6.5.3. All radiographs, including any showing unacceptable quality prior to repair shall be delivered to Purchaser upon completion of the work.

6.5.4. Films should be handled only at their edges, and with dry, clean hands to avoid finger marks on the surface of the film.

6.5.5. Sharp bending, excessive pressure and round handling of any kind must be avoided.

6.6. EXTENT OF TESTING

6.6.1. Radiographic inspection is required for shell butt welds (see 1.6.3 and 1.6.4), annular plate butt welds (see 1.6.6) and flush type connections with butt welds (see 1.6.1).

Inspection by radiographic methods is not required for roof plates or bottom plate welds or for welds joining roof plates to the top angle, the top angle to the shell plates, shell plate to the bottom plates, or appurtenances to the tank.

6.6.2. The following requirements apply to vertical joints:

- a.** For butt welded joints in which the thinner shell plate is less than or equal to 3/8 inch (10mm) thick, one spot radiograph shall be taken in the first 10 feet (3 m) of completed vertical joints of each type and thickness welded by each welder or welding operator.
 - b.** Thereafter, without regard to the number of welders or welding operators, one additional spot radiograph shall be taken in each additional 100 feet (30 m) (approximately) and any remaining major fraction of vertical joint of the same type and thickness. At least 25 percent of the selected spots shall be at the junction of vertical and horizontal Joints, with a minimum of two such intersection spar tank. In addition to the foregoing requirements, one random spot radiograph shall be taken in each vertical joint in the lowest course.
 - c.** For butt-welded joints in which the thinner shell plate is greater than 3/8 in (10mm) but less than or equal to 1 in (25 mm) in thickness, spot radiograph shall be taken according to item a above. In addition, all junctions of vertical and horizontal joints in plates in this thickness range shall be radiographed; each film shall clearly show not less than 3 inches (75 mm) of vertical weld and 2 in (50 mm) of weld length on each side of the vertical intersection. In the lowest course, two spot radiographs shall be taken in each vertical joint: one of the radiographs shall be as close to the bottom as is practical, and the other shall be taken at random.
- The butt weld around the periphery of an insert manhole or nozzles shall be completely radiographed.

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6.6.3. One spot radiograph shall be taken in the first 10 (3 m) feet of completed horizontal butt joint of the same type and thickness (based on the thickness of the thinner plate at the joint) without regard to the number of welders or welding operators.

Thereafter, one radiograph shall be taken in each additional 200 feet (60 m) (approximately) and any remaining major fraction of horizontal joint of the same type and thickness.

6.6.4. The number of spots radiographs required herein shall be applicable on a per tank basis, irrespective of the number of tanks being erected concurrently or continuously at any location.

6.6.5. Each radiograph shall clearly show a minimum of 254 mm of weld length. The film shall be centered on the weld and shall be of sufficient width to permit adequate space for the location of identification marks and a thickness gauge or penetrometer (IQI).

6.6.6. When bottom annular plates are required by API 650, the radial joints shall be radiographed as follows:
For single side welded joints using a backup bar, one spot radiograph shall be taken on 50 percent of the radial joints. Location of radiographs shall preferably be at the outer edge where the shell plate joints the annular plate. The minimum length of each radiograph shall be 6 inches.

6.7. ACCEPTANCE CRITERIA

Evaluation of indications and acceptance standards shall be in accordance with UW-51(b) and mandatory appendix 4 of ASME Sec. VIII, Div.1.

7.0 ULTRASONIC TEST PROCEDURE

7.1. PURPOSE

This procedure describes the performance method of Ultrasonic test for welds and base metal of storage tanks.

7.2. SCOPE

This procedure is established to be ensuring that all ultrasonic tests will be carried out according to ASME Sec VIII App.12 for weld accordance specification.

7.3. PERSONNEL

All non-destructive examination shall be performed by personnel certificate in accordance with level II of ISO 9712 / EN473 or SNT-TC-IA.

7.4. REFERENCE STANDARD

- ASME Sec. V (2015)
- ASME Sec VIII (2015)
- SNT-TC-IA
- Supplementary requirements for storage tank for Hydro Treating and Hydro Cracking services

7.5. APPLICABLE PART

 NISOC	<p>نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض</p> <p>خرید مخازن ذخیره ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0026_00)</p>								
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Extend of examination shall be done according to NDT MAP.

7.6. EQUIPMENT AND MATERIAL

7.6.1. FLAW DETECTOR

7.6.1.1 Pulse-echo, A scan presentation type Ultrasonic equipment shall be used. All equipment shall be equipped with gain or attenuation control. All instruments shall be calibrated for the examination specified herein and shall be capable of meeting the requirements of screen height linearity and amplitude control linearity of ASME Sec V.

