SARA SAE PRIVATE LIMITED

Management System Document Control Cover Sheet

Document Title	Ref. No.	Revision No.
Procedure for Liquid Penetrant Testing	**SES-26-701**	**5**

	Name	Position	Signature	Date
Reviewed and Approved by	VARUN SHARMA	ASNT NDT LEVEL III RT,UT,MT,PT,VT # 188262		01/06/2019
Prepared by	NISHAN SINGH	MANAGER QA		01/06/2019

Issued To		
Name:	Signature:	Date:

Document Control Stamp (Valid only if in red)

Revision Status

Revision No.	Effective Date	Description / Summary of Revision
0	23.06.2008	Initial Issue after NOV Sara
1	20.10.2011	Change of name of company from NOV Sara to SARA SAE
2	10.11.2012	Amendments added to highlighted clauses
3	19.12.2015	Amendments added to highlighted clauses for compliance to ASTM E 1417, API 6A/16A/16C/17D.
4	07.06.2017	Compliance with TechnipFMC Doc No. Q02007 Rev. AD
5	01.06.2019	Compliance with Client procedure. Complete formatting edited. Major Revision.

1. SCOPE:

1.1. This procedure covers for penetrant examination of materials for detecting discontinuities that are open to the surface such as cracks, seams, laps, laminations, through leaks, or lack of fusion and are applicable to in process, final, and maintenance examination of the material to be tested by using visible solvent removable process.

1.2. This procedure is applicable to forging components of alloy steel, stainless steel and carbon steel materials and other metallic materials, but can also be performed on other materials, provided that they are not porous

1.3. This is the Company approved procedure and shall be adhered to at all times except where the Client or Contract Document specifies other requirements.

2. REFERENCE STANDARDS:

The latest edition of the Standards and References cited were utilized in the current release of this inspection method. Changes to these Standards and References determined to affect the quality of the products and services of the project shall be cause for revision to this document.

2.1. ASTM E-165 – 18 - "Standard Practice for Liquid Penetrant Examination for General Industry"

2.2. ASTM E – 1417 – 13 "Standard Practice for Liquid Penetrant Testing

2.3. ASTM E-433 , " Standard Reference Photographs for Liquid Penetrant Examination"

2.4. ASTM E – 1220 : Standard Practice for Visible Penetrant testing Using Sovent removable Process.

2.5. ASME Section V - 2017, Article 6 - Nondestructive Examination.

2.6. API - 6A - " Specification for Well Head and Christmas Tree Equipment"

2.7. Cameron Doc. No. X - 008062

3. EXAMINATION COVERAGE:

3.1. Areas of the component to be examined shall be as specified by customer, applicable engineering specification or agreed quality plan with customer.

3.2. All examination shall be conducted with minimum 10% overlap for assuring 100% coverage of the required area.

4. PERSONAL REQUIREMENTS:

4.1. The personnel performing liquid penetrant examination as per this procedure shall be qualified and certified to either NDT Level I or NDT Level II or NDT Level III in visible solvent removable liquid penetrant testing technique as per Written Practice Number SES -26 – 743 latest revision.

4.2. Personnel performing analysis of liquid penetrant examination data or performing interpretation and evaluation of liquid penetrant examination results as per this procedure shall be qualified and certified either NDE Level II or NDE Level III in visible solvent removable liquid penetrant testing technique as applicable as per Written Practice Number SES -26 – 743 latest revision.

4.3. All NDE Level I, NDE Level II or NDE Level III certification of personnel shall be valid and current as-per Written Practice Number SES -26 – 0743 latest revision.

5. SAFETY PRECAUTIONS:

Personnel involved in the Liquid Penetrant Inspection should take following precautions because of the toxic and inflammable nature of chemicals used.

S/N#	Safety Requirements	Remarks
1.	Electrical Safety	a. The cables used with incandescent lamp must be shock proof with

		proper connectors. The connecters shall be connected to electric plug having proper earthing for preventing shock.
2.	Personnel Safety	a. The incandescent lamp must be used in glass envelop having shielding on top side for preventing glare in operator's eyes. b. Hand gloves for preventing direct contact of hand skin with penetrant material or test surface. c. Nose mask for preventing air bon particle entering in inertia of operator. d. Wear safety shoes and safety helmet. e. Wear safety belt during working at height.
3.	Fire Safety	a. Penetrant material is flammable. They must be stored in dry and cooled place having storage temperature range specified by the penetrant material manufacturer. b. Material Safety Data Sheet specified by the penetrant material manufacturer must be followed. c. Penetrant material must be protected from welding arc, grinding spark etc. which can cause fire.

