SARA SAE PRIVATE LIMITED

Management System Document Control Cover Sheet

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Procedure for Liquid Penetration Testing	**SES-26-701**	**7**

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Revision Log Sheet

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.
6	12.01.2021	Amendments added to bold & Italic Clauses
7	20.05.2024	Acceptance criteria for Lifting eyes of fabricated structure added.

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 - 23 - "Standard Practice for Liquid Penetrant Examination for General Industry"**

2.2. **ASTM E -1417 - 21 "Standard Practice for Liquid Penetrant Testing**

2.3. **ASTM E-433 – R23," Standard Reference Photographs for Liquid Penetrant Examination"**

2.4. **ASME Section V - 2023, Article 6 - Nondestructive Examination.**

2.5. **API Spec 6A - 21st Edition- Specification for Wellhead and Christmas Tree Equipment**

2.6. **API Spec 16A - 4th Edition- Specification for Drill Through Equipment**

2.7. **API Spec 16C - 3rd Edition, March 2021- Specification for Choke and Kill Equipment**

2.8. **API SPEC 16D- 3rd Edition Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment.**

2.9. **ASME BPVC.VIII.1 – 2023- BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1**

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 Rev 8.

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 Rev 8.

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 – 743 Rev 8.

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
I.	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. PROCEDURE QUALIFICATION

6.1 When procedure qualification is specified, a change of requirement in Table 1 identified as an essential variable from the specified value, or range of values, shall require re qualification of the written procedure and validation of the technique.

6.2 A change of a requirement identified as a nonessential variable from the specified value, or range of values, does not require requalification of the written procedure.

6.3 All changes of essential or nonessential variables from the value, or range of values, specified by the written procedure shall require revision of, or an addendum to, the written procedure.

6.4 The external and accessible internal weld surfaces and adjacent base material on each side of the weld shall be included in the examination.

6.5 The extent of examination shall be specified by the customer or the referencing Code Section.

6.6 Process monitoring of liquid penetrant systems can be accomplished by use of aluminum comparator block and Artificial defect sample. This should periodically be performed where penetrant may be subject to contamination or degradation.
The number of indications is recorded and establishes the number of indications which should be expected each time that particular same aluminum comparator block and Artificial defect sample processed with the same penetrant system.

Table 1: REQUIREMENTS OF A LIQUID PENETRANT EXAMINATION PROCEDURE

Requirement	Essential Variable	Nonessential Variable
Identification of and any change in type or family group of penetrant materials including developers, emulsifiers, etc.	✓	
Surface preparation (finishing and cleaning, including type of cleaning solvent)	✓	
Method of applying penetrant	✓	
Method of removing excess surface penetrant	✓	
Method of applying developer	✓	
Minimum and maximum time periods between steps and drying aids	✓	
Decrease in penetrant dwell time	✓	
Increase in developer dwell time (Interpretation Time)	✓	
Minimum light intensity	✓	
Surface temperature outside 5°C to 52°C or as previously	✓	

qualified		
Performance demonstration, when required	✓	
Personnel qualification requirements	--	✓
Materials, shapes, or size to be examined and the extent of examination	--	✓
Post examination cleaning technique	--	✓

7. LIQUID PENETRANT TESTING MATERIAL

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

7.2 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.

7.3 When using this procedure to examine austenitic, duplex or titanium material, all penetrant materials shall be analyzed 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 0.1% 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.

Make - Magnaflux		
Penetrant Material	Make	Brand Name
Penetrant	Magnaflux	SPOTCHECK (SKL-SP1)
Cleaner / Solvent	Magnaflux	SPOTCHECK (SKC-I)
Developer	Magnaflux	SPOTCHECK (SKD-S2)

7.4 When using this procedure to examine nickel-based material, all penetrant materials shall be analyzed 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 0.1% 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.

8. TEMPERATURE RANGE

8.1 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.

8.2 The temperature measurement device shall be calibrated once in six months or whenever meter has been repaired.

9. LIGHTING REQUIREMENT

9.1 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.

