|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **طرح نگهداشت و افزایش تولید 27 مخزن** | | | | | | |
| **NDE PROCEDURE**  **نگهداشت و افزایش تولید میدان نفتی بینک** | | | | | | |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| V01 | Nov. 2023 | IFR | Havayar Co. | M.Fakharian | S.Faramarzpour |  |
| V00 | May. 2023 | IFR | Havayar Co. | M.Fakharian | A.M.Mohseni |  |
| **Rev.** | **Date** | **Purpose of Issue/Status** | **Prepared by:** | **Checked by:** | **Approved by:** | **CLIENT Approval** |
|  | | | | | | |
| **Status:** | **IFA: Issued for Approval**  **IFR: Issued for Review**  **IFI: Issued for Information**  **AFC: Approved for Construction** | | | | | |

**REVISION RECORD SHEET**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **PAGE** | **V00** | **V01** | **V02** | **V03** | **V04** |  | **PAGE** | **V00** | **V01** | **V02** | **V03** | **V04** |
| **1** | X | X |  |  |  | **66** |  |  |  |  |  |
| **2** | X | X |  |  |  | **67** |  | X |  |  |  |
| **3** | X | X |  |  |  | **68** |  |  |  |  |  |
| **4** | X |  |  |  |  | **69** |  |  |  |  |  |
| **5** | X | X |  |  |  | **70** |  |  |  |  |  |
| **6** | X | X |  |  |  | **71** |  |  |  |  |  |
| **7** | X | X |  |  |  | **72** |  |  |  |  |  |
| **8** | X | X |  |  |  | **73** |  |  |  |  |  |
| **9** | X | X |  |  |  | **74** |  |  |  |  |  |
| **10** | X | X |  |  |  | **75** |  |  |  |  |  |
| **11** | X | X |  |  |  | **76** |  | X |  |  |  |
| **12** | X | X |  |  |  | **77** |  |  |  |  |  |
| **13** | X | X |  |  |  | **78** |  |  |  |  |  |
| **14** | X | X |  |  |  | **79** |  |  |  |  |  |
| **15** | X | X |  |  |  | **80** |  | X |  |  |  |
| **16** | X | X |  |  |  | **81** |  |  |  |  |  |
| **17** | X | X |  |  |  | **82** |  |  |  |  |  |
| **18** | X | X |  |  |  | **83** |  |  |  |  |  |
| **19** | X | X |  |  |  | **84** |  |  |  |  |  |
| **20** | X | X |  |  |  | **85** |  |  |  |  |  |
| **21** | X | X |  |  |  | **86** |  |  |  |  |  |
| **22** | X | X |  |  |  | **87** |  |  |  |  |  |
| **23** | X | X |  |  |  | **88** |  |  |  |  |  |
| **24** | X | X |  |  |  | **89** |  |  |  |  |  |
| **25** | X | X |  |  |  | **90** |  |  |  |  |  |
| **26** | X | X |  |  |  | **91** |  |  |  |  |  |
| **27** | X | X |  |  |  | **92** |  |  |  |  |  |
| **28** | X | X |  |  |  | **93** |  |  |  |  |  |
| **29** | X | X |  |  |  | **94** |  |  |  |  |  |
| **30** | X | X |  |  |  | **95** |  |  |  |  |  |
| **31** | X | X |  |  |  | **96** |  |  |  |  |  |
| **32** | X | X |  |  |  | **97** |  |  |  |  |  |
| **33** | X | X |  |  |  | **98** |  |  |  |  |  |
| **34** | X | X |  |  |  | **99** |  |  |  |  |  |
| **35** | X | X |  |  |  | **100** |  |  |  |  |  |
| **36** |  | X |  |  |  | **101** |  |  |  |  |  |
| **37** |  | X |  |  |  | **102** |  |  |  |  |  |
| **38** |  | X |  |  |  | **103** |  |  |  |  |  |
| **39** |  | X |  |  |  | **104** |  |  |  |  |  |
| **40** |  | X |  |  |  | **105** |  |  |  |  |  |
| **41** |  | X |  |  |  | **106** |  |  |  |  |  |
| **42** |  | X |  |  |  | **107** |  |  |  |  |  |
| **43** |  | X |  |  |  | **108** |  |  |  |  |  |
| **44** |  | X |  |  |  | **109** |  |  |  |  |  |
| **45** |  | X |  |  |  | **110** |  |  |  |  |  |
| **46** |  | X |  |  |  | **111** |  |  |  |  |  |
| **47** |  | X |  |  |  | **112** |  |  |  |  |  |
| **48** |  | X |  |  |  | **113** |  |  |  |  |  |
| **49** |  |  |  |  |  | **114** |  |  |  |  |  |
| **50** |  |  |  |  |  | **115** |  |  |  |  |  |
| **51** |  |  |  |  |  | **116** |  |  |  |  |  |
| **52** |  |  |  |  |  | **117** |  |  |  |  |  |
| **53** |  | X |  |  |  | **118** |  |  |  |  |  |
| **54** |  |  |  |  |  | **119** |  |  |  |  |  |
| **55** |  |  |  |  |  | **120** |  |  |  |  |  |
| **56** |  |  |  |  |  | **121** |  |  |  |  |  |
| **57** |  |  |  |  |  | **122** |  |  |  |  |  |
| **58** |  | X |  |  |  | **123** |  |  |  |  |  |
| **59** |  | x |  |  |  | **124** |  |  |  |  |  |
| **60** |  |  |  |  |  | **125** |  |  |  |  |  |
| **61** |  |  |  |  |  | **126** |  |  |  |  |  |
| **62** |  |  |  |  |  | **127** |  |  |  |  |  |
| **63** |  |  |  |  |  | **128** |  |  |  |  |  |
| **64** |  |  |  |  |  | **129** |  |  |  |  |  |
| **65** |  | X |  |  |  | **130** |  |  |  |  |  |

Contents

[1.0 INTRODUCTION 4](#_Toc150002002)

[2.0 GENERAL DEFINITION 4](#_Toc150002003)

[3.0 Scope 5](#_Toc150002004)

[4.0 References 5](#_Toc150002005)

[5.0 KWANGSHIN MACHINE IND. COMPANY NDE PROCEDURE 5](#_Toc150002006)

[6.0 Visual Test (VT) Procedure 49](#_Toc150002007)

[7.0 Operation Description and the Procedure 50](#_Toc150002017)

[8.0 Penetration Test (PT) 54](#_Toc150002022)

[9.0 Radiography Test Procedure 59](#_Toc150002031)

[10.0 Ultrasonic Test Procedure 68](#_Toc150002068)

[11.0 MAGNETIC Particle TEST Procedure 77](#_Toc150002107)

1. **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.

As a part of the Project, a New Gas Compressor Station (adjacent to existing Binak GCS) shall be constructed to gather of 15 MMSCFD (approx.) associated gases and compress & transfer them to Siahmakan GIS.

1. **GENERAL DEFINITION**

The following terms shall be used in this document.

|  |  |
| --- | --- |
| CLIENT: | National Iranian South Oilfields Company (NISOC) |
| PROJECT: | Binak Oilfield Development – Surface Fcilities; New Gas Compressor Station |
| EPD/EPC CONTRACTOR (GC): | Petro Iran Development Company (PEDCO) |
| OWNER: | OWNER is collectively refer to National Iranian South Oil Company (NISOC) and Petro Iran Development Company (PEDCO) |
| EPC CONTRACTOR: | Joint Venture of: Hirgan Energy – Design & Inspection (D&I) Companies |
| VENDOR: | HAVAYAR Company |
| EXECUTOR: | Executor is the party which carries out all or part of construction and/or commissioning for the project. |
| THIRD PARTY INSPECTOR (TPI): | The firm appointed by EPD/EPC CONTRACTOR (GC) and approved by CLIENT (in writing) for the inspection of goods. |
| SHALL: | Is used where a provision is mandatory. |
| SHOULD: | Is used where a provision is advisory only. |
| WILL: | Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR. |
| MAY: | Is used where a provision is completely discretionary. |

1. **Scope**

The scope of this instruction is to describe the non-destructive testing (NDT) which must be performed on welded area of the equipment produced by HAVAYAR Industrial Group.

A non-destructive test is a method by which, one can observe the safety or defects of the material without destroying the examined part. These tests are performed to identify the possible defects as a result of welding operation or the production procedure. Various non-destructive tests including visual test (VT), penetration test (PT), magnetic test (MT), ultrasonic test (UT) and radiography test (RT) are described in the note. This verity of tests could be ensuring the reliable performance of the constructed equipment.