6. LIQUID PENETRANT TESTING MATERIAL:

6.1. The penetrant testing products shall be compatible with the material to be tested and use for which the part is designed.

6.2. Penetrant material of either of following family group shall be used. Liquid material shall be of same family group. Intermixing of penetrant material from different family group is not allowed.

Family Group 01: Make - Magnaflux		
PenetrantMaterial	Make	Brand Name
Penetrant	Magnaflux	SPOTCHECK (SKL-SP1)
Cleaner / Solvent	Magnaflux	SPOTCHECK (SKC-S)
Developer	Magnaflux	SPOTCHECK (SKD-S2)
Family Group 02: Make - Adrox		
Penetrant Material	**Make**	**Brand Name**
Penetrant	The Oriental Chemical Works (P) Ltd.	ORION 115P
Cleaner / Solvent	The Oriental Chemical Works (P) Ltd.	ORION 115PR
Developer	The Oriental Chemical Works (P) Ltd.	ORION 115D
Family Group 03: Make - PMET		
Penetrant Material	**Make**	**Brand Name**
Penetrant	PMET, Gujrat, India	PP-15/PP-15 B
Cleaner / Solvent	PMET, Gujrat, India	PC-21/PC-21B
Developer	PMET, Gujrat, India	PD-31 B

6.3. When using this procedure to examine austenitic, duplex or titanium material, all penetrant materials shall be analysed individually for halogen content in accordance with paragraph T-640 of. ASME Section V as well as ASTM E-165. Total halogen content shall not exceed 1% by weight. A test certificate for the same shall be obtained from penetrant material manufacturer for each batch number used and shall be reviewed and maintained in file.

6.4. When using this procedure to examine nickel based material, all penetrant materials shall be analysed individually for total sulfur content in accordance with paragraph T-640 of ASME Section V as well as ASTM E-165. Total sulfur content shall not exceed 1% by weight. A test certificate for the same shall be obtained from penetrant material manufacturer for each batch number used and shall be reviewed and maintained in file.

6.5. Process monitoring of liquid penetrant systems can be accomplished by use of a Pratt & Whitney Aircraft Crack Panel TAM 146040 or equivalent. This should periodically be performed where penetrant may be subject to contamination or degradation. A new panel is processed for each new penetrant and is to be used for that penetrant only. The number of indications is recorded. This calibrates the panel, and establishes the number of indications which should be expected each time that particular panel is processed with the same penetrant system.

7. TEMPERATURE RANGE:

7.1. The temperature of penetrant as well as of test surface shall be from 5°C to 52°C inclusive throughout liquid penetrant examination. The temperature of penetrant as well as of test surface shall be measured by calibrated thermometer and recorded in report.

7.2. The thermometer shall be calibrated once in a six months or whenever meter has been repaired.

7.3. Whenever it is not possible to conduct liquid penetrant examination at above-mentioned temperature range, qualification of penetrant material at required temperature shall be carried out as per ASTM E-165 as well as ASME. Section V, Article 6.

8. LIGHTING REQUIREMENT:

8.1. Liquid Penetrant Testing shall be carried out in well-lightened area. Minimum visible light at the examination surface shall be 1,076 Lux. Light level shall be measured with calibrated light meter.

8.2. The light meter shall be calibrated once in a six months or whenever meter has been repaired.

8.3. Light level shall be measured with calibrated light meter once and shall be verified for maximum distance between test surface and the 100 W incandesce lamp during Liquid Penetrant Examination. Liquid Penetrant Examination on job surface can be conducted by similar bulb with test surface to bulb distance less than verified.