7.6.1.2 Flaw detector type site scan 240 (Sonatest) or equivalents may be used for this examination.

7.6.1.3 The equipment shall be capable of generating at test frequency within the range 2 MHZ to 4 MHZ and equipped with a stepped gain control calibration in units of 2.0 DB or less.

7.6.1.4 The equipment used shall be calibration at least 3 months for linear vertical presentation (screen height linearity) and amplitude control linearity and recorded.

7.6.2. SEARCH UNITS

The search units to be used shall have the following characteristics:

Row	Model	Size (mm)	Frequency	Thickness (mm)
1	$\alpha = 90^\circ$ - TR	Max Ø24 mm	2 ~ 4 MHZ	Up to 30
2	$\alpha = 70^\circ$	8x9 or 20x22	2 ~ 4 MHZ	Up to 30

7.6.3. RATE OF SCANING

The rate of scanning for examination shall not exceed 150mm/sec. unless calibration is verified at the scanning speed.

7.6.4. COUPLANT

Lubricant grease, wall paper adhesive, water, machine oil with SAE No.20 shall be used as a couplant.

7.7. SURFACE CONDITION

7.7.1. The base metal on each side of the weld shall be free of weld spatter, surface irregularities, loose foreign matter or coating that might interfere with the examination.

7.7.2. For contact examination the temperature differential between the calibration block and examination surface shall be within 14°C.

7.7.3. When the weld surface interferes with the examination, the weld shall be prepared as needed by permit examination. Preparation of as welded by grinding or machining may be required where surface irregularities would mask indication of unacceptable discontinuities.

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- 7.7.4.** The material surface shall be clean and free of dirt, grease and loose scale at a minimum distance of 1.5skip distance adding one inch.

7.8. CALIBRATION AND REFERENCE BLOCKS

- 7.8.1.** Weld locations and their identification shall be recorded on a weld map or in an identification plan.
- 7.8.2.** If welds are to be permanently marked, low stress stamps and/or vibrato ling may be used. Markings applied after final stress relief of the component shall not be any deeper than 3/64 in. (1.2 mm).
- 7.8.3.** Each weld shall be located and identified by a system of reference points. The system shall permit identification of each weld center line and designation of regular intervals along the length of the weld. A general system for layout of vessel welds is described in Non-mandatory Appendix A; however, a different system may be utilized provided it meets the above requirements.
- 7.8.4.** Weld locations and their identification shall be recorded on a weld map or in an identification plan. The following calibration block shall be available:
- IIW-V1 Calibration blocks (A2 block)
 - IIW-V2 Calibration blocks (DIN 54 122)
 - IOW beam profile block (BS 4331)

7.8.5. REFERENCE AND STANDARD

7.8.5.1 REFERENCE BLOCK MATERIAL

- 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.
- Reference block shall be manufactured as required by the reference code section, (fig 4) or as stated in the contract Engineering Standard.
- The blocks shall be contained the following reference reflectors:
 - Side drilled holes of 3.2 mm diameter.
 - The finish on the surface of block shall be no smoother than the surface finish of the components.

7.9. CHECK OF CALIBRATION

Calibration of equipment shall be done in two steps:

- Basic calibration block
- System calibration for angle & straight beam

7.9.1. BASIC HEIGHT LINEARITY

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Indication set at % of full screen	dB control change	Indication limits % of full screen
80%	-6 dB	32 to 48%
80%	-12dB	16 to 24%
40%	-6 dB	64 to 96%
20%	-12dB	64 to 69%

(Figure 2) Amplitude Control Linearity

7.9.3. TIME BASE LINEARITY (SWEEP RANGE CALIBRATION)

- Set a straight beam search unit in position "B" (fig 1) on the IIW block to attain 5 back reflections in the qualification range being certified.
- Adjust the time base so that the first and fifth back reflections coincide with the appropriate scale marks.
- Bring successive back reflections, in turn, to approximately the same heights (80% FSH).
- The leading edge of each signal should line up/break the time base line at the approximate graticule line.
- Record any deviations, but measured at approximately half full screen height and.
- Express any deviations from linearity as a percentage of the time base range between the first and fifth back reflection displayed. (Maximum acceptable=1%)
- Repeat using a range of 250mm.

7.9.4. RESOLUTION

Resolution of the combined electronic instrument and probe shall be proved on IOW (Institute of Welding) and IIW (International Institute of Welding) standard blocks to determine whether reflectors in close proximity to each other can be indicated clearly and separately.

7.9.5. STRAIGHT BEAM PROBE

The straight beam probe shall resolve the reflectors at a range of 85mm (2mm slit), 91mm and 100mm (flat surface) of the IIW calibration block.

7.9.6. ANGLE BEAM PROBE

The angel beam probe shall resolve the three (3) holes at 2.5mm spacing for hole frequencies (usually of 2-2.25 MHZ and higher), or the two (2) holes at 4mm spacing for low frequencies (2 MHZ) of the IOW beam profile block in fig 3.