It’s noted that NDE test of Bare block, Pump and filter is based on manufacture standard and are not considered in this procedure.

1. **References**

* ASME Sec. VIII Div. 1 (edition 2015) UW-5, 52 & Appendix 4.
* ASME B31.3 (edition 2015)
* ASME Sec. V Article 1, 2, 6, 9 (edition 2014).
* ASTM-E-94, Standard Guide for Radiographic Examination.
* ASNT recommended practices no. SNT-TC-1A for NDT personal qualification and certification (1996 Edition with 1998 Ad.).
* Iranian Petroleum Standard (IPS).

V01

* API 618

1. **KWANGSHIN MACHINE IND. COMPANY NDE PROCEDURE**

* UT PROCEDURE
* PT PROCEDURE

**NDE Procedure for Other Equipment**

1. **Visual Test (VT) Procedure**

This is the first non-destructive test which is done on the external and internal accessible parts.

**6.1 Validity**

This instruction is applicable for identification of visual defects in welding units in HAVAYAR Industrial Group or the contractor's workshops.

**6.2 Responsibilities**

The quality control operator is responsible for performing this test and the quality control manager is in charge of supervision and the final approval.

NDE personnel shall be qualified, in accordance with SNT-TC-1A (ASNT). Only qualified and certified Level II or Level III personnel will be done all examination and evaluation.

The vendor shall be responsible to for damages to property or for personal injuries which result from the gross negligence of the Supervisor(s) while performing his duty.

**6.3** **Defects**

Usually, the visual test done on the equipment and under-pressure parts shows the surface defects on the parts and the weld. Below, different defects and their adjustments are mentioned:

**6.4 Corrosion on the Materials Used**

This defect is usually seen on the surface of the materials which are kept in a situation good for corrosion for a long time Of course some of these effects can be created because of the improper producing methods or situations. In this case the quality control operator can approve or not.

Approve the defect according to the related standards regarding to the range of the corrosion (of course there is a defect called "Mill Scale" or "the factory oxidation" on most of the materials, which is NOT considered as a surface- defect).

Note: In visual tests every kind of breaking, cutting, bending or crushing which is caused during transferring or falling is not acceptable.

**6.5 Weld under Cut**

This is a common defect in welding which usually appears near the weld lines and is seen as depression or sharp and disordered edges near the weld. These defects are caused mainly because of the improper place of the welder, not adjusting the voltage and the ampere and also the improper size of the selected filler and electrode. Those defects with the depth exceeding 0.8mm or 10% of the base thickness, whichever less, are not acceptable. Undercuts with a length exceeding 10% of the weld length shall be repaired.

**6.6 Worm Hole (surface hydrogen bubbles)**

This defect is usually seen as big or small holes on the weld's surface (sometimes this defect appears on the middle layers which cannot be seen in visual tests). This defect is mainly appeared because of the grease on the welding surfaces, filters, electrodes or even the welder's gloves. To remove this defect, the surface of the welds must ground and again the welding operation should be performed.

**6.7 Burn Trough**

This defect is seen around the weld lines and on the metal surface as black or dark blue (according to the metal) extended spots. This defect is mainly appeared as a result of the high ampere or the uneven temperature on the parts/materials. To prevent this defect, it is better not to use high ampere and to move the temperature of the melted area on the thicker parts.

**5.8 Root & Cap Concavity**

This defect is seen as a concavity on the root or the cap and it is usually caused as a result of the high pace, low filtration and the improper electrode.

**6.9 Spatters**

This defect is seen as weld spatters on and around the weld line. This defect is mainly appeared as a result of welding operation with high ampere. All spatters shall be removed prior to painting.

1. **Operation Description and the Procedure**

**Definition and Usage**

This instruction is used for visual testing of the weld lines and other parts that must be tested in this way. Visual test is considered as a non-destructive test. All the tests always begin with the visual tests.

**Testing Procedure**

* Visual tests are usually done to define the condition of the surface, parallelism of two parts, the appearance or the leaking problem. Also, the lucidity, clearness and existence of other materials on the surface can be tested.
* Welds shall be examined visually before any other non-destructive examinations are performed. All cracks, lack of fusion, surface slag /scale overlaps, undercuts, arc strikes and surface porosity are unacceptable.
* The visual test must be done on all of the welded joints.
* All the weld surfaces must be cleaned by a wire brush (100% weld lines).
* Testing the fitting edges and its approval/non-approval (according to WPS) must be done before the visual test.
* Welding Gauge is used to measure the weld dimensions.
* All surfaces to be welded shall be visually inspected: they shall contain no limitations or other injurious defects.
* Structural attachment welds shall be continuous (skip welding not permitted). Filler welds shall have a minimum leg length of 4 mm.
* The temporary welds shall be subsequently removed and ground flush with the base material, and then inspected by non-destructive methods (magnetic particle or dye penetrant). On non-magnetic materials, this examination shall be made by dye penetrant method.
* Any defect found during this inspection shall be removed and repaired by a qualified welder using welding procedures approved by the Contractor. The method of removing attachments shall not injure the metal surface (i.e., they shall not be removed by hammering off).
* Defects that are outside of the applicable codes and standards, this specification, project specifications or other requirements stated on the purchase order, shall be cause for rejection and the manufacturer shall take such remedial action as is necessary to secure acceptance. Such work shall be subject to the inspection agency approval and shall be at the sole expense of the manufacturer.
* Complete repair of a weld is found by inspection to be unsound, or which are deposited from those properly qualified, shall be rejected, completely removed from the equipment, and replaced using an approved procedure.
* When welding is judged to be unsatisfactory by inspection agency, the individual responsibility for the work shall be suspended from welding and all his work examined by non-destructive means. Welding found to be unacceptable by the inspection agency shall be repaired. The individual may be repaired assigned only after additional training, the completion of satisfactory requalification tests, and with the approval of the inspection agency.
* All repairs shall be documented and shall be included in the Manufacturer’s data book. Repairs shall be advised to the inspection agency; the repair method, the welding procedure and welder qualification, etc., shall be in accordance with this specification and shall be approved by the inspection agency before any repair being initiated.
* Weld containing cracks shall be subject to additional non-destructive testing (Ultrasonic or magnetic particle) and then, the extent of repair shall be decided by the inspection agency. Repair welding will only be permitted after consideration of the nature and cause of cracking.
* Unacceptable defects shall be removed by chipping, grinding, machining or air-arc gouging. Where air-arc gouging is used, all carbon, cooper and other debris, including carburized metal, shall be removed by grinding or other mechanical methods approved by the inspection agency. Oxygen gouging of quenched and tempered steels or other high strength steels is not permitted.
* For partial repairs, the cut-out portion shall be sufficiently deep and long to remove the defect. At the ends and sides of the cut, there shall be a gradual taper from the base of the cut to the surface of the weld metal. The width and profile of cut shall provide adequate access for re-welding. Special care shall be taken to remove weld defects located at the root in order to obtain an acceptable root gap.
* Prior to commencing any repair, the repair groove shall be examined by dye penetrant method in accordance with ASME Code Section V to ensure all defects are removed.
* All repaired welds in joints shall be checked by repeating the original inspection procedure.

**Different Tests**

* Direct testing is a kind of visual test in which the distance between the eye and the material is less than 24 inches and the vision angle is less than 30°. In this test one can use a mirror to adjust the vision angle or the magnifying lens to enlarge the object. Also, there must be enough light and a torch, a projector, etc. can be used, if needed. In normal situations, the light needed for the visual testing is equal to 100 FC (1000 LUX) and in special situations like testing small parts, this amount increases to 50 FC. It is obvious that the eye of the tester must be well enough to see the objects.
* Sometimes the visual tests are done indirectly and by the means of other   
  tools. For example, mirror, binoculars, microscope, baroscopic, or the optical fiber can be used. Even in some cases using tools to perform the test is better than the direct visual test.
* Visual tests can be performed with helping lights, which is more than the environment light, that is somehow a supplementary for the direct visual test. In this method by shining direct light to the surface dark and light spots can be seen well. Light spots are defected parts. This method is used for glass or transparent materials. The light of the environment must be unchanging while testing. Classification of these defects is described in the employer's standards. Approval/ no approval of the defects in the visual test is according to the standards or the contract.

**Report**

Visual test reports are documented in "Visual Inspection Report" form. Name of the part, the date of the inspection, method of inspection, the results and the general specification of the part must be included in the report.

