

# Procedure

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# Liquid Penetrant Testing - ASME

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# REVISION INDEX

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## 1.0 SCOPE

- 1.1 This procedure details the methods and requirements for performing liquid penetrant testing by or on behalf of Industrial Performance Service (IPS) personnel. Fluorescent (Type 1) and visible (Type 2) dye penetrant examination using the solvent removable (Method C) or water-washable (Method A) processes may be used. This procedure is applicable to the examination of non-porous ferrous and nonferrous materials when referenced by applicable specification or code requirements, including but not limited to weldments with associated heat affected zones (HAZ), castings and raw materials.
- 1.2 This document meets or exceeds the minimum requirements of the ASME Code, Section V Article 6, current edition, and other codes and specifications specifically referencing this Code Section for the performance of liquid penetrant examinations.
- 1.3 The processes described herein are limited to the detection of discontinuities that are open to the surface.
- 1.4 When procedure qualification is specified by the referencing Code Section, a change of essential variable, as identified in Table T-621.1 of Article 6, shall require requalification of this procedure by demonstration. A change in nonessential variable does not require requalification. All changes, essential or nonessential, require revision of, or addendum to, this written procedure.

## 2.0 REFERENCE DOCUMENTS

- 2.1 Industrial Performance Services Written Practice, IPS-WP-01, Procedure for Qualification and Certification of Personnel
- 2.2 ASME Section V, Article 1, General Requirements
- 2.3 ASME Section V, Article 6, Liquid Penetrant Examination
- 2.4 ASME Section VIII - Pressure Vessels, Divisions 1 and 2
- 2.5 ASME B31.1, Power Piping
- 2.6 ASME B31.3, Process Piping

## 3.0 RESPONSIBILITY AND AUTHORITY

- 3.1 IPS requires all NDT examinations to be performed to a written examination procedure. The technician performing these examinations shall be responsible for carrying out these examinations in accordance with the instructions detailed in this procedure.

## 4.0 PERSONNEL QUALIFICATIONS

- 4.1 Personnel performing examination of this procedure shall be qualified and certified to NDT Level II or Level III in accordance with ASNT's RP No. SNT-TC-1A, and IPS's Written Practice IPS-WP-01 for the Qualification and Certification of NDT Personnel.

- 4.2 Personnel performing evaluations and/or reporting results in accordance with this procedure shall be certified Level II as a minimum.

## 5.0 EQUIPMENT AND MATERIALS

- 5.1 Penetrants- Fluorescent (Type 1) or visible (Type 2) penetrants may be used, provided adequate sensitivity level is achieved. Penetrant materials may be water washable (Method A) or solvent removable (Method C).

5.1.1 Intermixing of penetrant materials from different families or different manufacturers is not permitted. Such intermixing shall void the examination. Fluorescent penetrant examination shall not follow a color contrast examination.

5.1.2 Cleaners- Solvent based removers may be used provided they meet the requirements of ASME Section V, Article 6: T-641, Control of Contaminants.

5.1.3 Developers- Wet nonaqueous developers (aerosol type) shall be used and are applied by spraying.

**Note** *All penetrant materials shall be certified as to meeting the requirements of ASME Section V, Article 6; T-641, Control of Contaminants. Records of these certifications shall include the penetrant manufacturers' batch number, and the test results obtained. Records shall be maintained as required by the referencing code. Materials exceeding the maximum allowable level for sulfur, chlorine and fluorine as applicable shall be tagged to indicate their limitation for use and segregated from code materials*

## 6.0 AUXILIARY EQUIPMENT

- 6.1 Lighting

6.1.1 White Light- For non-fluorescent inspection, it shall be determined with a calibrated and operable white-light meter, that a minimum of 100 ftc (1076 lux) of visible light is present at the inspection surface. The light source, technique used, and light level verification are required to be demonstrated one time, documented, and maintained on file. For fluorescent inspections, the ambient white light in the darkened area measured on the surface to be examined shall not exceed 2 ftc (21.5 lux).

6.1.2 Ultraviolet Light- For fluorescent inspections, filtered ultraviolet radiation shall be used in a darkened area when performing examinations using fluorescent particles.

6.1.2.1 Black light intensity at the surface under examination shall be measured with a calibrated and operable black light meter prior to use, whenever the lights power source is interrupted or changed, and at the completion of the examination or series of examinations. A minimum of 1000 microwatts per square centimeter ( $1000\mu\text{w}/\text{cm}^2$ ) at the inspection surface shall be required.

6.1.2.2 Black lights shall be allowed to warm up for at least 10 minutes

prior to use or measurement of the intensity of the ultraviolet light emitted. LED UV-A sources do not require warmup.

6.1.2.3 Reflectors and filters should be checked and, if necessary, cleaned prior to use. Cracked or broken filters shall be replaced immediately.

6.1.2.4 The technician shall be in the darkened area for at least 5 minutes prior to performing the examination to allow for eye adaptation to dark viewing. If the technician wears glasses or lenses, they shall not be photosensitive (photo chromic) or permanently tinted.