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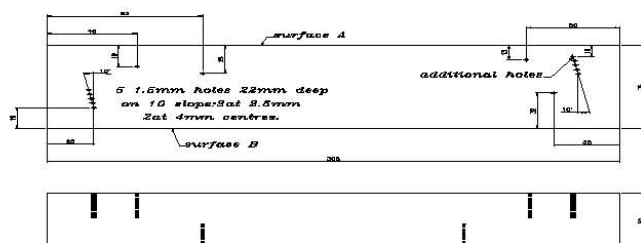
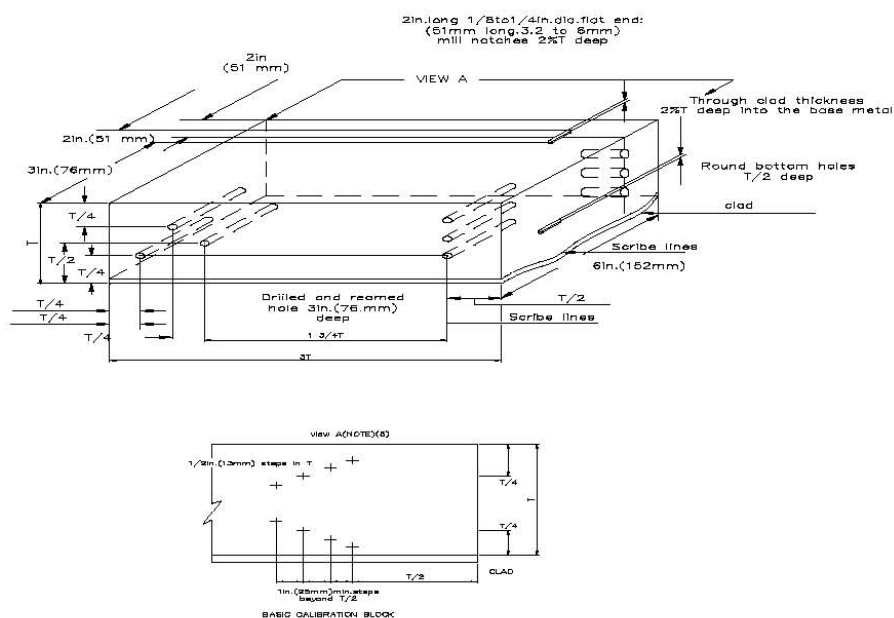


Figure (3) IOW BEAM PROFIEL BLOCK



(Figure 4) - BASIC CALIBRATION BLOCK

7.10. SYSTEM CALIBRATION

7.10.1. GENERAL REQUIREMENT

Calibration shall include the complete Ultrasonic examination system. The original calibration must be performed on the basic calibration block. In all calibrations, be obtained with the sound beam oriented for calibration perpendicular to the axis of the side-drilled holes and notches. The centerline of the search unit shall be at least 1.5 in (38mm) from the nearest side of the block (Rotation of the beam into the corner formed by the hole and the side of the block may product high amplitude at a ling beam path, this beam path shall not be used.

7.10.2. CALIBRATION SURFACE

Calibrations shall be performed from the surface (Clad or unclad; convex or un convex) corresponding to the surface of the component from which the examination will be performed.

7.10.3. COUPLANT

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

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7.10.4. CONTACT WEDGES

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

7.10.5. 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.

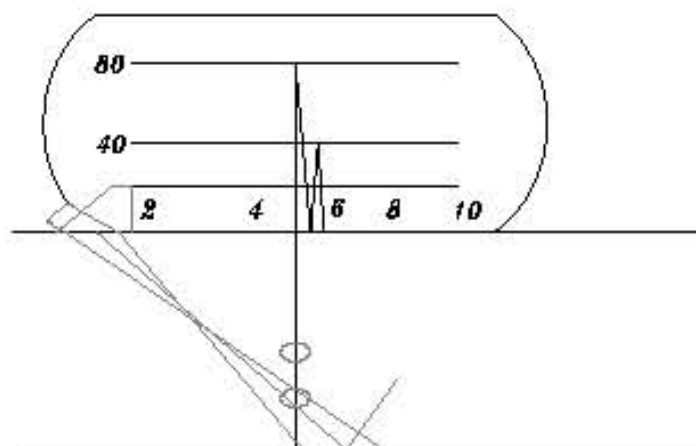
7.10.6. TEMPERATURE

For contact examination, the temperature difference between the calibration block and examination surface shall be within 14°C.

7.10.7. ANGLE BEAM CALIBRATION

The following calibrations shall be performed:

- Angle beam search unit checking
- Sweep range calibration
- Distance amplitude correction (DAC curve)
- Position calibration
- Echo amplitude measurement from the surface notch in the basic calibration block



7.10.8. ANGLE BEAM SEARCH UNIT CHECKING

Prior to start with its use each angle beam search unit has to be checked on the international institute of welding block type V1.