V01

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Client:** | | | **VISUAL INSPECTION REPORT** | | | | | | | **Manufacture:** | | | | | |
| **Date:** | **Form No.:** | | | | **Sub Project:** | | | | **Serial No.:** | | | | | **Equipment :** | |
| **Welding Process :** | | | | | | | | | | | | | | | |
| **Remarks** | **Kind of Defect** | | **Result** | | | | | **Joint Type** | | | **Welders No.** | | | | **Line No.** | |
| **Rej.** | **Rep.** | | **Acc.** | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| --- |  | |  |  | |  | |  | | |  | | | |  | |
| NISOC | | PEDCO | HE/DI | | | | TPI | | | | | | HAVAYAR | | |
| Owner | | EPD/EPC Contractor(GC) | EPC Contractor | | | | Third Party Ins. | | | | | Vendor | | | |
|  | | Name: | Name: | | | | Name: | | | | | Name: | | | |
|  | | Date: | Date: | | | | Date: | | | | | Date: | | | |
|  | | Sign: | Sign: | | | | Sign: | | | | | Sign: | | | |

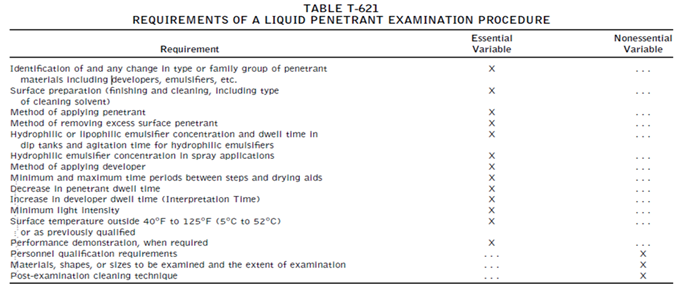
1. **Penetration Test (PT)**

The liquid penetrant examination method (Penetration Test) is an effective means for detecting discontinuities which are open to the surface of nonporous metals and other materials. Typical discontinuities detectable by this method are cracks, seams, laps, cold shuts, laminations, and porosity.

In principle, a liquid penetrant is applied to the surface to be examined and allowed to enter discontinuities. All excess penetrant is then removed, the part is dried, and a developer is applied. The developer functions both as a blotter to absorb penetrant that has been trapped in discontinuities, and as a contrasting background to enhance the visibility of penetrant indications. The dyes in penetrants are either color contrast (visible under white light) or fluorescent (visible under ultraviolet light).

**Requirements**

* The detail and description of requirements for pre-examination and minimum time for drying and etc. refer to ASME SEC. V Article 6 (edition 2010, addenda 2012), (paragraph T-621.1).
* All necessary additional information will be provided on liquid penetration test report.
* All weld deposit overlay including clad restoring at weld seams, whether by manual or automatic procedure, shall be 100% liquid dye penetrant examined in accordance with methods described in ASTM E165.
* Weld deposit overlay machined surfaces shall be 100% PT on finished condition.
* All cracks and circular defects greater than 1.6 mm diameter in weld deposit overlay shall be removed. Repaired areas shall be 100% re-inspected by liquid dye penetrant.

****

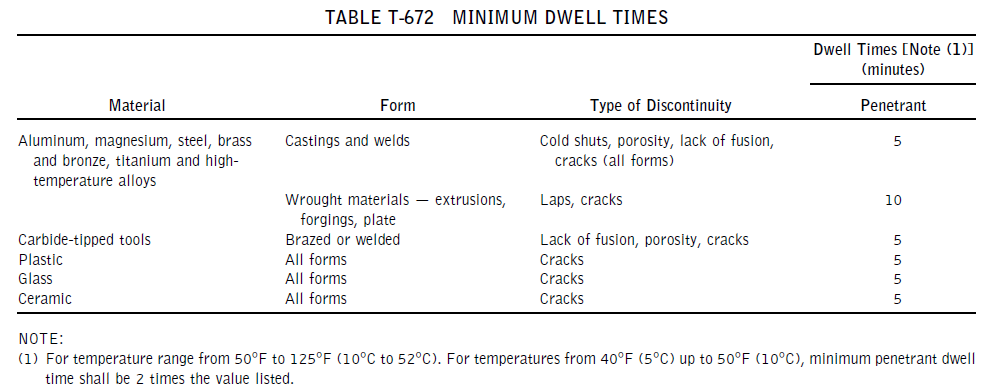
**General Comments**

* Dye penetration test on root passes after back chipping of the weld seems to be conducted after satisfactory on visual check.
* Temperature of the part to be examined as a standard technique temperature of the part to be processed shall not be below 50 F (10C) nor above 125 F (52 ) throughout the examination period.
* Surface preparation of parts before PT inspection shall meet the requirement ASME SEC V (edition 2010, addenda 2012) CHAPTER T-642
* The surface to be examined and all adjacent area within at least 25 mm shall be dry and free from all dirt, grease, lint, scale, welding flux, spatter and oil or other extraneous matter that could obscure surface indication and interfere with the examination. Excessive weld ripples, unevenness, etc. with may interfere with the evaluation of discontinuities shall be ground smooth.

**Examination Medium**

Using 3 special kinds of liquid sprays is essential to conduct PT which detail is indicated as below:

* “Cleaner” (thinner) is a transparent liquid spray that utilized to clean the Surfaces of the welded joints prior to the test and remove the excess penetrant on surface.
* “Dye penetrant” is a red color liquid spray, which indeed its usage is to penetrate into the smallest cracks of the weld joints. Applying method for penetration material is spraying and shall meet the requirement ASME SEC V (edition 2015), chapter T-671.
* “Developer” is a white liquid spray, which indeed shows the defects of weld areas.
* Penetrant material to be used or applied on austenitic stainless steel or titanium, chlorine and fluorine content shall be less than 1% by weight. In addition, in this case certificates of examination material shall be provided.
* PT materials is solvent washable type.
* Brand name of PT material is MAGNUFLUX (cleaner=SKC-S type & developer=SKD S2 type & penetrant=SKL-SP1 type). Irrespective of method or system all component materials (penetrant, cleaner and developer) shall be from the same brand or manufacture’s system. Interchanging or use of penetrant, developer & developer from different brand or manufacture shall not permitted.
* Excess water washable penetrant shall be removed with water spray. The water pressure shall not exceed 50psi and the water temperature shall not exceed 43 centigrade.
* Method of applying developer is done by spraying that provides a thin surface coating is obtained over entire surface being examined.
* Developer dwell time for final interpretation shall made within 10 to 60 min after the requirement of ASME SEC V (edition 2015), T-675.3 are satisfied. If bleed out does not alter the examination results, longer period is permitted. If surface to be examined is large enough to preclude complete examination within the prescribed or established time, the examination shall be performed in increments.



* Minimum light intensity of 500 LX is required to ensure adequate sensitivity during the examination and evaluation of indication.
* Performance demonstration of above PT material shall meet the requirement related data sheet that has been attached.
* Hydrophilic or lipophilic emulsifier information is not applicable for water washable method.
* Cleanliness shall be maintained after completion of welding. All Rods, flux and foreign materials shall be removed from the equipment of piping.

**Personnel Qualification**

* Qualification of personnel for dye penetration test is according to SNT-TC-1A (at least level II) 1996 edition with 1998 or similar.
* Interpretation shall be performed by personal qualification according to SNT-TC- 1A, level II or III.

**Penetration Test Procedure**

Prior to start the PT the entire joints surfaces and all adjacent areas within at least 25.4 mm shall be reform any rust, grease, burs, etc.

* After cleaning and drying of the surface to be examined shall be accomplished by normal evaporation or with forced hot or cold air. A minimum period of time shall be established to ensure that the cleaning solution has evaporated prior to application of the penetrant.
* Pressurized air would take away the dust & burs. Air should be clean and shall not contain oil, water or dirt.
* The targeted area which will undergo the test shall be cleaned-out by using a cleaner spray, using cleaner spray would remove all the probable grease and Residue stock to the joint areas.
* Cleaning the surface by using pieces of fabrics and also be dried-out (minimum drying time 5 min.), so that the surface is completely ready to start the test.
* 4.5-5) At this stage the red liquid spray will be applied (PENETRANT) after which that the liquid Penetrates into the cracks, which could take about 5 minutes for welds & min. 10 minutes for forging and plates to penetrate into the cracks.
* Before Appling the cleaner spray for removing all applied PENETRANT, area should be completely Dried-out.
* At this stage the surface metal is completely cleaned and dried so that the area is ready to apply the developer.
* After spraying the developer, one should wait for at-least 10 minutes up until the liquid completely issue out of the Cracks and only at that time, we could see the probably cracks & fractures.
* Study of Weld Defect such as pin holes and etc. is according to acceptance criteria: ASME Sec. VIII. Div. 1 appendix 8. (Edition 2015)
* After grinding the defected areas, it should be inspected by PT and to assure that the defects are completely repaired, all the above stages should be again applied by PT to the welded areas. Re–inspection by PT is in accordance with this procedure.
* The area & distance of spraying should be carefully measured in order to be most effective.
* Post examination 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.