## 6.2 Light Meters

6.2.1 Light meters used in accordance with this procedure must be calibrated at least once a year or when the meter has been repaired.

## 6.3 Dryer Units

6.3.1 A thermostatic control dryer may be used. Dryer temperature shall be checked and monitored in accordance with approved specifications. Oven temperatures are not to exceed 160°F, when used.

# 7.0 SURFACE PREPARATION

7.1 Satisfactory results may be obtained when the surface is in the as-welded, as-rolled, as-cast, or as-forged condition, but surface preparation by grinding, machining, or other methods may be necessary when surface irregularities could mask indications.

**CAUTION:** It is recognized that some mechanical cleaning and surface conditioning processes may cause a peening affect that could close discontinuities that would otherwise be open to the surface. In particular, sand, shot and bead blasting or other processes having a similar affect should be avoided. When these methods are used it shall be demonstrated that the integrity of the examination will not be compromised.

## 7.2 Pre-cleaning

7.2.1 Prior to each penetrant examination the surface to be examined and all adjacent areas within at least 1 inch (25 mm) shall be dry and free of any paint, dirt, grease, lint, scale, welding flux, weld spatter, oil, or other extraneous matter that could obscure surface openings or otherwise interfere with the examination.

7.2.2 Typical cleaning agents which may be used are detergents, organic solvents, de-scaling solutions, and paint removers. Degreasing and ultrasonic cleaning methods may also be used.

7.2.3 Drying after cleaning of the surface to be examined shall be accomplished by normal evaporation or with forced hot air. Part temperatures shall not exceed 125°F (52° C), after all visible traces of the cleaner have been removed, a minimum of five minutes drying time shall be observed prior to the application of the penetrant.

**CAUTION:** Longer drying times may be required depending upon the type of cleaning solution used and environmental conditions.

**8.0 LIQUID PENETRANT TEST PROCEDURE**

**8.1 Penetrant Application**

- 8.1.1 After all necessary surface preparation and subsequent cleaning is complete, the penetrant may be applied. Penetrant may be applied by any suitable means, such as spraying, dipping, or brushing. When testing weldments, penetrant application shall include the heat affected zone.
- 8.1.2 If the penetrant is applied by spraying using compressed air apparatus, filters shall be placed at the air inlet to preclude contamination of the penetrant by oil, water, or dirt sediments that may have collected in the lines.
- 8.1.3 The qualified minimum penetration time shall be as shown in Table T-672, Figure 1, for temperatures between 40° and 125°F (5° and 52°C). When it is impractical to conduct testing within this temperature range, a procedure shall be established and qualified as set forth in part T-653 of ASME Section V, Article 6.
- 8.1.4 Penetrant may be reapplied as necessary to prevent drying. Complete drying of the penetrant on the test item during the penetration time shall be cause for voiding the examination. Voided examinations shall be completely reprocessed.
- 8.1.5 The maximum penetrant dwell time shall not exceed the maximum recommended by the manufacturer.

Figure 1

| <b>Table T-672<br/>Minimum Dwell Times</b>   |   |  |                                    |
|--|---|--|------------------------------------|
| Material   | Form  | Type of Discontinuity                                    | Dwell Times                        |
|  |   |  | [Note (1)], (minutes)<br>Penetrant |
| Aluminum, magnesium, steel, brass and bronze, titanium and high-temperature alloys | Welds, heat-affected zones, and castings        | Porosity, lack of fusion, cracks (all forms), cold shuts | 5                                  |
|  | Wrought materials — extrusions, forgings, plate | Laps, cracks   | 10                                 |
| Carbide-tipped tools   | Brazed or welded                                | Lack of fusion, porosity, cracks                         | 5                                  |
| Plastic  | All forms                                       | Cracks   | 5                                  |
| Glass  | All forms                                       | Cracks   | 5                                  |
| Ceramic  | All forms                                       | Cracks   | 5                                  |

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.

**8.2 Excess Penetrant Removal**

**8.2.1 Method A (Water-washable)**

8.2.1.1 Excess penetrant shall be removed by flushing penetrant from external surfaces using a water spray. Water pressure shall not exceed 50 psi (350 Kpa) and the water temperature shall

not exceed 110° F.

#### 8.2.2 Method C (Solvent Removable)

8.2.2.1 Solvent removable penetrants are removed by first wiping the excess penetrant with a clean, lint free, dry cloth or absorbent toweling. The remainder of the surface penetrant is then removed with a solvent-dampened lint-free cloth or towel. The surface of the component shall not be flushed with solvent, and the cloth or toweling shall not be saturated with solvent. The surface shall be dried by blotting with a lint free dry cloth or towel, or by evaporation.

8.2.3 The component shall be observed under appropriate illumination to assure adequate removal of the surface penetrant. Over-removal of the surface penetrant shall require the component to be cleaned and reprocessed.

**CAUTION:** Washing operations shall be carefully observed and controlled to ensure that over-washing of the part surface and the resulting loss of sensitivity of the examination does not occur. Removal of fluorescent penetrants shall be done under a black light in order to facilitate and control the removal process.