7.10.8.1 EXACT LOCATION OF BEAM POINT

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The location of the beam exit point is checked by placing the search unit over the check mark and positioning for maximum response. The check mark on the block then coincides with the true point of exit of the central beam ray into the search unit.

7.10.8.2 ANGLE OF INCIDENT

The angle of incident is checked by placing the search unit on the angle scale and using the large hole with Perspex insert. In position of maximum response, the true point of beam centerline shall coincide with the true mark of angle scale.

7.10.9. SWEEP RANGE CALIBRATION

The sweep range may be calibrated in terms of units of metal path, projected surface distance or actual depth to the reflector, it is anyway preferable the calibration in terms of eight of V-path in articles non-mandatory app.

1. Position of the search unit for the maximum first indication from the $\frac{1}{4}$ T side drilled hole. Adjust the left edge of this indication to line 2 on the screen with the delay control.
2. Position the search unit for the maximum indication from the $\frac{3}{4}$ T hole. Adjust the left edge of this indication to line 6 on the screen with the range control.
3. Repeat delay and range control adjustments until the $\frac{1}{4}$ T and $\frac{3}{4}$ T, hole reflections start at sweep line 2 and 6.
4. Position the search unit for maximum response from the square notch on the opposite surface. The indication will appear near sweep line 8.
5. Two divisions on the sweep equal $\frac{1}{4}$ T.

7.10.10. POSITION CALIBRATION

1. Position the search unit for maximum response from the $\frac{1}{4}$ T hole. Place one end of the indexing strip against the front of the search unit, the other end extending in the direction of the beam. Mark the number 2 on the indexing strip at the scribe line which is directly above the hole.
2. Position the search unit for maximum indications from the $\frac{1}{2}$ T and $\frac{3}{4}$ T holes. Keep the same and of the indexing strip against the front of the search unit. Mark the numbers 4, 6 and 10 on the indexing strip at the scribe line.
3. Position the search unit for the maximum opposite surface notch indication. Mark the number on the indexing strip at the scribe line.
4. The calibration numbers on the indexing strip indicate the position directly over the reflector in sixteenths of the V path.

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- The depth from the examination surface to the reflector is T at 8, $\frac{3}{4}$ T at 6 (and 10), $\frac{1}{2}$ T at 4 (and 12), $\frac{1}{4}$ T at 2 (and 14) and 0 at 0 (and 16). Interpolation is possible for smaller increments of depth. This is measurement may be corrected by the radius of the hole, if the radius considered significant to the accuracy of reflector's location.

7.10.11. STRAIGHT BEAM CALIBRATION

The calibration shall provide the following measurements:

- Sweep range calibration
- Distance-amplitude correction (DAC)

7.10.12. SWEEP RANGE CALIBRATION

- Position the search unit for the maximum first indication from the $\frac{1}{4}$ T side driller hole. Adjust the left edge of this indication to line 2 on the screen with the delay control.
- Position the search unit for the maximum indication from $\frac{3}{4}$ T hole. Adjust the left edge of this indication to line 6 on the screen with the range control.
- Repeat delay and range control adjustments until the $\frac{1}{4}$ T and $\frac{3}{4}$ T hole reflections start at sweep line2 and 6.

7.10.13. DISTANCE AMPLITUDE CORRECTION

- Position for maximum response form the hole which gives the highest amplitude.
- If any sensitivity setting has changed by more than 20% or 2 dB of its amplitude, correct the sensitivity calibration and note the correction in the examination record. If the sensitivity setting has decreased, all datasheets since the last valid calibration check shall be marked void and the area covered by the voided data shall be reexamined. If the sensitivity setting has increased, all recorded indications since the last valid calibration or calibration check shall be reexamined and their values shall be changed on the data sheets or re-recorded.
- Position the search unit for maximum response from another hole indication.
- Mark the peak of the indication on the screen.
- Position the search unit for maximum amplitude form the third hole indication and mark the peak on the screen.
- Connect the screen marks and extend through the thickness to provide the distance-amplitude curve for the side drilled holes.

7.11. SCANING PROCEDURE

- The weld joint plus 10mm of base material adjacent to H.A.Z shall be 100% examined which straight and or angle beam search unit.

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2. During the scanning the response from basic calibration block hole shall be magnified increasing the gain setting value of reference response for the evaluation of the indications.
3. The search unit shall be moved as so to obtain a complete exploration of the weld. Each pass of the search unit shall overlay a minimum of 10% of transducer width. The rate of manual scanning shall not exceed 6 in. per second.
4. For butt weld joints, examination of axial flaws shall be performed utilizing at least two different angle beams, shear wave probes. The weld shall be scanned from both sides and on the inside and outside surfaces where access permit, to ensure complete coverage of the weld volume.
5. For set-on or set-in nozzle weld joints examination of the weld shall be performed utilizing at least two different angle beams, shear wave probes and a compression wave probe. The weld shall be scanned from the inside and outside surface of the shell and from the outside surface and internal bore of the nozzle.

