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**Pacific Gas and  
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**Work Procedure: WP 347-06**

Effective Date: 03/25/2022 Rev. 2

## Applied Technology Services (ATS)

### Liquid Penetrant Testing

☐ Yes ☒ No Approved for Nuclear Quality-Related Work ☒ ☐ Periodic Use ☒ Reference Use

#### 1. Scope

- 1.1 This procedure describes the requirements for performing Type I (fluorescent) and Type II (color contrast) penetrant examinations using Method A (water washable) and Method C (solvent removable) techniques.
- 1.2 This procedure may be used in the examination of nonporous materials, equipment, components, and welds for the detection of discontinuities open to the surface, as applicable to client specifications and applicable codes. The shape and size of objects to be examined are not limiting factors, provided the area(s) under examination can be properly examined within the time intervals specified in this procedure.

#### 2. Target Audience

- 2.1 ATS nondestructive examination employees and approved nondestructive testing (NDE) vendors.
- 2.2 ATS personnel performing examinations shall be qualified and certified in accordance with WP 347-01, "Written Practice for the Qualification and Certification of NDE Personnel".
- 2.3 Only Level II and Level III liquid penetrant personnel shall review, interpret, and evaluate results with respect to applicable codes, standards, and specifications.

#### 3. Safety

- 3.1 Follow all PG&E safety standards applicable to the work site, including, but not limited to:
  - Arc-flash and electrical hazards.
  - Confined or enclosed space hazards.
  - High-pressure or high-temperature fluids or steam.
  - Slips, trips, and falls and associated cuts, bruises, sprains, and worse can occur when working at heights, on stairways, or walking on steep, unstable, uneven, slippery, or wet surfaces.
  - Hazards associated with heights.

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#### 3.1 (continued)

- Rotating or moving machinery and equipment.
  - High noise level hazards.
  - Chemical or environmental hazards.
- 3.2 Wear all required personal protective equipment (PPE), including, but not limited to, appropriate gloves for handling solvents.
- 3.3 A thorough Job Hazard Analysis (JHA) or Job Safety Analysis (JSA), as applicable, must be performed and reviewed by all involved parties before and after the commencement of the examination activities.
- 3.4 Applicable Safety Data Sheets (SDS) must be available and reviewed for all solvents and materials used in this procedure.
- 3.5 All precautions related to the use, handling, storage, and disposal of the solvents and materials used in this procedure, as specified in the appropriate SDS, must be observed.
- 3.6 The liquid penetrant examination materials are highly volatile and flammable. Use them only in ventilated areas. The penetrant should not be heated above 125° F or exposed to open flames or hot surfaces.
- 3.7 Conduct waste disposal in accordance with all federal, state, local government environmental regulations.

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#### 4. Discussion

- 4.1 ATS uses liquid penetrant testing (PT) as a low-cost inspection method to locate surface-breaking defects in metals and joints. PT is used to detect casting, forging, and welding surface defects such as hairline cracks, surface porosity, leaks in new products, and fatigue cracks on in-service components.
- 4.2 PT is based on the liquid penetrant flowing into clean and dry surface-breaking discontinuities. After adequate penetration time, excess penetrant is removed and a developer is applied, which draws the penetrant out so the indication becomes visible.
- 4.3 This procedure can be summarized as follows:
- Pre-clean article to be inspected.
  - Apply penetrant to test part.
  - Allow correct dwell time to elapse.
  - Remove excess penetrant from part surface.
  - Dry, if applicable.
  - Apply developer and allow to dwell.
  - Inspect component.
  - Post-clean part.
  - Report findings.

#### 5. Definitions

- 5.1 Aqueous Developer: A developer in which the developing powder is either suspended or dissolved in water.
- 5.2 Bleedout: The action of entrapped penetrant spreading out from surface discontinuities to form an indication.

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- 5.3 Discontinuity: An interruption in the normal physical structure or configuration of an object.
- 5.4 Dwell Time: The total time that the penetrant is in contact with the part surface.
- 5.5 Indication: That which marks the presence of a discontinuity, as the result of detectable bleedout of a penetrant from the discontinuity.
- 5.6 Nonaqueous Developer: A developer in which the developing powder is applied as a suspension in a quick drying solvent.

