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**RECORD OF REVISIONS**

Rev	Date	Description	POC	RM
0	2/14/2017	Initial issue, no former KSL or LANL procedure.	David Bingham, <i>ES-EPD</i>	Larry Goen, <i>ES-DO</i>

Contact the Welding Standards POC for upkeep, interpretation, and variance issues.

ITM-1306-NDE-PT-201	<a href="#">Welding POC and Committee</a>
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## 1.0 Purpose & Scope

This procedure provides for the detection and evaluation of discontinuities open to the surface, such as cracks, linear, round and other types of surface discontinuities utilizing the Liquid Penetrant (PT) Method. Specifically, it addresses the use of the Water-washable, Fluorescent Dye technique (Type I, Method A), with Non-aqueous Wet Developer, as specified by ASTM E 165 and the ASME Boiler and Pressure Vessel Code Section V, Article 6.

## 2.0 Authority and Applicability

- A. **Authority.** This document is issued under the authority of the Laboratory Director to direct the management and operation of the Laboratory, as delegated to ADNHHO as provided in the Prime Contract. This procedure is issued under the authority of the ES-DO. It applies to Liquid Penetrant Nondestructive Examinations as described herein, performed within the scope defined in Section 1.0.

Issuing Authority (IA) and Responsible Manager (RM)/Office: Conduct of Engineering Office, Standards Manager.

- B. **Applicability.** This procedure applies to Liquid Penetrant Examination activities performed by LANL-authorized NDE inspectors listed with LANL Engineering Standards Manual Chapter 13.

## 3.0 Personnel Qualification and Training

### A. Qualification/Certification

Personnel performing Liquid Penetrant Testing in accordance with this procedure shall meet the following minimum qualifications of being certified or approved as either:

- Level II or Level III in accordance with ESM Chapter 13, Volume 6, WGIN 2-02, which is written based upon the guidelines of ASNT SNT-TC-1A.
- Level I or trainee in accordance with ESM Chapter 13, Vol. 6, WGIN 2-02, and working under the direct supervision of a Certified Level II or Level III.

## 4.0 Materials and Equipment

- A. **Penetrant.** Penetrant materials may be purchased in bulk or in aerosol cans. However, in cases of bulk materials the penetrant material cleanliness and traceability shall be maintained when transferring material from one container to another. Intermixing of materials from different penetrant designations or manufacturers is prohibited.

- B. **Materials.** Materials can only be decanted into clean containers. Previously-used containers shall be cleaned before introduction of penetrant materials by use of a solvent such as acetone or isopropyl alcohol.
- C. **Developer.** Developer shall be applied by spraying. Developer therefore cannot be purchased in bulk for field use and aerosol cans shall be used.
- D. **Cleaner.** All cleaners shall meet the sulfur and halogen maximum allowable content of 1%, except as noted in 4.E, below.
- E. **Material Certification.** Certification of the penetrant material compliance with the requirements of ASTM E 165 and ASME Boiler and Pressure Vessel Code Section V shall be obtained. Residual sulfur and halogens shall be limited to a maximum of 1% by weight. Certification of isopropyl alcohol or acetone is not required if the material is lab- or reagent-grade.
- F. **UV Lighting.** UV, or “black” lights, are required to make the dye in the penetrant to fluoresce. A minimum intensity is required in order to reliably see the indications, so all UV lamps shall be verified to provide a minimum of 1,000  $\mu\text{Watts}/\text{cm}^2$ , measured at a distance of 15 inches with a calibrated UV light meter.
1. Mercury vapor UV lamps must be inspected to ensure that the filter is not damaged and is clean and functional. If the lens is damaged the lamp shall not be used, both for the danger of the unfiltered UV radiation, and for the white light leakage that will compromise detection of indications. The lamp must be allowed to warm up for a minimum of 10 minutes after having been turned on before intensity measurements are made.
  2. LED UV light sources must be certified as meeting the requirements of ASTM E 2297 for wavelength.
  3. Very high intensity UV lamps are available (over 10,000  $\mu\text{Watts}/\text{cm}^2$ ) when using LED lamps. Care should be taken to minimize the time that potential indications are illuminated with high intensity lamps, to avoid exhaustion of the fluorescence of the dye.
- G. **Safety.** Penetrant materials can be flammable, and care must be taken to avoid all sources of ignition. In particular, the fumes and vapors associated with developer are very flammable. Penetrant inspection shall not be performed around or near open sources of ignition. Mercury vapor lamps contain liquid mercury, so care should be taken to not break the bulb. Mercury vapor bulbs also become very hot, and can burn skin that comes into contact with the lens or lamp housing.