7.12. EVALUATION

All indications which produce a response greater than 20% of reference level shall be investigated to the extent, the operator can evaluate the shape, identity location and size of all such reflectors in terms of acceptance standards of par. 13.

All indications in excess 50% of primary reference level shall be recorded.

Doubtful indications may be confirmed by radiographic examination.

The length of discontinuities shall be determined placing the search unit at two border points, in which the response is half the maximum value given by the local discontinuity.

7.13. ACCEPTANCE STANDARDS

Acceptance criteria shall be according to ASME Sec VIII, App. 12.

7.14. REMOVAL OF DEFECT

1. Indications or discontinuities in excess to standards shall be removed by mechanical means and repaired by qualified welding procedure, where necessary.
2. The repaired area shall be reinserted using the ultrasonic examination procedure according to this specification.

7.15. POST CLEANING

After examination the coupling media, used for the ultrasonic examination, shall be removed.

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7.16. REPORTING

Report shall have the bellow data as a minimum.

- Project name & No.
- Client.
- Report No.
- WPS No.
- Procedure No.
- Test technique.
- Probes information.
- Weld No.
- Type of material dimension thickness equipment
- Calibration sheet identity.
- Identification of weld or volume to be scanned.
- Surface condition.
- Map or record of indication detected.
- Date & time of exam.
- Basic calibration block.
- Reporting date.
- Frequency.
- Sensitivity.
- Ultrasonic instrument identification (including manufacturer's serial number)
- Couplant used, brand name or type
- Examination personnel identity
- Search unit cable(s) used, type and length.

8.0 LIQUID PENETRANT TEST PROCEDURE

This Specification gives the general requirement the liquid penetration examination, using visible penetrants type water washable/Solvent Removable, of parts which temperature remain in the range of 10 to 52°C during all steps of examination.

The examination for non-standard temperatures shall be qualified according to par. T-653 of ASME Sect.VArt.6. This Specification meets entirely the requirements of ASME Sec. V & Sec. VIII Div. I

8.1 SURFACE PREPARATION

- a. The surface to be inspected shall be finished to the drawing requirements. Where the drawing does not specify; otherwise, as welded surface condition shall be considered suitable for inspection.

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Surface preparation by grinding machining or other methods may be necessary where surface irregularities.

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

8.2 DRYING

After cleaning, drying of the surface to be examined shall be accomplished by normal evaporation or with forced hot or cold air. A minimum period of times shall be established to ensure that the cleaning solution has evaporated prior application of the penetrant.

After the cleaning operations have been completed, a minimum time of 30 minutes shall pass prior to penetrant application.

8.3 EXAMINATION METHOD

8.3.1. STANDARD TEMPERATURE

As a standard technique, the temperature of the penetrant and the surface of the part to be processed shall not be below 16 °C nor above 52 °C throughout the examination period.

Local heating or cooling is permitted provided the part temperature remains in the range of 16 °C to 52 °C during the examination. Where it is not practical to comply with these temperature limitations, other temperatures and items may be used, provided the procedures are qualified as specified in ASME SEC.V PART T-648.

8.3.2. PENETRANT APPLICATION

The penetrant may be applied by any suitable means, such as dipping, brushing or spraying.

8.3.3. PENETRANT DWELL TIME

Penetration time must remain on the part

to allow proper penetration should be as recommended by the penetrant manufacturer, but as a guide for selection of penetrant dwell times 5 minutes may be assumed. After the specified penetration time has elapsed, any penetrant remaining on the surface's shall be removed, taking care to minimize removal of penetrant from discontinuities.

Excess water washable penetrant shall be removed with a water spray. The water pressure shall not exceed 50 psi, and the water temperature shall not exceed 43 °C.

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In special applications, penetrant removal may be performed by wiping the surface with a clean, absorbent material dampened with water until the excess surface penetrant is removed, as determined by examination under white light for visible methods.

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

Local heating or cooling is permitted provided the temperature of the part remains in the range of 10 to 52 C for visible methods unless otherwise agreed by the contracting parties.

8.3.4. DEVELOPING

The developer shall be applied as soon as possible after penetrant removal; Insufficient coating thickness may not draw the penetrant out of discontinuities; conversely, excessive coating thickness may mask indications.

A-Wet Developer Applications

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

B- Aqueous Developer

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.

C- Developing Time

The length of time the developer is to remain on the part prior to examination should be not less than 7 min. Developing time begins immediately after the application of dry powder developer and as soon as the wet (aqueous and non-aqueous) developer coating is dry.

