

# TAM International, Inc.

## QI-8.2.4-15, Visible Liquid Penetrant Testing (LPT) Instruction for Ferromagnetic and Non-ferromagnetic Base Materials & Welds

Approved by Department Manager

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**Revision Level: B**

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### 1.0 SCOPE AND PURPOSE

- 1.1 This instruction can be used for examination of both ferromagnetic and non-ferromagnetic materials using the liquid penetrant testing (LPT) materials and techniques described within this document. This method is acceptable for the detection of open to the surface discontinuities. Properly applied this method can prove to be a valuable tool to aid visual inspection for locating cracks, voids, laps, porosity and other open to the surface indications.
- 1.2 Any changes to this instruction shall be reviewed and approved by TAM International, NDT Level III prior to application

### 2.0 REFERENCES

- 2.1 ASTM E165: Standard Test Method for Liquid Penetrant Examination
- 2.2 ASME Section V: Nondestructive Examination, Article 6 – Liquid Penetrant Examination
- 2.3 RP ASNT-TC-1A: Qualification and Certification of Nondestructive Testing Personnel
- 2.4 RP CP-189: Standard for Qualification and Certification of Nondestructive Personnel

### 3.0 PERSONNEL

- 3.1. Personnel performing examinations to this instruction shall be qualified and certified in accordance with minimum requirements of Level II as defined in ASNT-TC-1A, "Procedure for Qualification and Certification of Nondestructive Testing Personnel", latest edition or an equivalent program.
- 3.2. Only personnel certified to Level II or III shall interpret test results.

### 4.0 MATERIALS

- 4.1 All inspections using penetrant materials shall come from one manufacturing family and shall be of the same grouping as prescribed by the penetrant manufacturer. Penetrant materials used if not from the same manufacturer listed below shall be at least equivalent in performance.

4.1.1 Recommended Liquid Dye Penetrant materials to be used in this instruction are as follows:

- Magnaflux – SKC-C Spotcheck Cleaner
- Magnaflux – SKL-SP2 Spotcheck (Solvent Removable) Penetrant or
- Magnaflux – SKL-WP2 Spotcheck (Water Washable) Penetrant
- Magnaflux – SKC-C Spotcheck Developer

- 4.2 Mixing of multiple penetrant families is strictly forbidden and not allowed unless agreed upon by the NDT Level III and documented.
- 4.3 **Pre-cleaning:** Detergents, organic solvents, de-scaling solutions, paint removers, and cleaners must be compatible with the penetrant materials being used. If it is unclear as to the compatibility of the pre-cleaning method(s) with the penetrant materials prescribed within, contact the NDT Level III before proceeding.
- 4.4 **Penetrant:** Materials used shall be visible color contrasting, either water wash or solvent removable type. The materials used are further defined as Visible Dye Type II, using Method A (Water Washable) or Method C (Solvent Removable).
- 4.5 **Penetrant Removal / Cleaners:** Only organic solvents and cleaners within the family group as recommended by the penetrant manufacturer shall be used.
- 4.6 **Developers:** Non-aqueous based solvent developers of the same manufacturing family group as that of the penetrant shall be used. Certification of non-contaminant to materials including nickel base alloys, austenitic stainless steels and titanium shall be confirmed before use. Maximum levels of Sulfur and Chlorine shall be less than 1% and noted on the manufacturer data sheet.

## **5.0 TECHNIQUE**

- 5.1 Either Method A (Water Washable) or Method C (Solvent Removable) is acceptable. While either method is acceptable, in the case of relevantly easy access, moderately smooth surfaces and small inspection areas Method C is the preferred method.
- 5.2 All safety, health, or work restriction precautions for application of these materials shall be followed.

## **6.0 SURFACE PREPARATION**

- 6.1 Satisfactory results may be obtained when the surface of the part is in the as-welded, as-rolled, as-cast, or as-forged condition. In some cases surface preparation by grinding, buffing, machining or other method may be necessary if surface irregularities are noted which could potentially mask indications. Blasting with metal shot or dull grit is strictly forbidden as indications open to the surface could be panned shut thus rendering the test ineffective and/or inconclusive.
- 6.2 When cleaning stainless steel or other non-ferrite materials, use only approved brushes or grinders to avoid carbon contamination.
- 6.3 Prior to performing any liquid penetrant examination, the surface to be examined and adjacent areas within 1" of the inspection area shall be dry and free of all dirt, grease, lint, scale, welding flux, weld spatter, oil, or any other material which could obscure surface openings or interfere with the examination.