**Evaluation and Acceptance Standards**

* The reference for evaluation & interpretation will be done according to ASME SEC VIII, Div. 1, and APP.8 (edition 2015).
* The examination shall be evaluated and reported by qualified personnel.

**Safety Precautions**

* The area of the test should be completely cleaned and covered to avoid the wind.
* Avoid contact with skinned eyes. In case of contact with eyes, rinse And Seek Medical device. During performance, do not eat, drink or smoke. Wear suitable gloves and eye/face Protection. Contains no CFC propellant. Non-flammable propellant. Protect from sunlight, which do not expose to temperatures in excess of 50◦C according to ASTM-E 165 Minimum temperature for PT test is 15°C.

**Reports**

Finishing the test procedures, all the observations and analysis must be recorded in the Penetration Test Report form and after being signed by the quality control manager, the relevant inspector must confirm it and it must be kept in the project documentations.

Some information which must be recorded in the PT test report is: parts' materials, the name of the weld line or the part, reports conclusion, the kind of the defect (if any), etc.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Client:** | | | | | | | **PENETRATION TEST REPORT** | | | | | | **Manufacture:** | | | | | | | |
| Date: | **Form No.:** | | | | | **Sub Project:** | | | | | **Serial No.:** | | | | | | | **Equipment :** | | |
| **Reference :** | | | | | | | | | | | | | | | | | | | | |
| **Remark** | | | Acceptance  Criteria | **Result** | | | | | | Type of  Defect | | **Time(min.)** | | | | | **Material** | | **Joint Name** | |
| **Rej.** | | **Rep.** | | **Acc.** | | **Deve.** | | **Pen**. | | |
|  | | |  |  | |  | |  | |  | |  | |  | | |  | |  | |
|  | | |  |  | |  | |  | |  | |  | |  | | |  | |  | |
|  | | |  |  | |  | |  | |  | |  | |  | | |  | |  | |
|  | | |  |  | |  | |  | |  | |  | |  | | |  | |  | |
|  | | |  |  | |  | |  | |  | |  | |  | | |  | |  | |
|  | | |  |  | |  | |  | |  | |  | |  | | |  | |  | |
|  | | |  |  | |  | |  | |  | |  | |  | | |  | |  | |
|  | | |  |  | |  | |  | |  | |  | |  | | |  | |  | |
|  | | |  |  | |  | |  | |  | |  | |  | | |  | |  | |
|  | | |  |  | |  | |  | |  | |  | |  | | |  | |  | |
| NISOC | | PEDCO | | | HE/DI | | | | TPI | | | | | | | HAVAYAR | | | |
| Owner | | EPD/EPC Contractor(GC) | | | EPC Contractor | | | | Third Party Ins. | | | | | | Vendor | | | | |
|  | | Name: | | | Name: | | | | Name: | | | | | | Name: | | | | |
|  | | Date: | | | Date: | | | | Date: | | | | | | Date: | | | | |
|  | | Sign:  V01 | | | Sign: | | | | Sign: | | | | | | Sign: | | | | |

1. **Radiography Test Procedure**

**General**

**Surface Preparation**

Surfaces shall satisfy the requirements of the applicable materials specifications, with additional conditions, if necessary, by any suitable process to a degree that surface irregularities cannot mask or be confused with discontinuities. Maximum weld reinforcement shall not exceed the values given in ASME, Sec. VIII Div-1 UW-35 (edition 2015).

**Methods of Identification**

The method shall be used to produce permanent identification to the radiographies traceable to the contract, components, welds or weld seams, or part numbers, as appropriate. This identification mark shall not obscure the area of interest.

**Radiation Back Scatters**

As per ASME, Sec. V, T223, a lead symbol B with minimum dimensions of ½ in. In height and 1/16 in. in thickness. Shall be attached to the back of each film holder during each exposure to determine if back scatters radiation is exposing the film.

If a light image of the "B" letter appears on a darker background of the radiograph, the radiograph shall be considered unacceptable. In this case the protection against backscatters must be improved and the film retaken.

**Personnel Qualification**

Personnel performing radiography examination to this procedure shall be qualified and certified by IRAEO, (Islamic Republic Atomic Energy Organization) also shall meet the requirements of SNT-TC-1A at least level II (1996 Edition with 1998 ad.). Film interpreter shall have level II as a minimum.

Operation of radiographic generators will be undertaken by trained SNT-TC-1A level I radiographic machine operators.

Radiographer and his assistant radiographer must have at least a degree equivalent to ASNT-SNT-TC-1A and 3 years and 2 years of relevant practical experience in the construction of oil and gas projects and facilities, respectively.

Also, the X-ray interpreter must have at least a certificate equivalent to ASNT-SNT-TC-1A with 5 years of relevant film reading experience in the construction of oil and gas projects and facilities.

*Safety*: Before performing radiography, the personnel must be trained for using GAMA-Ray. They will be obliged to wear the dosimeter films badge.

V01

**Equipment and Materials**

**Film**

Any commercially available industrial radiography films may be used in accordance with SE 1815 (ASTM) standard test method for film system in industrial radiography. Radiography film for carbon steel and stainless-steel equipment shall be ultra-fine grain (Kodak type M or D4 (AGFA GEVAERT)). The film length shall be 150 mm minimum.

The film treatment shall be in accordance with the film supplier recommendations to fulfill the EN 584-1 category requirements.

In radiographing a continuous length of weldment with separate films, the separate films shall overlap at least 10 mm to ensure that no portion of the weld length remains unexamined.

**Lead Screens**

**Definition:** the two thin lead sheets on both sides of a radiography film are called lead screens or intensity screens.

Reasons for using intensity lead screens:

* By using these screens, the exposure duration decreases.
* By using these screens scattered radiant cannot reach the film from the floor.
* These screens can somehow protect the films.

**Image Quality Indicator (IQI) Design**

Penetrometers shall be either the whole type or the wire type and shall be manufactured and identified in accordance with the requirements or alternatives allowed in SE 142 or SE 1025 (for hole type) and SE-747 (for wire type), and appending. ASME V (edition 2015) & ASME Sec VIII Div. I (edition 2015) standard penetrometers shall consist of those in table T-233.1 for hole type and those in table T 233.2 for wire type (Wire type IQI shall be used for welds).

**Densitometer**

Densitometer shall be used for assuring compliance with film density requirements and densitometer calibration shall be verified by comparison with a calibrated step wedge film traceable to a national standard.

Calibration certificate shall be provided.

**Cassette**

Flexible PVC or rubber type cassette shall be used and film holders shall be light tight.

**Film Viewing Illuminator**

Film viewing illuminator shall provide sufficient light for comfortable viewing. Film viewing illuminator should provide sufficient light intensity to penetrate 4.0 densities. The brightness of surroundings should be about the same as the area of interest in radiograph. Single-film viewing shall be used, and the film density shall be in the range of 2.5 to 3.5.

**Shim**

The shim dimensions shall exceed to penetrometer dimensions such that the outline of at least three sides of the penetrometer images shall be visible in radiographies.

**Calibration**

**Source Size**

The equipment manufacturers or suppliers’ publications, such as technical manuals, decay curves, or written statements documenting the actual or maximum source size or focal point, shall be acceptable as source size verification.

**Step Wedge Film and Densitometer**

The density of step wedge comparison film and densitometers calibration shall be verified by comparison with a calibration step wedge film traceable to a national standard. The densitometer shall be calibrated in accordance with paragraph 5 of SE-1079- calibration of transmission densitometers.

**Examination**

**Source Selection of Radiation Energy**

**Gamma Radiation**

The recommended minimum thickness for which radio-active isotopes may be used as follow:

|  |  |
| --- | --- |
| **Material** | **Minimum thickness of Iridium192 cobalt 60** |
| Steel  Copper or high nickel copper  Aluminum | 0.75 in 1.5 in  0.65 in 1.3 in  2.50 in -- |

The maximum thickness for the use of radioactive isotopes is primarily dictated by exposure time, therefore; upper limits are not shown. The minimum Recommended thickness limitation may be reduced when the radiography techniques are used to demonstrate that the required radiography sensitivity have been obtained, by purchaser approval.