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

9.3 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.

10. GENERAL PRINCIPLES:

10.1 **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

10.2 **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

11. TEST PROCEDURE

11.1 SURFACE PREPARATION

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

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

11.1.3. 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.

11.2 DRYING AFTER PRECLEANING

11.1.4. 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.

11.3 PENETRANT APPLICATION

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

11.1.6. 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.

11.1.7. Penetrant shall be applied to area being examined and all adjacent areas of at least 1/2 inch wherever applicable.

11.4 PENETRANT DWELL TIME

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

11.4.2 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.

11.4.3 The maximum penetrant dwell time shall be 30 minutes.

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

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

11.4.6 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.

Table 1
Minimum Dwell Times

Material	Form	Type of Discontinuity	Dwell Times [Note (1)], (minutes) Penetrant
Aluminum, magnesium, steel, brass and bronze, titanium and high-temperature alloys	Castings and welds	Cold shuts, porosity, lack of fusion, cracks (all forms)	10
	Wrought materials — extrusions, forgings, plate	Laps, cracks	10
Carbide-tipped tools	Brazed or welded	Lack of fusion, porosity, cracks	10
Plastic	All forms	Cracks	10
Glass	All forms	Cracks	10
Ceramic	All forms	Cracks	10

NOTE:
(1) For temperature range from 50°F to 125°F (10°C to 52°C). For temperatures from 40°F (5°C) up to 50°F (10°C), minimum penetrant dwell time shall be 2 times the value listed.

11.5 DRYING AFTER EXCESS PENETRANT REMOVAL

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

11.6 DEVELOPER APPLICATION

11.6.1 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.

11.6.2 The aerosol container shall be shake and well prior to the application to ensure adequate dispersion of suspended particles

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

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

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

11.6.6 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.

11.7 DRYING AFTER EXCESS PENETRANT REMOVAL

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

11.8 DEVELOPER APPLICATION

11.8.1 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.

11.8.2 The aerosol container shall be shake and well prior to the application to ensure adequate dispersion of suspended particles

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

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

11.9 DEVELOPER DWELL TIME

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

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

11.10 OBSERVATION

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

11.10.2 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.

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

12. EXTENT AND AREA OF EXAMINATION/SAMPLING

12.1. **For API 6A-PSL 2 and API 16A Components**

- All accessible wetted and all accessible sealing surfaces of each finished part shall be examined after final heat treatment (if any) and after final machining operations.
- Weld Preparation for all type of pressure containing repair weld including repair weld of corrosion resistance and hard-facing overlay.

12.2. A**PI 6A-PSL 3, 3G, 4 & API 16C**:

- All accessible surfaces of each finished part shall be examined after final heat treatment (if any) and after final machining operations.
- Weld Preparation for all type of pressure containing production weld, repair weld and corrosion resistance and hard-facing overlay.

12.3. Pressure Containing Production Welds & Repair Welds, Corrosion resistance overlay and Hard-Facing overlay For API 6A (PSL 2, PSL 3/PSL 3G, PSL4), API 16A, API 16C.

- Examinations shall include 100% of the entire weld area plus ½" (13mm) of the adjacent base material on both sides of the weld after PWHT and final machining if any.
  Note: For PSL-4, Welding is not permitted, except weld overlay.

13. INTERPRETATION AND EVALUATION

13.1. Evaluation of Indications

13.1.1. **All indications shall be evaluated in terms of this procedure.**

13.1.2. **Only those indications with major dimensions greater than 1/16 inch (1.5 mm) shall be considered as relevant.**

13.1.3. **Linear, rounded, non-relevant, and questionable indications are defined in below:**

- **A linear relevant indication is the one having a length greater than three times the width.**
- **A rounded indication is one of circular or elliptical shaped with a length equal to or less than three time its width.**

14. ACCEPTANCE CRITERIA

14.1. For API 6A products (PSL- 2, 3, 4) and API 16C

➢ **Ferromagnetic materials**

✓ No relevant indication with a major dimension equal to or greater than 4.8 mm (3/16 in).