## **7.0 EXAMINATION SURFACE CLEANING**

- 7.1 Clean the area to be examined plus at least 1" adjacent area just prior to performing the examination using the approved cleaner. Allow the surface to dry by normal evaporation for a minimum of five (5) minutes to ensure that the cleaner has completely evaporated prior to penetrant application.

## **8.0 PENETRANT APPLICATION**

- 8.1 The penetrant may be applied to the part by brushing or spraying. Surface temperature of the part to be inspected shall not be lower than 60 degrees F (16 C) or higher than 100 degrees F (38 C) prior to application or throughout the examination period. Local heating and cooling may be used to achieve this temperature range.
- 8.2 Penetration dwell time shall be between 10 and 30 minutes depending on the inspection area surface temperature. Confirmation of proper penetrant dwell time may be achieved through testing with a standard such as a TAM Crack Panel or equivalent with five (5) known defect sizes. Adequate sensitivity is confirmed when the method produces a minimum of three (3) of the five (5) known cracks.
- 8.3 The manufacturer recommended instructions for dwell time and temperature should be reviewed when available. Penetrant dwell times shall not be less than 10 minutes.

**9.0 PENETRANT REMOVAL (SOLVENT REMOVABLE)**

- 9.1 Remove any excess penetrant after the specified dwell time. Care should be taken to minimize removal of penetrant from any discontinuities. Remove excess penetrant by using lint-free cloth or absorbent paper toweling lightly moistened with cleaner. Repeat this step as necessary to remove any remaining visible traces of penetrant and to ensure a high-contrast field free of background residual penetrant. Any flushing or flooding of the surface with the penetrant remover is prohibited.
- 9.2 Surfaces shall be thoroughly dry prior to application of developer.
- 9.3 After all visible penetrant has been removed and the area is deemed ready for developer application, allow the surface to dry by normal evaporation for a minimum of two (2) minutes.

**10.0 PENETRANT REMOVAL (WATER WASH)**

- 10.1 Remove any excess penetrant after the specified dwell time. Care should be taken to minimize removal of any penetrant from discontinuities. For the water wash method, the water used should range from 60 – 80 F (16 – 27 C) and have a maximum pressure of 45 PSI (3 Bar). Remove excess penetrant by gently washing the inspection area with a course water spray at approximately 45 degree angle and approximately 12” (30 cm) from the part. Repeat this step as necessary to remove any remaining visible traces of penetrant and to ensure a high-contrast field. Concentrated forced spraying of the water directly at the part at or above the maximum pressure is prohibited.
- 10.2 Drying can be facilitated by use of dry, clean shop air with a maximum 25 PSI (1.75 Bar) at 12” to 24” (30 – 61 cm) distance. Surfaces shall be thoroughly dry prior to application of developer.

**11.0 DEVELOPER APPLICATION**

- 11.1 The developer should be applied once the part is completely dry. Application of the developer shall be in the form of aerosol spray. The pressurized can containing the developer should be vigorously shaken until the contents are well mixed. Spraying in a light back and forth sweeping motion, taking care not to over-spray in large amounts rapidly as caking, dripping or running can take place. The developer should be in a thin even coating, sufficient to properly draw out penetrant from indications, but not excessive so as to result in masking of indications.
- 11.2 Developer dwell time shall be between 7 – 30 minutes depending on temperature, type and size indication believed present.

**12.0 EXAMINATION**

- 12.1 The examination shall take place in an area with normal or artificial lighting sufficient to produce a minimum of 100 fc (1000 lx) at the test surface. Additional illumination aids such as flashlights and

mirrors are acceptable. The examination area lighting shall be sufficient to assure proper visibility of all relevant indications that might be present. Evaluation should begin as soon as the developer is applied in order to assure proper evaluation of an indication's size. Failure to do so could result in small borderline indications becoming diffused in the developer and missed. Final evaluation shall be made after allowing the penetrant to maximize bleed out but not diffuse excessively. Dwell time should be a minimum of 5 minutes but not more than 30 minutes. When the inspection surface size precludes completion of the examination in the prescribed time, the examination can be performed in smaller increments.