**Special Conditions**

When special conditions do not make it practical to perform radiography within the limitations outlined in above table, the procedure shall be proved satisfactory by actual demonstration of penetrometer resolution on the minimum thickness of the material radio graphed.

**Direction of Radiation**

The direction of the central beam of radiation shall be centered on interest When-ever practical.

**Geometric Un-sharpness**

Geometric un-sharpness of the radiograph shall be determined in accordance with ASME Sec. V Article2



Where:

: Geometric un-sharpness.

: Source size: the maximum projected dimension of the radiating source (or effective focal point) in the plane, Perpendicular to the distance from the weld or object is subjected to radiography.

: Distance from source of radiation to weld or object being radio graphed.

: Distance from source side of weld or object being radio graphed to the film.

When required by the referencing code section geometric Un-sharpness of the radiography shall not exceed the following:

The geometrical un-sharpness shall not exceed 0.2 mm.

**Radiography Techniques**

A single-wall exposure technique shall be used for radiography whenever practical. When it is not practical to use a single-wall technique, a double-wall technique shall be used as alternative.

**Single Wall Viewing**

* In single wall viewing technique, the radiation passes through only one wall of the weld (material), which is viewed for acceptance on the radiograph. Source side markers shall be used when radiography the following:
  + Flat components or cylindrical castings curved or side is toward the source and when the “source-to-material” distance is less than the inside radius of the castings. Curved or spherical castings or welding whose convex side is toward the source.
* Film side markers shall be used when performing radiography, either curved or spherical components whose concave side is toward the source and when the “source-to material” distance is greater than the inside radius.
* Either side markers shall be used when radiography either curved or spherical components whose concave side is toward the source and the “source-to-material” distance is equal to the inside radius of the component.

**Double Wall Viewing**

For double-wall viewing, at least one location marker shall be placed on the source side surface adjacent to the weld (or on the material in the area of interest) for each radiograph.

**Mapping**

Mapping the placement of location marks when inaccessibility or other limitations prevent the placement of markers as stipulated in ASME Sec. V (edition 2015) article 2T-275.1 and T-275.2 a dimensioned map of the actual marker placement shall accompany the radiographs to show that full coverage has been obtained such as:

* Seam weld no. & film no.
* Welder stamp
* Weld thickness
* Location mark
* Client name
* Radiography date
* Item No.
* Repair & Re-shooting marker (R1, R2…)
* “F” marker when penetrometer is placed on film side.

Location markers (ASME Sec. V (edition 2015) article 2fig.T-275- attached) which are to appear as radiography images on the film, shall be placed on the part (not on the exposure holder/cassette). The identification marks shall include, project identification, equipment Tag No. and date of testing.

**Traceability:** all longitudinal and circumferential weld lines shall be properly numbered. During the radiography test, start and end points shall be clearly indicated.

**Penetrometer/(IQI) Selection**

IQI’s Material shall be selected from either the same alloy material group or grade as identified in ASME Sec. V (edition 2015), SE.1025. For welds joining dissimilar materials or filler metal the IQI material shall be selected based on materials group 1 (SE. 1025-7.3.4).

**Size:**

The designated hole penetrometer with essential hole or designated wire diameter shall be as specified in ASME Sec. V (edition 2015).

Article 2 table T-276. A Smaller hole in a thicker Penetrometer may be substituted for any section thickness listed in table T-276, provided equivalent penetrometer sensitivity (EPS) is maintained and all other requirements for radiographies are met. In determining sensitivity any allowable weld reinforcement should be accounted. For welds with strips or backing rings, the thickness of backing ring is not regarded in determination of sensitivity.

**Number of penetrometers:**

When one or more film holders are used for an exposure, ate least one penetrometer imager shall appear on each radiograph.

If the requirements of T-282 are met by using more than one penetrometer, one shall be representative of the lightest area of interest and the other the darkest area of interest.

The intervening densities, on the radiograph, shall be considered as having acceptable density.

**Placement of penetrometers:**

Penetrometer shall be placed adjacent to the weld seam in accordance with ASME Sec. V, Para. T 277.1

**Sensitivity:**

The sensitivity required using wire type IQI shall be 2%.

**Part thickness at IQI location:**

Where inaccessibility prevents hand placing the penetrometer (s) on the source side, it shall be placed on the film side in contact with the part being examined. A lead letter “F” shall be placed adjacent to or on the penetrometer (s).

**Film Processing**

After performance of radiography all films shall be developed as below sequence for manual processing:

**a) Developer**

Replenishment rates and renewal of solutions shall be done according to manufacturer's recommendation.

* 5 to 8 minutes in 20 °C

**b) Stop bath in 20 °C**

When the temperature is higher or lower, development line must be changed and manufacturer's recommendation should be followed.

**c) Fixing**

* Hangers should be agitated vertically for 10 to 20 seconds and again at the end of the first minute in order to obtain uniform fixing.
* At least twice clearing time to 15 minutes.

**d) Washing**

* Clean running water hourly flow.
* Care should be taken not to over wash the films.
* 16 ~ 30 °C

**e) Drying**

* Warm, filtered or circulating air dries the film.
* 30 to 45 minutes in ambient temperature to 60 °C

**Evaluation**

**Quality of Radiographies**

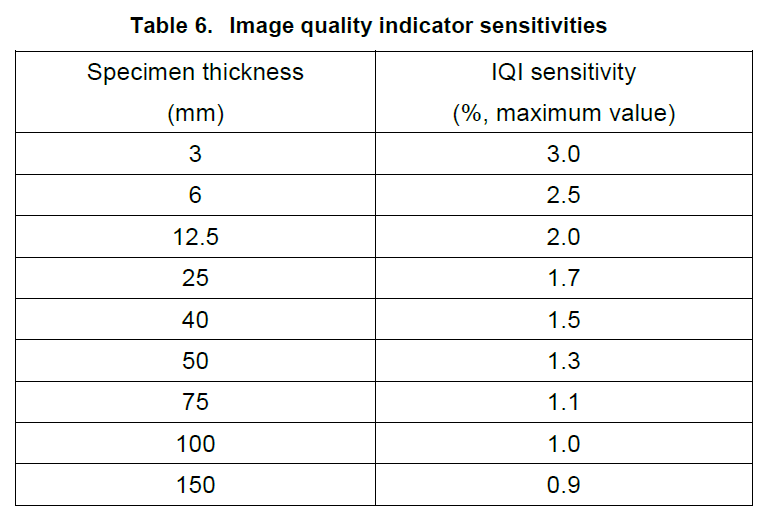
All radiographies shall be free from mechanical, chemical, mechanical or the blemishes to the extent that they do not mask and are not confused with the image of any discontinuity in the area of interest of the object being radio graphed.

**Radiography Density**

The transmitted film density through the radiographic image of the body of the appropriate hole penetrometer or adjacent to the designated wire of a wire penetrometer and the area of interest shall be 2.0 minimum for radiographies made with a gamma ray source. A tolerance of 0.05 in density is allowed for variations between densitometer readings (ASME Sec. V Art. 2 (edition 2015) paragraph. T-282-1, T-282).

**IQI (penetrometer) Sensitivity Film Density**

IQI (penetrometer) sensitivity film density shall be within a range of 2.5 to 3.5 radiography shall be performed with a technique of sufficient sensitivity to display the hole penetrometer image and the 2T hole, or the designated wire of a wire penetrometer, which are essential indications of the image quality of the radiograph. The sensitivity maximum shall be according to Table-6.



**Extent of Examination**

The extent of examination shall be according to NDT table and following the requirements of the code and relative client specification.

**Acceptance Standards**

Refer to ASME Sec VIII, Div. 1 (edition 2015)-UW-51(b) a) Butt welded joints surfaces shall be sufficiently free from coarse ripples, grooves, overlaps and abrupt ridges and valleys to permit proper interpretation of radiographic and the required nondestructive examinations.

If there is a question regarding the surface condition of the weld when interpreting a radiographic film, the film shall be compared to the actual weld surface for determination of acceptability.

Indications shown on the radiographies of welds and characterized as imperfections are un-acceptable under the following condition:

1) Any indications characterized as a crack or zone of incomplete fusion or penetration.

2) Any other elongated indication at radiography, 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 t (19mm) for t over 2 1/4 in. (57mm)

Where:

t= thickness of weld excluding any allowable reinforcement.

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

4) Rounded indications in excess of that specified by the acceptance standards given in ASME sec. VIII, DIV I, (edition 2010, addenda 2012).

**Note:** spot RT shall be done as per ASME Sec. VIII, Div. 1 (edition 2015) UW-52; however, the acceptance criteria shall be according to UW-51 (as specification).