✓ No more than ten relevant indications in any continuous 40 cm2 (6 in2) area.

✓ Four or more relevant indications in a line separated by less than 1,6 mm (1/16 in) (edge to edge) are unacceptable.

✓ No relevant indications in pressure contact sealing surfaces.

➢ **Non- Ferromagnetic materials**

✓ No relevant rounded indication with a major dimension equal to or greater than 4.8 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 & Weld Overlay NDE**

- ✓ 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 indications in pressure contact sealing surfaces.
- ✓ No 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)
  Note: For PSL-4, Welding is not permitted, except weld overlay.

➢ **Repair Welds**

- ✓ 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 indications in pressure contact sealing surfaces.
- ✓ No 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)

  Note: For PSL-4, Welding is not permitted, except weld overlay.

14.2. **For API 16A products**

➢ **Surface NDE Acceptance Criteria for Surfaces other than Pressure- contact (Metal to Metal) Sealing Surfaces**

- ✓ No relevant indication with a major dimension equal to or greater than 5 mm (3/16 in).
- ✓ No more than ten relevant indications in any continuous 40 cm^2 (6 in^2) area
- ✓ Four or more relevant indications in a line separated by less than 1.6 mm

(1/16 in) (edge to edge) are unacceptable.

- **Surface NDE Acceptance Criteria for Pressure -contact (Metal to Metal) Sealing Surface**

  - ✓ There shall be no relevant indications in the pressure -contracts (metal to metal) sealing surfaces.

- **Weld & Weld Overlay NDE**

  - ✓ No relevant indication with a major dimension equal to or greater than 5 mm (3/16 in.).
  - ✓ No more than ten relevant indications in any continuous 40 cm^2 (6 in^2) area.
  - ✓ Four or more relevant indications in a line separated by less than 1,6 mm (1/16 in.) (edge to edge) are unacceptable.
  - ✓ No relevant indications in pressure contact sealing surfaces.
  - ✓ No relevant indications in pressure contact sealing surfaces.
  - ✓ No 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)

- **Repair Welds**

  Surfaces of ground-out areas for repair welds shall be examined prior to welding to ensure defect removal using acceptance criteria for fabrication welds as below.

  - ✓ No relevant indication is acceptable on ground and gouged surface of repair weld preparation.

- **For completed repair weld.**

  - ✓ No relevant indication with a major dimension equal to or greater than 5 mm (3/16 in.).
  - ✓ No more than ten relevant indications in any continuous 40 cm^2 (6 in^2) area.
  - ✓ Four or more relevant indications in a line separated by less than 1,6 mm (1/16 in.) (edge to edge) are unacceptable.
  - ✓ No relevant indications in pressure contact sealing surfaces.

- ✓ No 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)

14.3. **Acceptance criteria for lifting eyes of fabricated structure: - As per clause 7-4 of ASME Sec VIII Div-1**

All surface to be examined shall be free of –

a) **Relevant linear indications.**

b) **Relevant rounded indications greater than 3/16 in. (5 mm).**

c) **Four or more relevant rounded indications in a line separated by 1/16 in. (1.5, mm); or less, edge to edge.**

15. POST EXAMINATION CLEANING

15.1. 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.

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

16. REPORTING

16.1. As a minimum following information shall be documented in report APPENDIX 'A'- WORK SHEET FOR MANUAL LIQUID PENETRATION TESTING:

16.1.1. Name of customer.

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

16.1.3. Procedure number and revision, acceptance criteria.

16.1.4. Area examined or location of liquid penetrant examination.

16.1.5. Method of surface preparation.

16.1.6. Forging material and forging thickness at examination surface.

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

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

16.1.9. Examination personnel identity and certification level.

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

16.1.11. Lighting equipment

16.1.12. Date of examination.

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