- H. **Material Selection:** Only penetrant materials listed in this procedure are permitted to be used. The following materials are approved for use with this procedure:

**Magnaflux Products, Level 2 Sensitivity**

- Penetrant: Zyglo ZL-60D
- Developer: Zyglo ZP-9F

**NOTE:** *No other penetrant materials may be used with this procedure. The penetrant materials are an essential variable for Liquid Penetrant Examination per the ASME Code; consequently, no other materials may be utilized without qualification and revision of this procedure.*

## 5.0 Surface Preparation

In general, satisfactory results may be achieved when the surface to be inspected is in the as-welded, as-rolled, as-cast, or as-forged condition. Surface preparation by grinding, machining, or other methods may be required to remove surface irregularities.

- A. **Precleaning.** All parts or areas of parts shall be clean and dry prior to penetrant application. The surface to be examined and adjacent areas within 1 inch of the area to be inspected shall be cleaned. "Clean" shall mean that the surface is free of rust, scale, welding flux, weld spatter, grease, paint, oily films, dirt, and residues from previous penetrant examinations, and so forth, that might interfere with the penetrant inspection.
- B. **Method.** Cleaning of the area to be examined may be done by use of detergents, organic solvents, or vapor degreasing. Cleaners must not leave a residue that could interfere with the subsequent penetrant inspection. Certification of reagent-grade acetone or isopropyl alcohol used for precleaning is not required. As a final precleaning step, a solvent such as acetone or isopropyl alcohol shall be used to clean the surface.
- C. **Drying.** After cleaning, drying of the surface to be examined shall be accomplished by normal evaporation or with forced air, as appropriate. The part shall be dried for a minimum of five (5) minutes, or longer if needed, to ensure that the surface is completely dry prior to penetrant application.
- D. **Special Requirements.** Surfaces that require a specific surface finish shall be in that condition prior to the final Liquid Penetrant Examination as prescribed by the applicable specifications. Penetrant inspection shall always be conducted prior to surface peening.

## 6.0 Procedure, General Requirements

- A. **Temperature.** The test surface and materials shall be maintained in the temperature range of 40 °F to 125 °F throughout the examination period. Wash

water temperature shall be in the range of 50 °F to 125 °F. Higher or lower temperatures are permitted only when the penetrant materials have been qualified for the temperature to be used during the examination. Documentation of that qualification shall be included with the test report.

- B. **Lighting.** UV (365nm) lighting and visible lighting must be verified. The minimum intensity obtained from the UV light shall be 1,000  $\mu$ Watts/cm<sup>2</sup>, when measured at a distance of 15". The maximum visible (background) light intensity allowable is 2 fc (20 lx). The light meter(s) used for verification of lighting acceptability shall have been calibrated within the past year.
- C. **Deviation from Procedure.** Any deviation or failure to comply with the steps in this procedure shall be cause for reprocessing of the part or component.

## 7.0 Procedure, Specific Requirements

- A. **Penetrant Application.** Upon completion of all surface preparation, the penetrant shall be applied by spraying, dipping, or brushing.
- B. **Coverage.** The surface in the area of interest shall be coated completely and the full coating maintained for the required penetration (dwell) time. The dwell time shall be a minimum of 10 minutes. Dwell times should not exceed one hour, but may if the surface is rewetted as needed and there is no sign of the penetrant drying or becoming sticky.
- C. **Excess Penetrant Removal.** After the appropriate dwell time, excess penetrant shall be removed using a coarse water spray. The spray nozzle shall be specifically manufactured for the purpose of penetrant removal. The spray nozzle, insofar as is possible, should be maintained at least 12" from the part surface, and the water pressure shall not exceed 40psi. The excess penetrant shall be removed under black light to ensure overwashing does not occur.
  - 1. Excess penetrant may be removed by wiping. The initial wiping process shall use a dry, lint-free cloth to remove the bulk of the excess penetrant. Following the initial removal, clean, lint-free cloths that have been lightly dampened with water shall be used to remove the remainder of the excess. The excess penetrant shall be removed under black light to ensure overwashing does not occur.
- D. **Drying.** After washing the part of excess penetrant, the part should be blotted with clean, lint-free cloth to remove the bulk of the water, then the part shall be allowed to dry completely. Fans may be used for air movement to help facilitate complete drying. The use of heated air or ovens is not permitted.