8.4 INTERPRETATION

Final interpretation shall be made within 7 to 30 min after the wet developer coating is dried. If bleed out does not alter the examination results, longer periods are permitted.

The type of discontinuities is difficult to evaluate if the penetrant diffuses excessively in to the developer. If this condition occurs, close observation of the formation of indication during application of the developer may assist in characterizing and determining the extent of the indications. With a color contrast penetrant, the developer forms Uniform white coating, surface discontinuities are indicated by bleed out of the

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penetrant which is normally a deep red color that stains the developer. Indication with a light pink color may indicate excessive cleaning.

Inadequate cleaning may leave an excessive back ground making interpretation difficult. Adequate illumination is required to ensure adequate sensitivity during the examination and evaluation of indication.

8.5 ACCEPTANCE STANDARDS

Evaluation of indications and acceptance standards shall be in accordance with Appendix 8 of ASME Sec. VIII, Div.1.

8.6 REPAIRING AND REEXAMINATION

Unacceptable imperfection shall be removed by chipping or grinding, when the area shall be cleaned and prior to making weld repairs, the area shall be examined by suitable method to ensure that it has been removed or reduced to an imperfection of acceptable size. Welding shall be performed according to relevant qualified welding procedure.

The repaired area shall be reexamination by the liquid penetrant method.

9.0 LEAK TEST PROCEDURE

9.1 GENERAL NOTES

- a- The leak testing methods in storage tank shall be applied for bottom & annular plates, all reinforcing pads and roof plates.
- b- The correct choice of leak testing method for sensitivity, cost and reliability shall be checked.
- c- It is important to distinguish the sensitivity associated with the instrument employed to measure leakage and the sensitivity of the test system followed using the instrument.

9.2 METHODS

The leak testing method that uses in storage tank normally described as follows:

- a. Direct pressure technique
- b. Vacuum box technique.
- c. Penetration oil technique.

9.3 GENERAL REQUIREMENT

The leak testing shall be performed before hydrostatic testing. For the leak testing the following items shall be checked before testing:

- a. Personnel qualification / certificate b-Calibration of equipment/tools

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- b. Extent of examination
- c. Acceptable test sensitivity of leakage rate
- d. The test surface shall be free of oil, grease, paint or other contamination's that might mask a leak
- e. The pressure or vacuum limitation unless specified in specification shall not exceeding % 25 of the design pressure
- f. When dial indicating and recording pressure gages are used in leak testing, they should preferably have the dial graduated over a range of about double the intended
- g. Maximum pressure, but in no case the range shall be less than 1½ no more than four items that pressure.
- h. The whole dial indicating and recording type gages used shall be calibrated against a standard dead weight tester, a calibrated master gage, or a mercury column, and re calibrated at least once a year, when in use.

9.4 DIRECT PRESSURE TECHNIQUE

- a. Prior to examination the test pressure shall be held for a minimum of 15 min.
- b. The temperature of the surface of the parts to be examined shall not be below 5 C nor above 50 c throughout the examination. Local heating or cooling is permitted provided temperatures remain within the range of 5C to50 C during the test.
- c. The area under test is acceptable when no continuous bubble formation is observed.
- d. When leakage is observed, the position of the leak(s) shall be marked. The component will then be de pressurized, and the Leak repaired. After repair have been made, the repaired area or areas shall be retested in accordance with the requirements of this procedure.
- e. After testing, surface cleaning may be required for product service ability.
- f. This procedure shall be used for testing of roof plates except floating roof and reinforcing pads. For testing the roof plates applying internal air pressure after filling the tank at hydrostatic test not exceeding the weight of the roof plates.

9.5 AIR TEST/SOAP TEST

The welds of each pad or segment shall give a 0.5 kg/cm² or 14.5 psi air and soap solution test in the presence of company inspector before testing the vessel. The holes shall be left open for use as tell-tale holes. They shall be filled with corrosion inhibiting grease after test and prior to shipment.

All certificate (gauge, water & recorder) shall be available with TPA approval 24 hours before the hydro test.

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Nozzle reinforcing plates when used shall have threaded tell-tale holes and be subjected to an air and soapy water tightness.

9.6 OIL PENETRANT TEST PROCEDURE

Penetrant Testing (Oil Test) operations after ending of annular root pass welding to first course is done as follows:

- 1- Welding lines and around of welded lines clean with wire brush
- 2- Any dust on surface and around of welded area clean with sweep
- 3- Surface of welding and it's around should not be wet
- 4- Behind of welded part must be cleaned from outside
- 5- Liquid with high osmotic properties (preferably gasoline) must be Pouring around tank from outside (Just behind the welding line)
- 6- A thin layer of powder is poured on welding line if needed or employer inspector request
- 7- Visual inspection of the inside is done after 8 to 24 hours

10.0 MAGNETIC PARTICLE TEST PROCEDURE

10.1 PURPOSE

This procedure covers the requirement of magnetic particle examination utilizing with AC Yoke -Visible method.

