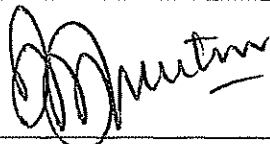
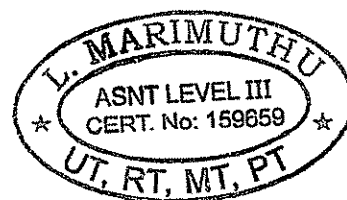




PROCEDURE FOR LIQUID PENETRANT EXAMINATION (Visible Method)

Prepared by	Reviewed by	Approved by
Kaushal Kumar Engineer Level II	M S Ravikumar Sr. Manager Level II	Level III
		



Effective Date 30 08 2016



1. RECORD OF REVISION

Revision No.	Date of Revision	Reason for Revision
01	28 07 1999	Revision in entirety
02	14 08 2003	Clause 2.1,2.2,2.3,12.1.2.2,12.1.3.1,12.13.2 and 13.1.2.1 modified Clause 8.2 added
03	30 08 2016	Revised in entirety based on latest standards.



1.0 SCOPE

- 1.1 This procedure defines the method, techniques and acceptance standards for liquid penetrant Examination of all shapes of ferrous and Non-ferrous product forms in Boilers, Boiler Auxiliaries, pressure vessels, Heat Exchangers and structural.
- 1.2 In pressure vessels the Examination shall include all welds around openings; attachment welds with a throat thickness over 6mm and on finished surfaces of welds as required by referencing code. The examination includes base material 13mm on each side of the weld.

2.0 REFERENCE

- 2.1 ASME Section VI Article 6, I & VIII (Division 1 &2) -2015
- 2.2 ASME B 31.1 /2015
- 2.3 AWS D 1.1 /D1.1M: 2015

3.0 EQUIPMENT

- 3.1 The term 'penetrant materials' as used in the procedure is intended to include all liquid penetrants, solvents (penetrant removers) or cleaning agents, developers etc used for 'Liquid penetrant Examination'.
- 3.2 Penetrant used shall be of solvent removable type and have a color contrast, which can be seen, readily in daylight or under normal interior illumination.
- 3.3 The cleaner used for the surface cleaning shall be an organic chemical such as Acetone or Trichloro Ethylene.
- 3.4 Developer shall be of non-aqueous suspendible type. When the developer dries, it shall form a white coating of fine powder on the part.
- 3.5 The Chemicals used for the examination of austenitic stainless steel or nickel base alloys shall be analysed for sulphur and total halogens. The residual amount of total sulphur and chlorine content shall not exceed 1% by weight.

4.0 SURFACE PREPARATION

- 4.1 In general satisfactory results may be obtained when the surface is as welded, as rolled, as forged or as cast condition. When the surface irregularities might mask the indications of unacceptable discontinuities, the surface shall be prepared by grinding or machining or any other suitable method.
- 4.2 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, rust, paint, oil or any other extraneous matter that could obscure surface openings or otherwise interfere with the examination by preventing the penetration.



- 4.3 Shot blasting may close discontinuities at the surface and should not be used before conducting penetrant examination. If the component is shot blasted, the surface is to be etched before conducting penetrant examination.
- 4.4 Prior to the application of the penetrant, the surface is recleaned with typical industrial cleaning agents such as Acetone.

5.0 DRYING AFTER PREPARATION

After cleaning, drying of the surface shall be accomplished by normal evaporation and ensure that the cleaning solution has evaporated. The minimum time required for the cleaner to dry from the surface 60 seconds and maximum time shall be 10 minutes depending on the position.

6.0 TECHNIQUES

- 6.1 Color contrast (visible) penetrant shall be used with solvent removable penetrant process.
- 6.2 The temperature of the penetrant and the surface of the part shall not be below 5°C and not above 52°C throughout the examination period. Local heating or cooling is permitted provided the part temperature remains in the range of 5°C to 52°C during the examination.

7.0 TECHNIQUE RESTRICTIONS

- 7.1 Intermixing of penetrant materials from different families or different manufacturers is not permitted.
- 7.2 Fluorescent penetrant examination shall not follow a color contrast penetrant examination.

8.0 EXAMINATION

8.1 Penetrant Application

- 8.1.1 The penetrant shall be applied by brushing, spraying or dipping after the surface is dried. For spraying a handpump or an aerosol spray cans will be used.

8.2 Penetration time

The penetrant shall be remaining wet on the minimum and maximum period (dwell time) as given in Table 2 or as qualified by demonstration for specific application.

Table 2

MATERIAL	FORM	MINIMUM DWELL TIME	MAXIMUM DWELL TIME
----------	------	--------------------	--------------------



Alumimium, Magnesium, steel, Brass, Bronze, Titanium		TEMPERATURE RANGE	TEMPERATURE RANGE
		10 TO 52°C	10 TO 52°C
	Casting and Welds	10 Minutes	20 Minutes
	Wrought materials- Extrusions, Forging and Plates.	10 Minutes	20 Minutes

8.2.1 If the penetrant has completely dried up during the dwell time, then the surface shall be recleaned and reexamined.