9. General Principles:

9.1. **Process Sequence:**

The testing proceeds through the following stages:

- Preparation and precleaning
- Application of penetrant
- Excess penetrant removal
- Application of developer
- Inspection
- Recording
- Post cleaning

9.2. **Effectiveness**

The effectiveness of the penetrant testing depends upon many factors such as:

- Type of penetrant material and testing equipment
- Surface preparation and condition.
- Material under examination and expected discontinuity
- Part temperature.
- Penetrant and Developer dwell time
- Viewing condition

10. TEST PROCEDURE:

10.1. SURFACE PREPARATION:

10.1.1. Liquid penetrant testing as per this procedure shall be carried out on as forged surface

10.1.2. Surface Preparation by wire brush, grinding, machining or other methods may be necessary where surface irregularities could mask indications of unacceptable discontinuities. Cleaner material as shown in Table in paragraph 6.0 of this procedure shall be used during surface preparation.

10.1.3. The use of grit blast cleaning or acid treatments on the surface before liquid Penetrant examination is prohibited.

10.1.4. Prior to liquid penetrant examination, the surface to be examined and all adjacent areas within at least 1 inch (25 mm) shall be dry and free of all dirt, grease, lint, welding flux, weld spatter, paint, oil, irregularities and other extraneous matter which could mask or be confused with a defect.

10.1.5. Surface preparation of stainless steels and nickel alloys shall be performed using dedicated tools made from materials that will not cause iron contamination of the surface. For example, wire brushes must be stainless steel and abrasive discs shall be of aluminum oxide with a nylon or fiberglass base.

10.2. DRYING AFTER PRECLEANING

10.2.1. Drying of the pre-cleaned surfaces shall be accomplished by normal evaporation for minimum 5 minutes before applying penetrant. It shall be ensured that cleaning solution has evaporated prior to application of penetrant.

10.3. PENETRANT APPLICATION:

10.3.1. Penetrant shall be applied by spraying from non rechargeable aerosol cans.

10.3.2. Sufficient care shall be taken to ensure that all the area to be examined shall be thoroughly and uniformly coated during application of the penetrant material.

10.3.3. Penetrant shall be applied to area being examined and all adjacent areas of at least 1/2 inch wherever applicable. All examination shall be conducted with minimum of 10% overlap for assuring 100% coverage of required area.

10.3.4. The area being examined shall be maintained wet with the penetrant.

10.4. PENETRANT DWELL TIME:

10.4.1. The penetrant dwell time shall be 20 minutes minimum if the temperature of penetrant or examination surface is from 5°C to 10°C.

10.4.2. The penetrant dwell time shall be 10 minutes minimum if the temperature of penetrant and examination surface is more than 10°C and up to 52°C.

10.4.3. The maximum penetrant dwell time shall be 30 minutes.

10.4.4. The penetrant shall not be allowed to dry or the examination process must be repeated.

10.4.5. The minimum dwell time for HVOF type TC hard facing of valve gates, stems and seats using wet fluorescent LPI shall be 10 min.

10.4.6. List of recommended dwell time is given in Table 1

RECOMMENDED MINIMUM DWELL TIMES

Material	Form	Type of Discontinuity	Dwell Times[A] (minutes) Penetrant[B]	Developer[C]
Aluminum, magnesium, steel, brass and bronze, titanium and high-temperature alloys	castings and welds	cold shuts, porosity, lack of fusion, cracks (all forms)	5	10
	wrought materials — extrusions, forgings, plate	laps, cracks (all forms)	10	10
Carbide-tipped tools		lack of fusion, porosity, cracks	5	10
Plastic	all forms	cracks	5	10
Glass	all forms	cracks	5	10
Ceramic	all forms	cracks, porosity	5	10

all

10.5.2. At last, small traces of penetrant shall be removed by solvent damped cloth.

10.5.3. To minimize the removal of penetrant from discontinuities, care shall be taken to avoid the use of excess solvent. Flushing the surface with solvent following the application of penetrant and prior to application of developing is prohibited.

10.6. DRYING AFTER EXCESS PENETRANT REMOVAL:

10.6.2. After removal of excess penetrant, the test surface shall be allowed to dry by normal evaporation for 1 minute minimum to 10 minutes maximum.

10.7. DEVELOPER APPLICATION:

10.7.1. The non-aqueous developer (solvent suspended developer) shall be applied as soon as practical after excess penetrant is removed and examination surface is dried, by spraying it from non-rechargeable aerosol can such that a uniform thin coating layer shall be produced on the examination surface.

10.7.2. The aerosol container shall be shakened well prior to the application to ensure adequate dispersion of suspended particles

10.7.3. Flow of spraying the developer material shall be such that it shall not produce a thick layer of developer material on localized region.