### 8.3 Drying after Penetrant Removal

#### 8.3.1 Method A (Water-washable)

8.3.1.1 The surface may be dried by blotting with clean material or by circulating warm air, provided the surface temperature is not raised above 125°F (52° C).

#### 8.3.2 Method C (Solvent Removable)

8.3.2.1 The surface may be dried by normal evaporation, blotting, wiping, or forced air.

### 8.4 Developing

8.4.1 A thin coating of developer shall be applied over the surface being examined as soon as possible after penetrant removal. The developer shall be applied within 15 minutes after penetrant removal.

8.4.2 Suspension type developers shall be thoroughly agitated prior to application.

8.4.3 Nonaqueous developers shall be applied only to a dry surface by spraying.

8.4.4 Nonaqueous developers shall be dried by normal evaporation.

8.4.5 If, after developer application, the examination surface exhibits an excessive background, the test shall be voided and the item thoroughly cleaned and reprocessed.

8.4.6 Interpretation shall be performed after a developing time has elapsed

allowing bleed-out of the penetrant. The elapsed development time shall be a minimum of 10 minutes and a maximum of 60 minutes. Developing time begins as soon as the developer coating is dry. If bleed-out does not alter the examination results, longer periods are permitted.

**Note:** *The accuracy of flaw characterization may be improved by careful observation of the inspection surface while the developer is being applied.*

#### 8.5 Post-Cleaning

8.5.1 When post examination cleaning is required, it should be conducted as soon as practical after evaluation and documentation using a process using a process that does not adversely affect the part.

#### 8.6 Marking

8.6.1 When required, the locations of unacceptable indications will be marked on the test surface using project approved markers.

### 9.0 INTERPRETATION AND EVALUATION OF INDICATIONS

9.1 Relevant indications are those which result from mechanical discontinuities such as cracks, porosity, etc.

9.2 Any indication in excess of the acceptance standards which is believed to be non-relevant shall be regarded as a defect and shall be reexamined to verify whether or not actual defects are present. Nonrelevant indications and broad areas of fluorescence or pigmentation which would mask indications of defects are unacceptable. Such areas shall be cleaned and re-examined.

9.3 Linear indications are those which the maximum length of the indication is more than three times the maximum width. Rounded indications are those which are circular or elliptical with a maximum length less than or equal to three times the maximum width.

9.4 Any questionable or doubtful indications shall be re-examined to determine whether or not they are relevant.

9.5 Final evaluation shall be based upon the referencing Code Section (Section 12) or customer supplied specifications and detailed as such on the Liquid Penetrant Test form.

### 10.0 DOCUMENTATION

10.1 A liquid penetrant examination report shall be prepared and furnished to the client. A standard report form will be used unless otherwise specified by the client.

10.2 The report shall include the following information:

- a) Part Identification
- b) Procedure identification and revision
- c) Liquid Penetrant type (visible or fluorescent)
- d) Type (number or letter) of each penetrant, remover, and developer used

- e) Technician's name and certification level
- f) Examination results
- g) Map or record of indications
- h) Material and thickness
- i) Acceptance code and criteria
- j) Date examinations were performed.
- k) Lighting equipment

## 11.0 SAMPLE REPORT

### 12.0 ACCEPTANCE CRITERIA - ASME

- 12.1 Acceptance standards of ASME Section VIII Div. 1 & 2, B31.1 and B31.3 are defined in the following:

- 12.1.1 Section VIII, Division 1 & B31.3

- 12.1.1.1 An indication of an imperfection may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation.
- 12.1.1.2 A relevant indication is an indication that is greater than 1/16" in its major dimension.

- 12.1.1.3 All Surfaces to be examined shall be free of:
- a) Relevant linear indications
  - b) Relevant rounded indications greater than 3/16"
  - c) Four or more relevant indications in a line separated by 1/16" or less.
- 12.1.2 Section VIII, Division 2
- 12.1.2.1 An indication of an imperfection may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation.
- 12.1.2.2 A relevant indication is an indication that is greater than 1/16" in its major dimension.
- 12.1.2.3 All Surfaces to be examined shall be free of:
- a) Relevant linear indications
  - b) Relevant rounded indications greater than 3/16"
  - c) Four or more relevant indications in a line separated by 1/16" or less.
- 12.1.2.4 Crack like indications detected, irrespective of surface conditions, are unacceptable.
- 12.1.3 B31.1 and B31.3
- 12.1.3.1 A relevant indication is an indication that is greater than 1/16" in its major dimension
- 12.1.3.2 All surfaces to be examined shall be free of:
- a) Relevant linear indications
  - b) Relevant rounded indications greater than 3/16"
  - c) Four or more relevant indications in a line separated by 1/16" or less.
  - d) Ten or more rounded indications in any 6 inches of surface with the major dimension of this area not to exceed 6 inches with the area taken in the most unfavorable location relative to the indications being evaluated.