### 6. Responsibilities

- 6.1 The NDE unit Supervisor ensures that only qualified and certified personnel are assigned to perform and comply with this procedure.
- 6.2 Liquid PT certified technicians are responsible to comply with this procedure and complete all required records and reports.

### 7. Instructions

- 7.1 Before you Start
- 7.1.1 Gather the materials and equipment listed in Table 1.

**Table 1**

APPROVED MATERIALS FOR TYPE 1 FLUORESCENT PENETRANT EXAMINATION	
<b>Method A Water Washable</b>	
Penetrant	• Magnaflux ZL-15B, ZL-19, ZL-60D
Developer	• Magnaflux ZP-4B, ZP-9F, SKD-S2
Clean Wiping Materials	• White cloths, for removing cleaner, penetrant, and developer
Solvent	• Water to remove excess penetrant



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Method C Solvent Removable	
Penetrant	<ul style="list-style-type: none"> <li>• Magnaflux ZL-2C, ZL-27A               <ul style="list-style-type: none"> <li>• Residual halogens shall not exceed 750 ppm</li> <li>• Sulfur content shall not exceed 1,000 ppm</li> </ul> </li> </ul>
Cleaner/Remover	<ul style="list-style-type: none"> <li>• Magnaflux SKC-S, SKC-HF</li> </ul>
Developer	<ul style="list-style-type: none"> <li>• Magnaflux ZP-4B, ZP-9F, SKD-S2</li> </ul>
Clean Wiping Materials	<ul style="list-style-type: none"> <li>• White cloths for removing cleaner, penetrant, and developer</li> </ul>
APPROVED MATERIALS FOR TYPE 2 VISIBLE PENETRANT EXAMINATION	
Method A Water Washable	
Penetrant	<ul style="list-style-type: none"> <li>• Magnaflux SKL-WP</li> </ul>
Developer	<ul style="list-style-type: none"> <li>• Magnaflux SKD-S2</li> </ul>
Clean Wiping Materials	<ul style="list-style-type: none"> <li>• White cloths, for removing cleaner, penetrant, and developer</li> </ul>
Cleaner/Remover	<ul style="list-style-type: none"> <li>• Water to remove excess penetrant</li> </ul>
Method C Solvent Removable	
Penetrant	<ul style="list-style-type: none"> <li>• Magnaflux SKL-SP1, SKL-SP2</li> </ul>
Cleaner/Remover	<ul style="list-style-type: none"> <li>• Magnaflux SKC-S, SKC-HF</li> </ul>
Developer	<ul style="list-style-type: none"> <li>• Magnaflux SKD-S2</li> </ul>
Clean Wiping Materials	<ul style="list-style-type: none"> <li>• White cloths, for removing cleaner, penetrant, and developer</li> </ul>

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APPROVED MATERIALS FOR TYPE 1 FLUORESCENT PENETRANT EXAMINATION
Other penetrant materials may be used with the approval of the cognizant ATS Level III or with the customer's approval. Where other materials are used, they shall be documented in the examination report.
EQUIPMENT
<ul style="list-style-type: none"> <li>• Applicator, such as swab or brush</li> <li>• Black light</li> </ul>
MISCELLANEOUS
<ul style="list-style-type: none"> <li>• Liquid Penetrant Report (to record findings)</li> </ul>

## 7.2 Techniques and Materials

**Table 2**

CONDITION	DETAILS
Allowable Examination Techniques	<ol style="list-style-type: none"> <li>1. Fluorescent (Type I) <ul style="list-style-type: none"> <li>• Water Washable (Method A)</li> <li>• Solvent-Removable (Method C)</li> </ul> </li> <li>2. Visible (Type II) <ul style="list-style-type: none"> <li>• Water Washable (Method A)</li> <li>• Solvent-Removable (Method C)</li> </ul> </li> </ol>
Examination Technique Restrictions	<ul style="list-style-type: none"> <li>• Fluorescent penetrant examination shall not follow a color contrast penetrant examination.</li> <li>• Intermixing of penetrant materials from different family groups or different manufacturers is not permitted.</li> <li>• Re-examination with water washable penetrants may cause loss of marginal indications due to contamination.</li> <li>• To avoid producing mixed waste, the supervisor must approve in advance any liquid penetrant inspection used on materials that have smearable contamination.</li> </ul>