8.3 REMOVAL OF EXCESS PENETRANT

8.3.1 After the required dwell time has elapsed, the excess penetrant remaining on the surface shall be removed by wiping with a lint free cloth, repeating the operation until most traces of penetrant have been removed. Final left out penetrant shall be remove by wiping with a clean cloth moistened with the solvent. Excessive application of the cleaner shall be avoided to prevent the possibility of removing the penetrant from discontinuities causing a decrease in the sensitivity of the test. **FLUSHING THE MATERIAL SURFACE WITH THE SOLVENT FOLLOWING THE APPLICATION OF PENETRANT AND PRIOR TO DEVELOPING IS PROHIBITED.**

8.3.2 Drying after excess penetrant removal.

8.3.2.1 After the removal of excess penetrant the surface shall be dried by normal evaporation. The minimum time required for the surface to get dried by normal evaporation is 60 seconds and maximum shall be 10 minutes. Drying of developer shall be by normal evaporation.

8.4 DEVELOPING

8.4.1 The developer shall be applied by spraying to provide uniform coating as soon as possible to the dry surface after the removal of excess penetrant. Insufficient coating thickness may not draw penetrant out of discontinuities. Excessive coating thickness may mask indications.

8.5 WET DEVELOPER APPLICATION

8.5.1 Prior to applying suspension type wet developer to the surface the developer must be thoroughly agitated too ensure adequate dispersion of suspended particles. The developer shall be applied by spraying using spray pump or aerosol spray can. The developer shall be applied over the surface in such a manner to assure complete



coverage of the part with a thin, uniform film of developer. Drying of developer shall be by normal evaporation.

8.6 DEVELOPMENT TIME

8.6.1 The surface shall be closely observed during the application of the developer to monitor the behavior of the indication, which tends to bleed-out. Developing time for final interpretation begins as soon as a wet developer coating is dry. The minimum developing time shall be 10 minutes and maximum shall be 60 minutes.

9.0 INTERPRETATION

9.1 Final interpretation shall be made within 10 to 60 minutes after the wet developer coating is dry. If the bleed - out does not alter the examination results longer periods are permitted.

9.2 The surface shall be examined in increments if the surface to be examined is large enough to complete the inspection within the prescribed time.

A minimum light intensity of 100 foot candle (1000 lux) is required to ensure adequate sensitivity during the examination and evaluation of indications, which can be achieved by a hand lamp or torch light positioning at a distance of 300mm. The light intensity shall be measured with white light meter prior to evaluation of indications or verified light source shall be used. Verification of light sources is required to be demonstrated only one time, documented, and maintained.

10.0 EVALUATION

10.1 Flaws at the surface will be indicated by bleed out of the penetrant. However localize surface irregularities such as machining marks or other surface conditions may produce false indications. Broad areas of pigmentation which would mask indications are not acceptable and such areas shall be cleaned and reexamined.

10.2 The surface shall be examined in increments if the surface to be examined is large enough to complete the inspection within prescribed time.

10.3 An indication of an imperfection may be large than the imperfection that causes it however, the size of the indication is the basis for acceptance evaluation.

10.4 Relevant indications area are those which result from mechanical discontinuities (imperfection).

10.5 Only indications with major dimension greater than 1.5mm shall be considered relevant.



- 10.6 Any indication which is believed to be non-relevant shall be regarded as a defect until the indication is either eliminated by surface conditioning or it is evaluated by other non-destructive testing and proved to be non-relevant.
- 10.7 Linear indications are those indications in which the length is more than three times the width.
- 10.8 Rounded indications are those which are circular or elliptical with the length equal to or less than three times the width.
- 10.9 Any questionable or doubtful indications shall be reexamined to determine whether they are relevant, or not.

11.0 ACCEPTANCE STANDARD

11.1 Welds and Materials (as per ASME Sec 1 and VIII Div 1&2)

11.1.1 All surface to be examined shall be free of

11.1.2 A) Relevant linear indications.

B) Relevant rounded indications greater than 5mm.

C) All relevant indications shall be investigated to assure that no leak-path exists in welds joining nipples to drums, dished-ends and headers.

11.1.3 Four or more relevant rounded indications in a line separated by 1.5mm or less edge to edge.

11.1.4 In attachment welds of non-load carrying class, indications from crack or due to material separation are unacceptable

11.2 For Power Piping (as per ASME B31.1)

11.2.1 Indications whose major dimensions greater than 2.0mm shall be considered relevant.

11.2.2 The following relevant indication are unacceptable:

- a. Any crack or linear indications.
- b. Rounded indication whose dimensions greater than 5.0mm.
- c. Four or more rounded indication in a line separated by 2.0mm or less edge to edge.
- d. Ten or more rounded indication in any 3870mm² of surface with the major dimensions of this area not to exceed 150mm with the area taken in the most unfavorable location relative to the indications being evaluated.