10.7.4. Sufficient care shall be taken that all the examination area shall be covered during developer application.

10.8. DEVELOPER DWELL TIME:

10.8.1. Developing time will start immediately after the application of the developer material on the examination surface and wet developer coating becomes dry.

10.8.2. Developing time shall be 10 minutes minimum to 30 minutes maximum.

10.9. OBSERVATION:

10.9.1. The indications shall be observed by the contrast between the color of the penetrant (red) and developer (white).

10.9.2. Indication with light pink color may indicate excessive cleaning. Inadequate cleaning may leave excessive background making interpretation difficult. In either inadequate cleaning or excessive cleaning, entire liquid penetrant testing shall be repeated.

10.9.3. Final inspection shall be made when the development time has been elapsed. Aids for visual examination, such as magnification instruments can be used.

10.10. INTERPRETATION AND EVALUATION:

10.10.1. All indications shall be investigated to the extent that the Inspector can evaluate such indications in terms of the applicable acceptance criteria.

10.10.2. Forgings which are evaluated to be unacceptable, but it is believed that they will be acceptable after minor surface conditioning (filling, grinding or machining), shall have their surface conditioned and retested in accordance with this procedure.

10.10.3. Forgings which are unacceptable and cannot be made acceptable by minor surface conditioning shall be separated from acceptable forgings and dispositioned in accordance with internal non-conformance procedure.

10.10.4. Relevant indications: An Indication with major dimension greater than 1.5mm. Such indications include.

10.10.4.1. Cracks.

10.10.4.2. Linear indications – those indications in which the length is equal to or more than three times the width.

10.10.4.3. Rounded indications are indications which are circular or elliptical with the length less than three times the width.

10.10.5. Non-relevant indications include :-

10.10.5.1. Localized surface imperfections, such as may occur from machining marks or surface conditions. These are not relevant to the detection of unacceptable discontinuities and shall not be reported.

10.10.6. Any questionable or doubtful indications shall be retested to verify that actual discontinuities are present

10.11. POST EXAMINATION CLEANING:

10.11.1.1. On completion of testing and interpretation, the part shall be cleaned with lint free cloth piece to remove all the trace of non-aqueous developer. Further it shall be ensured that no trace of penetrant is remained on the test surface. In case the test part contains entrapped Penetrant which is bleeded out after the application of developer, shall be flashed with solvent and wiped out with clean lint free cloth piece. Proper post cleaning shall be ensured before leaving site.

10.11.1.2. If required a suitable corrosion protection shall be applied.

11. REPORTING

11.1. As a minimum following information shall be documented in report:

11.1.1. Name of customer.

11.1.2. Identification of items examined (part number, drawing number, purchase order number, heat number, lot number-as applicable).

11.1.3. Procedure number and revision, acceptance criteria.

11.1.4. Area examined or location of liquid penetrant examination.

11.1.5. Method of surface preparation.

11.1.6. Forging material and forging thickness at examination surface.

11.1.7. Liquid penetrant type (Visible as per this procedure).

11.1.8. Type (number or letter designation) of each penetrant, penetrant remover and developer used.

11.1.9. Examination personnel identity and certification level.

11.1.10. Interpretation and evaluation of all relevant indications and their location(s).

11.1.11. Lighting equipment

11.1.12. Date of examination.

11.1.13. The names and employers of any witness the examination.

12. ACCEPTANCE STANDARDS

12.1. The acceptance standards for the interpretation of items inspected shall be Client requirements or the Contract Document.

12.2. If no Client requirements or Contract Document are available the international specification relevant to the work-scope shall be used.

12.3. Below is the acceptance standard as per required standard and specifications

Surface NDE

The following acceptance criteria apply:

— no relevant linear indication;

— no relevant rounded indication with a major dimension equal to or greater than 5 mm ($^{3}/_{16}$ in);

— four or more relevant rounded indications in a line separated by less than 1,6 mm ($^{1}/_{16}$ in) (edge to edge) are unacceptable;

— no relevant indication in pressure-contact sealing surfaces.

Weld NDE

In addition to above requirements following additional acceptance requirements shall apply:

Rounded indications greater than 3 mm (1/8 in) for welds whose depth is 16 mm (5/8 in) or less, or 5 mm (3/16 in) for welds whose depth is greater than 16 mm (5/8 in).