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CONDITION	DETAILS
Standard Examination Temperature Range	<ul style="list-style-type: none"> <li>The temperature of the penetrant and the surface of the material or weld under examination shall not be below 40°F or above 125° F throughout the examination period.</li> <li>Local heating or cooling is permitted provided the temperatures remain in the range of 40° - 125° F during the examination.</li> </ul>
Qualification of Procedures for Non-Standard Temperatures	<ul style="list-style-type: none"> <li>When liquid penetrant examination is required on a material or weld whose surface temperature deviates from the 40°- 125°F range, then a nonstandard temperature procedure must be qualified in accordance with the procedure for nonstandard temperatures in ASME Section V, Article 6.</li> </ul>
Time of Examination	<ul style="list-style-type: none"> <li>When the time of examination is not specifically stated in the governing code or job specifications, perform the liquid penetrant examination for acceptance after the final post weld heat treatment.</li> </ul>
Penetrant Materials Approved for Use	<ul style="list-style-type: none"> <li>See Table 1</li> <li>Acetone, alcohol, and Spotcheck products are flammable and must be stored in approved containers isolated from any open flame or heat source.</li> <li>Use flammables in well-ventilated areas. Good housekeeping rules apply.</li> </ul>
Control of Contaminants	<ul style="list-style-type: none"> <li>When examining austenitic or duplex stainless steels, titanium, or nickel base alloys, the total sulfur and total halogen (chlorine and fluorine) content shall not exceed 1% of the residue by weight.</li> <li>Obtain certification of contaminant content for all liquid penetrant materials from the manufacturer.</li> <li>Certification shall include manufacturer's batch numbers and test results as required by the referencing Code Section.</li> </ul>
Illumination	<ul style="list-style-type: none"> <li>Visible Penetrants: Adequate white or natural illumination of 100 footcandles (fc) minimum at the examination surface is required to ensure no loss of sensitivity in the examination</li> <li>Fluorescent Penetrants: Conduct the examination in a darkened area using an ultraviolet "black light," with a minimum intensity of 1000 μW/cm2 on the surface of the part being inspected.</li> </ul>

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CONDITION	DETAILS
	<ul style="list-style-type: none"> <li>Background that is white or natural illumination during fluorescent PT inspections shall not exceed 2 footcandles (fc) in the inspection area.</li> <li>The examiner shall be in the darkened area for at least five (5) minutes prior to performing the examination.</li> <li>Allow the black light to warm up for 5 minutes prior to measurement of UV intensity and use.</li> <li>Measure the UV intensity with a black light meter prior to use, whenever the light's power source is interrupted or changed, and at the completion of the examination or series of examinations.</li> <li>Check and clean the lenses daily when in use.</li> <li>Replace cracked or broken lenses immediately.</li> <li>Examiners who wear eyeglasses may not wear photo sensitive lenses.</li> </ul>
Calibration	<ul style="list-style-type: none"> <li>At a minimum, annual calibration of light meters for both visible and ultraviolet is required.</li> <li>Repaired light meters require re-calibration.</li> <li>If meters have not been used for one year or more, calibration shall be done before being used.</li> </ul>

### 7.3 Surface Preparation

7.3.1 Surface preparation by grinding, machining, or other methods may sometimes be necessary where surface irregularities could otherwise mask indications of unacceptable discontinuities.

7.3.2 Shot, sand, grit, vapor blasting, or other metal peening or smearing operations may mask relevant indications and consideration must be taken when used.

7.3.3 Conditioning of surfaces prior to the examination can affect the results. The general precautions relative to surface conditioning as described in ASME Section V, Article 24, SE-165, Annex A1, should be followed.



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7.3.4 Prior to testing, examine the surface and all adjacent areas within at least 1 inch to ensure the surface is:

- a. Dry
- b. Free of any dirt, grease, lint, scale, welding flux, weld spatter, oil, or other extraneous matter that could obscure surface openings or otherwise interfere with the examination.