- E. **Developing.** Developer shall be applied as soon as possible after excess penetrant removal and drying of the surface. Developer shall be applied by spraying only. As compared to visible dye penetrant, the coating of the developer should be lighter than for the visible technique. No other method of application is permitted by this procedure. The developer shall be applied in light coats, with no “blotching” or drops of developer. Ideally, the developer will “flash” dry almost immediately after application. Developing time for final evaluation begins immediately after the application and drying of the developer.

## 8.0 Interpretation and Evaluation of Indications

The evaluation process should begin immediately upon application of developer, and as a consequence the Inspector will monitor the behavior of indications during the development process. Final inspection of the test surface and evaluation of indications shall begin 10 to 60 minutes after applying the developer.

- A. **Lighting.** UV light intensity shall be at least 1,000  $\mu\text{Watts}/\text{cm}^2$  at the surface being evaluated. Background white light levels shall not exceed 2 fc.
- B. **Final Interpretation.** Final interpretation shall be made not less than 10 minutes, nor more than 60 minutes, after application of the developer. If bleed-out does not alter the examination results, longer periods are permitted. The use of the longer interpretation time shall be documented in the test report. Because a discontinuity is difficult to characterize if its indication has diffused excessively into the developer, the part and development of indications shall be observed throughout the development and interpretation time.
- C. **Acceptance Criteria.** Acceptance criteria shall be provided by the NDE requestor and shall be documented on the NDE Inspection Report.

## 9.0 Post Examination Cleaning

Post-inspection cleaning shall be accomplished as soon as possible after Evaluation and Documentation. Post-inspection cleaning should leave no penetrant material residue, and shall not be injurious to the part.

## 10.0 Responsibilities

This procedure is controlled and maintained by the Welding Program Administrator, as part of the LANL Engineering Standards Manual.

- A. **Responsible Line Manager (RLM).** The RLM shall ensure only those personnel who meet the requirements of this procedure are permitted to perform inspections/activities covered by this procedure. Personnel performing inspections shall be qualified and certified in accordance with Paragraph 3.0 of this procedure.

- B. **Test Personnel.** Personnel performing examinations per this procedure are expected to verify that their certification in the Liquid Penetrant method is current. It is the responsibility of test personnel certified to Level I, II, or III to perform the dye penetrant tests described herein and record the results of that examination. Personnel certified to Level II or III shall supervise the examination, when performed by a Level I or trainee, and evaluate the results of this examination. Personnel performing PT testing shall wear appropriate safety and protective equipment during field-testing as noted in the Integrated Work Document and have the appropriate personal protective equipment (PPE) as defined in the Material Safety Data Sheet (MSDS).

### 11.0 Implementation

As noted throughout.

### 12.0 Documents and Records

Test reports generated as a result of this procedure shall be maintained in accordance with LANL records policies. The test object owner shall ensure that records are appropriately stored and are traceable to the part that has been examined.

### 13.0 Acronyms and Definitions

Definitions of terms used in this procedure can be found in ASTM E1316.

For other definitions, see LANL [Definition of Terms](#) or [Acronyms and Names](#).

### 14.0 History

This document supersedes any conflicting requirements in O&M Criterion 419, [Inspections and Testing of Pressure Vessels and Pressure Relief Valves](#), but the Criterion remains in force and effect for each nuclear and high-hazard facility until they complete any necessary Unreviewed Safety Question (USQ) or Unreviewed Safety Issue (USI) review determinations.

### 15.0 References

**ASTM International E165**, *Standard Recommended Practice for Liquid Penetrant Inspection Method*

**ASTM International E1316**, *Standard Terminology for Nondestructive Examinations*

**ASTM International E2297**, *Standard Guide for Use of UV-A and Visible Light Sources and Meters used in the Liquid Penetrant and Magnetic Particle Methods*

**American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code**, *Section V, Nondestructive Examination*

**American Society for Nondestructive Testing (ASNT) SNT-TC-1A**, *Qualification and Certification of NDT Personnel*



**16.0 Forms**

ITM-1306-NDE-PT-201-FM01, Penetrant Testing Inspection Report

**17.0 Contact**

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