10.2 APPLICABLE PART

Regarding project specification and standards, this examination shall be performing according to NDT MAP.

10.3 PERSONNEL QUALIFICATION

The operator performing magnetic particle testing will be qualified and to level. level II personnel may be certified by their employer in accordance with the recommendations in SNT – TC – 1A.

10.4 SURFACE CONDITION OF THE OBJECT

The objects under test shall meet the requirements of the relevant welding specifications and ASME Sec V, that the surfaces not to be such to cause indications, which might be interpreted as defected indications. The surface under test and all adjacent area within least 25 mm of the material on either side will be dry and free from grease, dirt, slag, scale, welding flux, spatter, oil, or other extraneous matter that could interfere with examination.

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10.5 EQUIPMENT/TEST MEDIA

Equipment will have valid calibration status. It is not allowed to use equipment without a valid calibration status.

- Equipment
- yoke type: model (MPT) M
- yoke type, model Magna Flux
- Field strength indicator
- ASME penetrometer
- field direction indicator
- Test Media

Whenever water carrier-based test suspensions are being used, suitable conditioning agent have to be added to provide wet proper wet dispersing and to reduce the surface tension of the test suspension in addition to corrosion protection. The test media which used in this test may be as below:

Fluid spray, magna flux 7 HF.

NOTE 1: Perfect removing of contrite paint is a main problem alter each testing, and residual paint may cause contamination.

NOTE 2: Intermixing of different chemical brands is not allowed.

Contrast Paint

When contrast paint is applied temporarily on surface where the contrast has to be enhanced it must be demonstrated that indication can be detected through the enhancement coating.

Full surfaces of testing shall be painted before magnetizing with below media Paint contrast MR – 72

10.6 METHOD OF TESTING

When testing in accordance with this method, particles media is during magnetization and the object will be inspected during magnetization. Each period of on / off switching is depending on to the yoke type (it is about 3 Sec.), but testing will be continuous.

10.6.1. TYPE OF CURRENT

Alternating current shall be used in combination with the electromagnetic yoke.

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10.6.2. DIRECTION OF MAGNETIZATION, CHECKING OF FIELD STRENGTH AND OVERLAP

Every part shall be magnetized in two directions where the magnetization has to be approximately perpendicular to the first magnetization.

Checking the field strength and the direction of the magnetization can be performed by using ASME type the overlap of the magnetic fields has to be 10% minimum to assure 100% testing.

10.6.3. YOKE MAGNET

The minimum and maximum pole distance is about 75mm ~ 165mm

With respect to the ASTM E 709, the lifting power for AC current is 4.5Kg and for DC current will be 18 Kg.

10.6.4. CHECKING SUSPENDED PARTICLES

A pear-shaped centrifuge shall be used to check the suspended particles, the centrifuge tube has been at rest, the amount of settlement is ink determined. The settlement equals the concentration of the test liquid the concentration of the test liquids shall be:

Color contrast suspension: 1.3 to 2.5 ml per 100 ml.

10.6.5. APPLICATION OF TEST MEDIA

The test suspensions shall be supplied with a squeeze bottle or a spray can. They have to be constantly agitated to prevent the test suspension to settle down. the testing temperature shall not exceed 57° C.

6.6.7) Lighting conditions

All testing with color type particles shall be performed only at the day light with sufficient white light.

10.6.6. DEMAGNETIZATION

Whenever the client asked specifically for de- magnetization, this will be performed by the operator.

10.6.7. POST – EXAMINATION CLEANING

Post- cleaning is or necessary where magnetic particle material could interfere with subsequent processing or with service requirements. The client should specify when post – examination cleaning is needed and the extent required.

All surface with contrast paint or residual inks shall be cleaned before welding and when they interfere with service requirements.

10.7 INTERPRETATION OF INDICATION

10.7.1. INDICATION

Indications are made visual based on the fact that magnetized particles are being attracted and held in a leakage flux field. These indications are not necessarily defecting because also surface roughness and changes in permeability can cause indications (non-relevant indications).

10.7.2. NON-RELEVANT INDICATION

Non-relevant indications are indications as described above and those indications that are not being caused by mechanical imperfections such as grooves and undercutting.

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10.7.3. RELEVANT INDICATION

Relevant indications are indications that are being caused by mechanical imperfections with a dimension greater than 1.6 mm.

10.7.4. DESCRIPTION OF INDICATION

Liner indication: A liner indication is one having a length greater than three times the width.

Rounded indication: 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 as long as the nature of any indication is uncertain it will be regarded as a relevant indication

10.8 ACCEPTANCE CRITERIA

Acceptance criteria shall follow the limits of ASME Sec VIII, App. 6. The following limits are for rejected indicates.