7.3.5 To clean the surface area:

- a. Use typical cleaning agents such as detergents, organic solvents, descaling solutions, and paint removers.
- b. Degreasing and ultrasonic cleaning methods may also be used.

7.3.6 To dry the surface area:

- a. Allow at least 1 minute, but not more than 4 hours for normal evaporation before applying liquid penetrant.
- b. Warming the parts in drying ovens, with infrared lamps, forced warm air, or exposure to ambient temperature are also acceptable drying methods.
- c. Part temperatures shall not exceed 125° F prior to application of penetrant.

## 7.4 Examination

### 7.4.1 Penetrant Application

- a. Apply penetrant by dipping, brushing, or spraying.
- b. WHEN spraying using compressed air type apparatus,

PLACE the filters on the upstream side near the air inlet to preclude contamination of the penetrant by oil, water or dirt sediment that may have collected in the lines.

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## 7.4.1 (continued)

- c. The penetrant should completely cover:
  1. The surface of the area under examination.
  2. At least 1/2 inch of adjacent area if the entire component is not examined.

#### 7.4.2 Dwell times:

- Shall be in accordance with Table 3 or as qualified by demonstration for specific applications.
- Shall not exceed the manufacturer's recommended range unless demonstrated and documented on a similar part under inspection.
- Unless otherwise specified, the presence of cracks should be assumed, and additional dwell time may be required when parts of unfamiliar types are first examined.

### Table 3

MINIMUM AND MAXIMUM DWELL TIMES		
Temperature Range	Minimum Dwell Time	Maximum Dwell Time
50° - 125°F	10 minutes	60 minutes
40° - 49°F	20 minutes	60 minutes

### 7.4.3 Excess Penetrant Removal

- a. After the specified dwell time has elapsed:
  1. Remove any remaining surface penetrant.
  2. While removing, minimize removal of penetrant from possible discontinuities.

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#### 7.4.3 (continued)

- b. IF the penetrant is removable with solvent,

THEN:

1. Wipe with a cloth or absorbent paper until most traces of penetrant have been removed.
2. Remaining traces of penetrant shall be removed by lightly wiping the surface with cloth or absorbent paper slightly moistened with solvent.
3. NEVER apply solvent directly to the part surface to remove excess penetrant.

#### 7.4.4 Removing Excess Water Washable Penetrant

- a. Remove the excess penetrant with a water spray.
- b. The water pressure shall not exceed 50 psi and water temperature shall not exceed 110° F.

#### 7.4.5 Drying

##### a. Water Washable Penetrants

1. If dry or non-aqueous developer is used, dry the surface by blotting with a clean material or by using circulating warm air provided the temperature of the surface is not raised above 125° F.
2. The temperature in the dryer shall not be hot enough to cause the temperature on the surface of the part to exceed 125° F.
3. Remove the parts from the drying oven as soon as they are dry.
  - Excessive time in the dryer can cause damage to the part as well as evaporation of the penetrant, which can impair the sensitivity of the inspection.
  - Drying time will vary with size, nature and number of parts under inspection.

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#### 7.4.5.a (continued)

4. If aqueous developer is used:
  - May be applied to the part immediately after the excess penetrant has been removed and prior to drying.
  - Shall be dried by circulating warm air.
  - Blotting is not permitted for aqueous developer.
  - The temperature in the dryer shall not exceed a range that will cause the temperature on the surface of the part to exceed 125° F.
5. The precise drying time is dependent upon dimensions, geometry, drying procedure, and humidity.
  - Minimum drying time: 10 minutes.
  - Maximum drying time: 30 minutes for warm air driers and 2 hours for blotting.
- b. Solvent Removable Penetrants
  1. The surface may be dried by normal evaporation or forced air.
  2. Minimum drying time: 1 minute.
  3. Maximum drying time: 30 minutes.