**Record**

* Each radiography shall be documented on the format radiography examination on report form. The report shall be signed and dated by the Qualified and certified personnel, whom evaluate the results of radiographies.
* The following radiography records shall be maintained as agreed upon between purchaser and supplier.
* Radiography standard shooting sketch.
* Weld repair documentation.
* Film
* Film interpretation record containing as a minimum:
  + Disposition of each radiography (acceptable or reject-able).
  + If reject-able, cause for rejection.
  + Surface indication verified by visual examination (mold, mark, etc.)
  + Signature of the film interpreter.
* An original radiography examination and original films report and RT. Films shall be prepared and furnished by NDT. Contractor to the client. Report of radiography examination (Exhibit-1) will be used unless otherwise specified by client.
* Type, power and focal size of the γ-ray camera shall be indicated in test report.

**Report**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | **Quality Control Radiographic Test Report** | | | | Code No: | | | Date & Rev: | | |
|  | | | | | Report No: | | | Date: | | |
|  | | | | | Page: of | | | | | |
| **Item No.** | **RT No.** | **Weld Location** | **Weld No.** | **Welder No.** | | **THK (mm)** | **Film Length** | **Film Segment** | **ACC.** | **RP.** | **RS.** | **RET.** | **Type of Defect/Lengt** | **Remark** |
|  |  |  |  |  | |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | |  |  |  |  |  |  |  |  |  |
| **JUDGMENT: ACC:Accept, RP:Repair, RS:Reshoot, RET:Retake** | | | | | | | | | | | | | | |
| Type of Defect:  **SL**:Slag line, **LF**: Lack of Fusion, **LC**: Longitudinal Crack, **FM**:Film Mark, **CU**:Cap Under Cut, **SP**:Spherical Porosity, **CL**:Cold Lap, **TC**: Transverse Crack, **IW**: Incomplate Weld, **RU**: Root Undercut, **CP**:Cluster Porosity, **LP**: Lack of Penetration, **CC**: Crater Crack, **EP**: Excess Penetration, **HB**: Hollow Bead, **PH**: Pin Hole, **WH**: Worn Hole, **RC**: Root Concavity, **SC**:Shrinkage Cavity, **SI**: Slag Inclusion | | | | | | | | | | | | | | |
| **Remark:** | | | | | | | | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NISOC | PEDCO | HE/DI | TPI | | HAVAYAR |
| Owner | EPD/EPC Contractor(GC) | EPC Contractor | Third Party Ins. | Vendor | |
|  | Name: | Name: | Name: | Name: | |
|  | Date: | Date: | Date: | Date: | |
|  | Sign: | Sign: | Sign: | Sign: | |

V01

1. **Ultrasonic Test Procedure**

**Scope**

This procedure describes the Ultrasonic examination method and acceptance standard of welds in steel for construction of Air Receiver that to be fabricated in HAVAYAR Industrial Group Co. and meet the requirement of ASME code section VIII, ASME B 31.1 and section V.

**Personnel Qualification**

All personnel who will perform non-destructive examination shall be qualified and certified as level II in accordance with the requirements of ASNT recommended practice SNT-TC-1A.

**General Requirement**

**Applicable Parts**

1. On all pressure resistance welds that cannot be radiography tested.
2. When thickness is greater than 50 mm on all pressure resistance welds after hydro test.
3. When other tests do not give clear and entirely comprehensive results.
4. UT of head knuckle.

**Equipment**

**SITESCAN 140 is a Pulse-echo**

A-scan; direct contact type ultrasonic equipment is used. It’s capable to receiving & presenting reflects pulses on its screen. 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 in paragraph 5.1.

**Search Units**

Straight or angel beam probes are the search units with commercial name of ORION. Angel beam probes exist in 45°, 60° and 70°. The search unit size shall be selected according to the following table:

**Straight Beam**



**Angle Beam**



Search units with contoured contact wedges may be used to aid ultrasonic coupling.

**Frequency**

This examination shall be conducted with a pulse-echo ultrasonic instrument capable of generating frequencies over the range of at least 1 MHz to 5 MHz. Instrument operating at other frequencies may be used if equal or better sensitivity can be demonstrated and documented.

**Screen Height Linearity**

The ultrasonic instrument shall provide linear vertical presentation within ± 5% of the full screen height for 20 % to 80% of the calibrated screen height.

The procedure for evaluation screen height linearity is provided in appendix I of article 5, ASME Code Sec. V and shall be performed at the beginning of each period of extended use (or every 3 months, whichever is less).

**Amplitude Control Linearity**

The ultrasonic instrument shall utilize an amplitude control, accurate over useful range to ± 20 % of the nominal amplitude ratio, to allow measurement of indications beyond the linear range of the vertical display on the screen. The procedure for evaluation amplitude control linearity is given in appendix II of article 5, ASME. Code Sec.V and shall be performed at the beginning of each period of extended use (or every 3 months, whichever is less).

**Coupland**

SAE No.20 or No.30 motor oil, glycerin, pine oil, water, walls paper adhesive or water base paste shall be used. Coupland’s may not be comparable to one another and Couplet shall be used for calibration and examination.

**Calibration**

**Basic Calibration Block (s)**

The basic calibration reflectors shall be used to establish a primary reference response of the equipment. The basic calibration reflectors may be located either in the component material

or in a basic calibration block. Where the block thickness ±1 in. spans two of the weld thickness ranges shown in fig.1, the block’s use shall be acceptable in those portions of each thickness range covered by 1 in.

Basic calibration blocks shall be of similar metallurgical structure and the same or an equivalent p-number grouping as the finished component for the purposes of this, p-numbers 1, 3, 4 & 5 materials are considered equivalent.

**System Calibration:**

The calibration shall be calibrated according to the following explanation:

**Angle Beam Calibrations:**

The calibration shall provide the following measurements. (Refer to Article 4, Appendix B, ASME Code Sec.V)

(1) Sweep range calibration

(2) Distance- amplitude calibration

(3) Position calibration

(4) Echo amplitude measurement from the surface notch in the basic calibration block when an electronic amplitude correction device is used, the primary reference response shall be equalized at a nominal constant screen height at or between 40 to 80 % of full screen height over the distance range to be employed in the examination.

**Straight Beam Calibrations:**

The calibration shall provide the following measurements. (Refer to Article 4, Appendix C, ASME Code Sec.V)

(1) Sweep range calibration

(2) Distance-amplitude correction When an electronic distance-amplitude correction device is used, the primary reference response shall be equalized on the basic calibration block at a screen height between 40% and 80% of full screen height over the distance range to be employed in the examination.

**Calibration:**

Shall be performed prior to use of the system in the thickness range under examination. A calibration check shall verify the sweep range calibration and distance amplitude correction.

**Sweep Range Correction**:

If a point on the DAC curve has moved on the sweep line more than 10% of the sweep reading or 5% of full sweep, whichever is greater, correct the sweep range calibration and note the correction in the examination record. If reflectors are recorded on the data sheets, those data sheets shall be voided and a new calibration shall be recorded. All recorded indications since the last valid calibration or calibration check shall be re-examined with the corrected calibration and their values shall be changed on the data sheets.

**DAC Correction:**

If a point on the distance-amplitude correction (DAC) curve has decreased 20% or 2 dB of its amplitude, all data sheets since the last calibration check shall be marked void. A new calibration shall be made and recorded and the area covered by the voided data shall be re-examined. If any point of the distance-amplitude correction (DAC) curve has increased more than 20% or 2 dB of its amplitude, all recorded indications since the last valid calibration or calibration check shall be re-examined with the corrected calibration and their values shall be changed on the data sheets.

**Examination Procedure**

**WELD and HAZ**

**General Requirements**

The scanning shall be performed at gain setting at least two times the primary reference level. Evaluation shall be performed with respect to the primary reference level. The volumes shall be scanned by straight and angle beam techniques as described in detail in para.7.1.2. and 7.1.3. Two angle beams, having nominal angles of 45° and 60° with respect to a perpendicular to the examination surface, shall generally be used. Other pairs of angle beams are permitted provided the measured difference between the angles is at least 10°.

**Angle Beam Method**

Scanning shall be made basically from outside surface of the vessel by direct contact method. The angle beam shall be directed at approximate right angle to the weld axis from two directions where possible to detect the reflectors oriented parallel to the weld. In addition, the angle beam shall be directed essentially parallel to the weld axis to detect the reflectors-oriented transverse to the weld. The search unit shall be manipulated so that the ultrasonic energy passes through the whole volumes of weld and heat affected zone (20 mm) of base metal.