- Any liner indications
- Rounded indications > 4.8 mm
- Four or more rounded indication in a line separated by less than edge to edge

Note: An indication of an imperfection may be larger than the imperfection that causes it; however, the size of an indication is the basis for acceptance evaluation.

10.9 REPORTING

All testing shall be reported on standard reports. The report shall contain the following information:

- Procedure and technique
- Type of equipment and equipment identification number
- Identity of operator and qualification, signature and stamp
- Report number
- Date of examination
- Weld or identification number
- Order number, drawing number, request number
- Test suspension and contrast paint
- Material type
- Acceptance criteria
- Weld method and welder number

10.10 REFERENCE

- ASME SEC. V article 7(Edition 2023)

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-Project Specification

11.0 VISUAL TEST PROCEDURE

11.1 VISUAL INSPECTION

Visual inspection is the most common used type of inspection. In this method flaws can be detected by naked eye or with help of instruments. VT shall be performed before, during and after welding operations by qualified inspector, to detect discontinuities. VT. is also performed after sand blasting and painting.

11.2 PRIOR TO WELDING

Examination of the base metal prior to fabrication can detect conditions that can cause weld defects. Scabs, seams, scale can be detected with VT. Plate lamination may be observed on cut edges. Dimension should be confirmed by measurements. Base metal should be identified type and grade. Correction should be made before work proceeds.

After the parts are assembled for welding, the weld joint root opening, edge preparation and other features should be checked that might affect the quality of the weld. Here is a list of check points:

1. Joint prep, dimensions and cleanliness
2. Clearance dimensions of backing strips, rings or consumable insert
3. Alignment and fit-up
4. Welding process and consumables
5. Specific preheat temp.
6. Tack weld quality

11.3 DURING WELDING

During welding VT is the primary method of quality control. Here are some check points of this phase:

1. Treatment of tack welds
2. Quality of root pass and succeeding weld layers
3. Proper preheat and inter pass temp.
4. Sequence of weld passes
5. Inter pass cleaning
6. Root condition prior to welding second side
7. Distortion
8. Conformance with applicable procedure

The most critical part of a weld is the root pass. Complete VT of the root pass may detect conditions that can cause a defect in the completed weld. The root opening should be monitored as the welding

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progresses. The tack weld, clamps or braces should be designed to maintain specific root opens to assure proper joint penetration and alignment.

Inspection of successive layers of weld metal is concentrated on the bead shape and cleaning. When specified, preheat and inter pass temperatures should be monitored at the proper times with a suitable temp Measuring Device. The amount of heat input and also welding sequence and placement of each weld pass may be specified to maintain mechanical proper ties or limit distortion or both. Each weld pass should be evaluated before the next bead is applied.

11.4 AFTER WELDING

Items that are checked after welding are:

1. Final weld appearance
2. Final weld size
3. Extent of welding
4. Dimensional accuracy
5. Amount of distortion

Many of the following discontinuities on the surface can be found by VT:

1. Cracks
2. Undercut
3. Overlap
4. Exposed porosity and slag inclusions
5. Unacceptable weld profile
6. Roughness of the weld

For detection and accurate evaluation of discontinuities, the weld surface should be thoroughly cleaned of oxide and slag, which if not can cause the weld to be rejected by most codes.

Dimensional accuracy of weld elements is determined by conventional methods. The conformity of the weld size and contour may be detected by using suitable weld gages. The size of a fillet welding joints, whose members are at right angles, or near, is defined in terms of the length of legs. The gage should determine if the leg size is within the allowable limits, and whether there is excessive concavity or convexity.

For groove welds, the height of reinforcement should be consistent with requirements. Surface appearance requirements differ widely. The weld surface appearance should meet the requirements of the standard. Cracks, incomplete fusion and unfilled craters are not accepted.

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11.5 ACCEPTANCE CRITERIA

Acceptance criteria should be accepted by API 650 Para. 6.5.

11.6 ALIGNMENT OF JOINTS

11.6.1. VERTICAL JOINTS

Plate thickness up to 15.9mm: 10% of plate thickness or 1/16 in (1.6mm) whichever is smaller

Plate thickness over 15.9mm: 10% of plate thickness or 1/8 in (3.2mm) whichever is smaller

11.6.2. HORIZONTAL JOINTS

20% of the upper plate thickness or 1/8 in (3.2mm) whichever is less

11.7 REPAIR

Welds that fail to meet the visual inspection shall be reworked before hydrostatic testing in accordance with the following:

- Defects in welds shall be chipped, melted out, or machined out until sound metal is reached on all sides. Subject to the approval of the inspector, the resulting cavity shall be filled with the weld metal and retested.
- Re welding shall be required if the resulting thickness is below the minimum required for design and hydrostatic test condition. All defects in area above the minimum thickness shall be feathered to at least a 4:1 taper.
- The repair weld shall be examined visually for defects.