12.0 WELDS MADE TO STRUCTURAL WELDING CODE AWS D 1.1

- 12.1 For statically and cyclically loaded non-tubular connections made to AWS code the acceptance of any discontinuity shall be based upon a visual examination of the discontinuity after the removal of developer medium and evaluated for its nature and size. Where the discontinuity cannot be seen after removal of the developer medium either directly or using magnifying glass evaluation shall be based on the size and nature of liquid penetrant indication.

13.0 ACCEPTANCE STANDARD (AS PER AWS)

13.1 Statically loaded non-tubular connections.

- 13.1.1 Indications from cracks, lack of penetration and lack of fusion are not acceptable.

13.2 Porosity.

- 13.2.1 Complete joint penetration groove welds in butt joints transverse to the computed tensile stress shall have no visible piping porosity.
- 13.2.2 For all other groove welds and for fillet welds, the sum of the visible piping porosity of 1.0 mm or greater in diameter shall not exceed 10 mm in any linear 25 mm of weld and shall not exceed 20 mm in any 300 mm length of weld.

13.3 Undercut

- 13.3.1 For material less than 25 mm thick, undercut shall not exceed 1.0 mm except that a maximum 2.0 mm is permitted for an accumulated length of 50 mm in any 300 mm
- 13.2 For material equal to or greater than 25 mm thick undercut shall not exceed 2.0 mm for any length of weld.

14.0 Cyclically loaded non-tubular connections.

- 14.1 Indications from Cracks, Lack of penetration and lack of fusion are not acceptable in any welds.

14.2 Porosity

- 14.2.1 Complete joint penetration groove welds in butt joints transverse to the direction of computed tensile stress shall have no piping porosity. For all other groove welds, the frequency of piping porosity shall not exceed one in 100mm of length and the maximum diameter shall not exceed 2.5 mm.
- 14.2.2 The Frequency of piping porosity in fillet welds shall not exceed one in each 100mm of weld length and the maximum diameter shall not exceed 2.5mm. EXCEPTION for fillet welds connecting stiffeners to web, the sum of the diameter of piping porosity



shall not exceed 10mm in any linear 25mm of weld and shall not exceed 20mm in any 300mm length of weld.

14.3 Undercut.

- 14.3.1 In primary members, undercut shall not be more than 0.25mm deep when the weld is transverse to tensile stress under any design loading condition. Undercut shall not be more than 1mm deep for all other cases.

15.0 REPAIR AND RE-EXAMINATION

- 15.1 Whenever an imperfection is repaired by chipping or grinding the excavated area shall be blended into the surrounding surface so as to avoid sharp notches, crevices or corners.
- 15.2 After a defect is thought to have been removed and where welding is required after repair, the area shall be examined for removal of defects, area cleaned and repair carried out. The repaired area shall be blended into the surrounding surface as in 14.1 and re-examined by the liquid penetrant or any other NDT methods originally required for the affected area.

16.0 PERSONNEL QUALIFICATION

- 16.1 Wherever penetrant examination is required by the referencing code, the same shall be conducted by Level I and evaluated by a personnel qualified to minimum Level II as per ASNT SNT-TC-1A Edition 2006.

17.0 POST CLEANING

- 17.1 After the examination and evaluation is completed all penetrant testing material shall be removed from the surface, so that it will not interfere with the subsequent processing or service requirements.

18.0 REPORTING

- 18.1 Where penetrant test is mandatory, a copy of the report signed by personnel certified to minimum Level-II will be issued in format R49-720B or equivalent, after completion the examination.



BHARAT HEAVY ELECTRICALS LIMITED
RANIPET - 632406
NON - DESTRUCTIVE TESTING

BHE:NDT:RP:PT:01
REVISION 03
PAGE 10 of 10

BHARAT HEAVY ELECTRICALS LIMITED

BAP / RANIPET 632 406

R49-720/B

NON-DESTRUCTIVE TESTING

LIQUID PENETRATION TEST

REPORT NO : REQ DT :
REF NO : BAY :
WORK ORDER : DU :
CUSTOMER :
PART NAME :
PART NUM : QTY :
DRAWING NO. : REV :
STAGE OF TEST :
MATERIAL SPECIFICATION : CHP :
SURFACE CONDITION :
QP REFERENCE :
REMARKS :
QC-INSPECTOR NAME :
DATE OF TEST :
PROCEDURE REFERENCE :
TYPE OF PENETRANT :
PENETRANT REMOVER :
TYPE OF DEVELOPER :
TEMPERATURE :
DEWELL TIME :
REMARKS :

(LEVEL-II)

OPERATOR NAME & LEVEL

APPROVED BY NDT

APPROVED BY EXTERNAL I