**Straight Beam Method**

1. The heat affected zone and weld where practicable shall be scanned with the straight beam search unit. The scanning shall be performed at a gain setting of at least two times the primary reference level and evaluation shall be performed with respect to the primary reference level.
2. The scanning of the adjacent base metal shall be performed to detect reflectors that affect interpretation of angle beam results, and is not to be used as an acceptance rejection examination. Locations and areas of such reflectors shall be recorded.

**Angle Beam Examination**

The refraction angle of the angle beam transducer shall be measured using IIW standard calibration block. The tolerance of the refraction angle shall not be more than ± 2°.

**Scanning Sensitivity**

The scanning shall be performed at a gain setting at least two times the primary reference level and evaluation shall be performed with respect to the primary.

**Detection of Defects Parallel to the Weld**

The angle beam shall be directed at approximately right angle to the weld axis from two directions where possible. The search unite shall be manipulated so that the ultrasonic beam passes through the required volumes of weld and adjacent base metal.

**Detection of Transverse Defects**

The angle beam shall be directed parallel to the weld axis. The search unit shall be manipulated so that the ultrasonic beam passes through the all of the volume to be examined.

**Surface Condition**

* **Base Metal:** The base metal on each side of the weld shall be free of weld spatter, surface irregularities, or foreign matter that might interfere with the examination.
* **Weld Metal:** Where the weld surface interferes with the examination, the weld shall be prepared as needed to permit examination.

**Extent of Scanning**

**Examination Coverage**

The volume shall be examined by moving the search unit over the examination surface so as to scan the entire examination volume.

Each pass of the search unit shall overlap a minimum of 10 % of the transducer dimension perpendicular to the scan.

**Rate of Search Unit Movements**

The rate of search unit movement for examination shall not exceed 6 in. /sec unless calibration is verified at scanning speed.

**Length Measurement**

The length of the reflector shall be obtained by recording the position from reference line and the location along the length of weld as determined by 50 % of DAC for each of reflector.

**BASE METAL**

**General requirement**

The equipment shall be of the pulse-echo straight beam type. The transducer is normally 1 to 11/8 in. [25 to 30 mm] in diameter or 1 in [25 mm] square; however, any transducer having a minimum active area of 0.7 in2 [450 mm2] may be used. The test shall be performed by direct contact method.

**Test Conditions**

The examination shall be conducted in an area free of operations that interfere with proper functioning of the equipment. Plate surface shall be clean and smooth sufficiently to maintain a reference back reflection from the opposite side of the plate at least 50% of the full-scale during scanning.

The surface of plates inspected by this method may be expected to contain a residue of oil or rust or both. Any specified identification which is removed when grinding to achieve proper surface smoothness shall be restored.

**Apparatus**

The amplitude linearity shall be checked by positioning the transducer over the depth resolution notch in the IIW or similar block so that the signal from the notch is approximately 30% of the screen height, and the signal from one of the back surfaces is approximately 60% of the screen height (two times the height of the signal from the notch).

A curve is then plotted showing the deviations from the above-established 2:1 ratio that occurs as the amplitude of the signal from the notch is raised in increments of one scale division until the back reflection signal reaches full scale, and then is lowered in increments of one scale division until the notch signal reaches one scale division.

At each increment the ratio of the two signals is determined. The ratios are plotted on the graph at the position corresponding to the larger signal. Between the limits of 20% and 80% of the screen height, the ratio shall be within 10% of 2:1. Instrument settings used during inspection shall not cause variation outside the 10% limits established above.

**Procedure**

Unless otherwise specified, ultrasonic examination shall be made on either major surface of the plate.

**Test Frequency**

A nominal test frequency of 2 1/ 4 MHz is recommended. When testing plates less than 3/4 in. (20mm) thick a frequency of 5 MHz may be necessary. A clear, easily interpreted trace pattern should be produced during the examination.

**Scanning**

Scanning shall be along continuous perpendicular grid lines on nominal 9-in. [225-mm] centers, or at the option of the manufacturer, shall be along continuous parallel paths, transverse to the major plate axis, on nominal 4-in.

[100-mm] centers, or shall be along continuous parallel paths parallel to the major plate axis, on 3-in. [75-mm] or smaller centers. Measure the lines from the center or one corner of the plate with an additional path within 2 in. [50 mm] of all edges of the plate on the searching surface.

Test shall be started with adjusted instrument that will produce a first reflection from the opposite side of a sound area of the plate from 50% to 90% of full scale. Minor sensitivity adjustments may be made to accommodate for surface roughness.

When a discontinuity condition is observed during general scanning adjust the instrument to produce a first reflection from the opposite side of a sound area of the plate of 75 ± 5% of full scale. Maintain this instrument setting during evaluation of the discontinuity condition.

**Thickness Measurement**

Procedures used for ultrasonic examination for thickness determination shall conform to the following standards in Article 23, as applicable:

1. SE-114 Recommended Practice for Ultrasonic Pulse-Echo Straight-Beam Testing by the Contact Method
2. SE-797 Standard Practice for Thickness Measurement by Manual Contact Ultrasonic Method

**Acceptance Standards**

This standard shall apply unless other standards are specified for specific applications within this division.

**ASME Section VIII Div.1**

All imperfections that produce an amplitude 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 following acceptance standards.

1. Imperfections that are interpreted to be cracks, lack of fusion or incomplete penetration is unacceptable regardless of length.
2. All other linear type imperfections are unacceptable if the amplitude exceeds the reference level and the length of the imperfection exceeds the following.

* 1/4” (6mm) for T up to 3/4”
* 1/3T for T from 3/4” to 2 ¼” (19mm to 57mm);
* 3/4” for T over 2 ¼” (57mm)

1. Where T is the thickness of the weld excluding any allowable reinforcement.

For a butt weld joining two members having different thickness at the weld, T is 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.

**ASME Sec.V**

Acceptance–rejection standard, Imperfections that cause an indication greater that 20% of the reference level shall be investigated to the extent that the ultrasonic examination personnel can determine their shape, identity, and evaluate them in terms of I and II.

1. Crack, lack of fusion or incomplete penetration is unacceptable regardless of length.
2. Other imperfections are unacceptable if the indication is unacceptable regardless of length.

* 1/4” for T up to 3/4 “
* 1/3T for T from 3/4” to 21/4”
* 3/4” for T over 2 1/4”

1. Where T is the thickness of the weld being examined. If the weld joins two members, having different thickness at the weld. T is the thinner of these two thicknesses.

**Post Cleaning**

If examination carried on before welding, the area shall be cleaned with brushing, washing or any other way that cannot produce any problem either for base metal or welding or weld metal.

**Report**

The result of ultrasonic examination shall contain following information as minimum:

Project Name & No., Client, Report No., Request No., WPS No., Procedure No., Test technique, Probes, Weld No., Type of material/ Dimensions, Ultrasonic examination system (equipment), Examination personnel identity and level, Calibration sheet identity, Identification and location of weld or volume scanned, Surface from which examination is conducted, Map or record of indications detected or areas clear, Date and time examinations were performed, Couplant, Basic calibrations block identification, Surface condition, Frequency, Special equipment, Calibration & Reference block, Sensitivity.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ISSUE:** | |  | | | | | **ULTRASONIC TEST REPORT(UT)** | | | | | **QCP.No:** | | | | **Rev** | |
| **VER:** | | **Report No:** | | | | | |
| **Code:** | | **Page: of** | | | | **Date:** | |
| **Project:** | | | | **Equipment Name:** | | | **Drawing No:** | | | | | | **Weld No:** | | | | |
| **Client:** | | | | **Contractor:** | | | **Equipment No:** | | | | | | **Part No:** | | | | |
| **Material:** | | | | | | | **Testing Subject:** | | | | | | | | | | |
| **Thickness:** | | | | | | | **Base Metal** | | | **Weld Metal** | | | | | **Casting** | | |
| **Surface Condition:** | | | | **Standard:** | | | **Welding Process:** | | | | | | **Groove Type:** | | | | |
| **Equipment Maker:** | | | | **Model:** | | | **Calibration Black:** | | | | | | **Base Material:** | | | | |
| **Probe Angle:** | | | | **Calibration Range:** | | | **Couplant:** | | | | | | **Examination Method:** | | | | |
| **Frequency:** | | | | **Size:** | | | **Evaluation Standard:** | | | | | | **Transfer Correction(db):** | | | | |
| **Standard Sensitivity: SDH FBH Notch** | | | | | | | | | | | | | | | | | |
| **No** | **Head No.** | | **Scan dir.** | | **Thickness** | **Distance** | | **Length** | **Depth** | | **DAC. %** | | | **Defect** | | | **Result** |
|  |  | |  | |  |  | |  |  | |  | | |  | | |  |
|  |  | |  | |  |  | |  |  | |  | | |  | | |  |
|  |  | |  | |  |  | |  |  | |  | | |  | | |  |
|  |  | |  | |  |  | |  |  | |  | | |  | | |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NISOC | PEDCO | HE/DI | TPI | | HAVAYAR |
| Owner | EPD/EPC Contractor(GC) | EPC Contractor | Third Party Ins. | Vendor | |
|  | Name: | Name: | Name: | Name: | |
|  | Date: | Date: | Date: | Date: | |
|  | Sign: | Sign: | Sign: | Sign: | |

V01

1. **MAGNETIC Particle TEST Procedure**

**Scope**

This procedure covers the magnetic particle examination (MT) for pressure parts & non pressure parts to pressure parts welds line that performed in fabrication of Vessels according to related weld map & NDT table.