### 13.0 EVALUATION OF INDICATIONS

- 13.1 Discontinuities at the surface are indicated by bleed-out of the penetrant. Broad areas with a light pink or reddish hue color may be due to residual background penetrant remaining prior to developer application. Areas such as these could mask an indication and are considered unacceptable. Any area showing evidence of poor or insufficient cleaning as described above shall be cleaned and reexamined.
- 13.2 Mechanical discontinuities at the surface shall be evidenced by the bleeding out of penetrant, however localized imperfections such as machine marks, sharp corners, abrupt geometry changes can all cause similar bleed out. While indications such as these are non-relevant, further processing or re-inspection is required to confirm status.
- 13.3 An indication is evidence of a mechanical discontinuity. Only indications with a major dimension greater than 1/16" (1.6 mm) shall be considered relevant.
- 13.4 Linear indications are those indications in which the length is more than three times the width. Rounded indications are indications that are circular or elliptical in the shape with the length equal or less than the width.
- 13.4 Relevant indications are those which are greater in size as noted in paragraph 13.3 and are the result of discontinuities not intended by design or the inherent material properties. Relevant indications are not necessarily defects and will require further evaluation.
- 13.5 The final determination of the indication size shall be determined by measuring the bleed-out area within time period defined in paragraph 11.2.
- 13.6 Any relevant indication that cannot be removed by minor surface conditioning shall be recorded in the penetrant report. The suspect area shall be marked on the part inspection surface.

### 14.0 ACCEPTANCE STANDARD

- 14.1 For this instruction, the following acceptance standard shall apply unless superseded by other standards or customer specifications. All surfaces examined shall be free of:
- Relevant linear base material or weld indications, with length greater than 1/16" (1.6 mm).
  - Four (4) or more relevant rounded indications in a line separated by 1/16" (1.6 mm) or less (edge to edge).
  - One single rounded indication greater than 1/8" (3.1 mm) in the weld.
  - Any indication found in the weld, regardless of size that is determined to be a potential cause for tool failure, (i.e. weld pinholes or cracks, etc)
  - Any indication that is believed to be non-relevant shall be regarded as a defect unless it is shown, after re-examination and re-evaluation by the same methods, to assure that no defect is present.

### 15.0 DEFECT REMOVAL AND/OR REPAIR

- 15.1 Non-acceptable indications shall be removed by suitable means and re-welded if required. When a defect is removed and determined that a repair by welding is not required, the excavated area shall be blended with

the surrounding surface so as to avoid sharp notches, crevices, or corners remaining. Upon completion, the area shall be re-examined using this instruction to confirm acceptance.

15.2 After removal of a defect and prior to making a weld repair, the affected area shall be re-examined using this instruction to confirm removal of the defect.

15.2 If a removal area requires weld repair, the welding process shall be by the same instruction as the original weld. Upon completion of the weld repair, the suspect area shall be re-examined using this instruction to confirm acceptance.

**16.0 REPORTING**

16.1 After all examinations and required repairs have been performed to the satisfaction of the applicable specification or standard, a report shall be generated reflecting acceptance of the test results. The report at minimum shall contain the following information:

- The technician name, date and certification level
- Part and serial number of the tool or part inspected
- Description of the material type and area of inspection
- All relevant indications recorded and a sketch to show the locations
- Name of the agency performing the test
- Procedure number with revision level if applicable
- Penetrant method materials used, batch numbers and expiration date
- Environmental condition under which the exam was performed
- Any special equipment used
- Any re-work required (i.e. grinding, polishing, welding)
- Status after final completion of the examination

| Rev | Date     | Description   | Prepared By:  | Reviewed By / Approved By     | Date      |
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| A   | 2/17/11  | New Document  | Thomas Young  | M. Wyatt, B. Brooks, T. Young | 2/21/2011 |
| B   | 10/09/14 | Annual Review, Add Revision Box, Remove Review Date | Greg Fletcher |                               |           |
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