#### 7.4.6 Developer Application

- a. Apply the developer as soon as possible after the penetrant removal.
- b. The time interval shall not be less than the minimum nor more than the maximum drying times specified in sections 7.4.5.a and 7.4.5.b.
- c. Fluorescent Penetrants
  1. Non-Aqueous (Solvent)
    - Dry the surface of the part prior to application of the non-aqueous developer.

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#### 7.4.6.c.1 (continued)

- Apply by spraying except where safety, health, or restricted access, preclude it.
- Under such conditions, solvent suspended developer may be applied by brushing.
- With all applications, ensure that complete part coverage has been obtained.
- BECAUSE this type of developer evaporates very rapidly at normal room temperature:
  - It does not require the use of a dryer.
  - Use with proper ventilation.
- Dipping or flooding parts with non-aqueous developers is prohibited since it will flush (dissolve) the penetrant from within the discontinuities.

#### d. Visible Penetrants

##### 1. Non-Aqueous (Solvent)

- Dry the surface of the part prior to applying the non-aqueous developer.
- Spray on solvent suspensions except where safety, health, or restricted access, preclude it.
- Under such conditions, apply solvent suspended developer by brushing with all applications to ensure that complete part coverage has been obtained.
- BECAUSE this type of developer evaporates very rapidly at normal room temperature:
  - It does not require the use of a dryer.

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#### 7.4.6.d.1 (continued)

- Use with proper ventilation.
- Dipping or flooding parts with non-aqueous developers is prohibited since it will flush (dissolve) the penetrant from within the discontinuities through its solvent action.

#### 7.4.7 Developing Time

- a. The developing time required to draw penetrant from discontinuities into the dried developer on the surface shall be a minimum of 10 minutes and a maximum of 60 minutes.
- b. Interpreting examination results for acceptance purposes must be made within this time period.
- c. IF bleedout does not alter the examination results,  
THEN longer periods are permitted.
- d. IF the surface is too large to completely examine in the prescribed time,  
THEN examine surface portions one at a time.
- e. Observe the surface being examined during the developing period to detect the nature of certain indications which might excessively bleed out.
- f. Take precautions to prevent any object from touching the dry developer film because it is very brittle, loosely held, and easily damaged.
- g. BECAUSE the true size and type of discontinuities are difficult to evaluate if the penetrant diffuses excessively in the developer,  
OBSERVE the surface when applying the developer to detect the nature of any indications, which tend to bleed out profusely.

#### 7.4.8 Final Cleaning

- a. Clean with an approved manufacturer's cleaner or a cleaner approved by the referencing Code Section or customer specification.

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#### 7.4.8 (continued)

- b. Whenever liquid penetrant examination is required for nickel base alloy, austenitic stainless steel, or titanium, the requirements of Table 2, "Control of Contaminants" section, must be met.

#### 7.5 Interpretation of Indications

##### 7.5.1 Visible Penetrants

- a. The developer forms a more or less uniform white coating.
- b. Surface discontinuities are indicated by bleeding-out of the penetrant, which is normally of a deep red color staining the developer.
- c. Indications with a light pink color may indicate excessive cleaning.
- d. Inadequate cleaning may leave an excessive background making interpretation difficult.

##### 7.5.2 Fluorescent Penetrants

- a. The developer forms a more or less uniform white coating.
- b. Surface discontinuities are indicated by bleeding-out of the penetrant which is colored by fluorescent dyes and fluoresce when illuminated by a black light.
- c. Inadequate cleaning may leave an excessive background making interpretation difficult.

##### 7.5.3 Non-Relevant Indications

- a. Regard a non-relevant indication as an imperfection unless:
  - 1. It is shown by reexamination by the same method.
  - 2. The use of other nondestructive methods and surface conditioning indicate that no unacceptable imperfection is present.

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#### 7.5.3 (continued)

- b. Broad areas of fluorescence or pigmentation which could mask indications of discontinuities:
  1. Are unacceptable.
  2. Shall be cleaned and reexamined.

#### 7.5.4 Relevant Indications

- a. Relevant indications result from mechanical imperfections open to the surface.
- b. An indication of an imperfection may be larger than the imperfection that causes it.
- c. The size of the indication is the basis for acceptance evaluation.
- d. Linear and rounded indications are determined based on the length to width ratio specified in the applicable Code acceptance criteria.
- e. Rounded indications may be circular or elliptical.
- f. Aligned indications are a group of three or more indications which touch a straight line connecting any two of the groups.