**Personal Qualification**

Personal qualification for MT operator & interpretation shall meet the requirement ASME SEC V-ARTICLE 7 (Ed 2015) mandatory appendix chapter I-722.

**Surface Preparation**

Prior to magnetic particle examination surface preparation & contrast shall meet the requirement of ASME SEC V-article 7 (Ed 2015) chapter T-741.

**Equipment**

Applicable MT method for this procedure is Yoke with AC current and white contrast method. This method only useful to detect discontinuities that be open to the surface of the part. For this technique, alternating current electromagnetic yokes shall be used. For material thickness less than 6 mm alternating current yokes are superior to direct or permanent magnet yokes of equal lifting power for the direction of surface discontinuities.

**Calibration**

**Lifting Power**

Prior to use, the magnetizing power of electromagnetic yokes shall have been checked within the past year. The magnetizing power of permanent yokes shall be checked daily prior to use. The magnetizing power of all yokes shall be checked whenever the yoke has been damaged. Each alternating current electromagnetic yoke shall have a lifting power of at least 4.5 Kg at the maximum pole spacing that will be used.

**Magnetic Field Adquecy & Direction:**

Pie shaped magnetic particle field indicator according fig ASME SEC V (ed 2015) T-764.1.1 shall be positioned on the surface to be examined, such that the copper-plated side is away from the inspected surface. A suitable field strength is indicated when a clearly defined line (or lines) of magnetic particles from a cross the copper face of the indicator when the magnetic particles are applied simultaneously with the magnetizing force. When a clearly defined line of particle is not formed, the magnetizing technique shall be changed as needed.

**Examination**

The ferromagnetic particle for yoke method (white contrast) is wet type (aerosol spray cans) applied when magnetizing current remain on the parts.

Examination coverage shall be conducted with sufficient field overlap to ensure 100% coverage at the required sensitivity according to ASME SEC V-T-774&764.

Direction of magnetizing: at least two separate examinations shall be performed on each area. During the second examination, the lines of magnetic flux shall be approximately perpendicular to those for magnetization may be used for second examination.

The temperature of the wet particle suspension and the surface of the part shall not exceed 60˚c and not less than medium freeze temperature.

The magnetic field will be held for minimum 5 second to allow particle magnetization and then it will be withdrawn.

Excess particle removal: Accumulations of excess dry particles in examination shall be removed with a light air stream from a bulb or syringe or other source or power shall be maintained while removing the excess particles.

Demagnetizing and post examination cleaning is not required for this method.

**Interpretation**

The interpretation shall identify if an indication as false, non-relevant or relevant. False and non-relevant indication shall be proven as false or non-relevant. Interpretation shall be carried out to identify the location of indication & character of indication.

For visible (color contrast) magnetic particles method surface discontinuities are indicated by accumulation of magnetic particles which should contrast with the examination surface. The color of magnetic particle shall be sufficiently different than the color of the examination surface. A minimum light intensity 1000 lx is required on the surface to be examined to ensure adequate sensitivity during the examination & evaluation of indication.

**Evaluation**

Evaluation of indication shall meet the requirement of ASME SEC VIII.DIV 1 (Ed 2015) appendix 6, chapter 6-3.

1. All indications shall be evaluated in terms of the acceptance standards of the referencing.
2. Discontinuities on or near the surface are indicated by retention of the examination medium. However, localized surface irregularities due to machining marks or other surface condition may produce false indications.
3. Broad areas of particle accumulation, which might mask indications from discontinuities, are prohibited, and such areas shall be cleaned and reexamined.

**Acceptance Criteria**

Acceptance criteria shall meet the requirement of ASME SEC VIII.DIV 1 (Ed 2015) appendix 6, chapter 6-4 as below:

All surfaces to be examined shall be free from of:

(A) Relevant linear indications.

(B) Relevant linear indications greater than 4.8 mm.

(C) Four or more relevant rounded indication in line separated by 1.6mm or less, edge to edge.

**Re Examination**

* Treatment of indications believed a non-relevant any indication which is believed to be non- relevant shall be regarded as an imperfection unless it is by reexamination by the same method or by the use of other nondestructive methods and/ or by surface conditioning that no unacceptable imperfection is perfect.
* **Examination of areas from where imperfections have been removed:** After a defect is removed and prior to making weld repairs, the area shall be examined by suitable method to ensure it has been removed or reduced to an acceptable size imperfection.
* **Re Examination of Repair Areas:** After repairs have been made, the repaired area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners and re- examined by the magnetic particle method and by all other methods of examination that were originally required for the affected area, except that, when the depth of repair is less than the radiographic sensitivity required, re- radiography may be omitted.

**Record & Reporting**

Magnetic Particle Examination records shall be filed for the period required by contract unless otherwise agreed to by the interested parties.

Examination condition and interpretation & evaluation shall be recorded on the report form of Magnetic Particle.

The report shall indicate all requirements that described in ASME SEC V (Ed 2010) article 7-T-792.

Blank format of MT report has been attached

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | **Magnetic Particle Test Report** | | | | | | Code No: | | | | Date & Rev: | | |
| Report No: | | | | Date: | | |
| Page: of | | | | | | |
| **Item No.** | **MT No.** | **Weld Location** | **Weld No.** | **Welder No.** | | **THK(mm)** | **Film Length** | **Film Segment** | | **ACC.** | | **RP.** | **RS.** | **RET.** | | **Type of Defect/Length** | **Remark** |
|  |  |  |  |  | |  |  |  | |  | |  |  |  | |  |  |
|  |  |  |  |  | |  |  |  | |  | |  |  |  | |  |  |
|  |  |  |  |  | |  |  |  | |  | |  |  |  | |  |  |
|  |  |  |  |  | |  |  |  | |  | |  |  |  | |  |  |
| **JUDGMENT: ACC:Accept, RP:Repair, RS:Reshoot, RET:Retake** | | | | | | | | | | | | | | | | | |
| **Pre Examination:** | | | | | | | | | **Surface Preparation:** | | | | | | | | |
| **Method of Inspection?**  **Dry Wet Visible Floursent** | | | | | | | | | | | | | | | | | |
| **How the magnetic field applied to the media?**  **Residual** [**Continuous**](https://www.google.com/search?client=firefox-b-ab&biw=1280&bih=887&q=Continuous&spell=1&sa=X&ved=0ahUKEwjTpOb0q6PRAhUD3iwKHYSQAxAQBQgWKAA) **True-**[**Continuous**](https://www.google.com/search?client=firefox-b-ab&biw=1280&bih=887&q=Continuous&spell=1&sa=X&ved=0ahUKEwjTpOb0q6PRAhUD3iwKHYSQAxAQBQgWKAA) **AC DC Half-wave Prods**  **Yoke Cable warp Other** | | | | | | | | | | | | | | | | | |
| **Direction of field: Longitudinal Circular** | | | | | | | | | **Strength of Field:** | | | | | | | | |
| **Post Examination:** | | | | | | | | | **Demagnetizing Technique (if required):** | | | | | | | | |
| **Cleaning (if required):** | | | | | | | | | **Marking method:** | | | | | | | | |
| **Remark:** | | | | | | | | | | | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NISOC | PEDCO | HE/DI | TPI | | HAVAYAR |
| Owner | EPD/EPC Contractor(GC) | EPC Contractor | Third Party Ins. | Vendor | |
|  | Name: | Name: | Name: | Name: | |
|  | Date: | Date: | Date: | Date: | |
|  | Sign: | Sign: | Sign: | Sign: | |

V01