#### 7.6 Standards of Acceptance

##### 7.6.1 See Table 4

**Table 4**

ASME Section	Details
Section I Power Boilers	<ul style="list-style-type: none"> <li>Only indications with major dimensions greater than 1/16 inch shall be considered relevant.</li> <li>A linear indication is one having a length greater than three times the width.</li> <li>A rounded indication is one of circular or elliptical shape with the length equal to or less than three times the width.</li> </ul>





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ASME Section	Details
	<ul style="list-style-type: none"> <li>Any questionable or doubtful indications shall be reexamined to determine whether or not they are relevant.</li> <li>Flat Plate in Corner Joints – all surfaces to be examined shall be free of: <ul style="list-style-type: none"> <li>Relevant linear indications</li> <li>Relevant rounded indications greater than 3/16 inch</li> <li>Four or more relevant rounded indications in a line separated by 1/16 inch or less (edge to edge).</li> </ul> </li> <li>Castings – surface indications are unacceptable if they exceed the following: <ul style="list-style-type: none"> <li>All cracks and hot tears</li> <li>Any group of more than six linear indications other than those (all cracks and hot tears) above in any rectangular area of 1 1/2 inch × 6 inch or less, or any circular area having a diameter of 3 1/2 inch or less.  <p style="margin-left: 40px;">Note: These areas being taken in the most unfavorable location relative to the indications being evaluated.</p> </li> <li>Other linear indications more than 1/4 inch long for thicknesses up to 3/4 inch inclusive, more than one-third of the thickness in length for thicknesses from 3/4 inch to 2 1/4 inch, and more than 3/4 inch long for thicknesses over 2 1/4 inch.</li> <li>Aligned acceptable indications separated from one another by a distance equal to the length of the longer indication are acceptable.</li> <li>All indications of nonlinear imperfections with any dimension exceeding 3/16 inch.</li> </ul> </li> </ul>
Section VIII Pressure Vessels	<ul style="list-style-type: none"> <li>Only indications with major dimensions greater than 1/16 inch are considered relevant.</li> <li>A linear indication is one having a length greater than three times the width.</li> <li>A rounded indication is one of circular or elliptical shape with the length equal to or less than three times the width.</li> <li>Any questionable or doubtful indications shall be reexamined to determine whether or not they are relevant.</li> <li>All surfaces to be examined shall be free of: <ul style="list-style-type: none"> <li>Relevant linear indications.</li> <li>Relevant rounded indications greater than 3/16 inch</li> </ul> </li> </ul>



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ASME Section	Details
ASME B 31.3 Process Piping	<ul style="list-style-type: none"> <li>A linear indication is a closed surface area marking or denoting a discontinuity requiring evaluation, whose longest dimension is at least three times the width of the indication.</li> <li>A rounded indication is a closed surface area marking or denoting a discontinuity requiring evaluation, whose longest dimension is less than three times the width of the indication.</li> <li>Castings - Examination of castings is covered in ASME B31.3 paragraph 302.3.3</li> <li>Welds and components other than castings - ASME B31.3 specifies liquid penetrant examination for the detection of cracks only, and all cracks are rejectable.</li> </ul>
API 1104 Welding of Pipelines and Related Facilities	<ul style="list-style-type: none"> <li>Any indication with a maximum dimension of 1/16 inch (2mm) or less shall be classified as non-relevant.</li> <li>Relevant linear indications (those in which the length is more than three times the width) shall be considered a defect should any of the following conditions exist: <ul style="list-style-type: none"> <li>Linear indications evaluated as crater or star cracks exceed 5/32 inch (4mm) in length.</li> <li>Linear indications are evaluated as cracks other than crater or star cracks.</li> <li>Linear indications are evaluated as Incomplete Fusion and exceed 1 inch (25mm) in total length in a continuous 12 inch (300mm) length of weld or 8% of the weld length.</li> <li>Relevant rounded indications (those in which the length is three times the width or less) shall be considered a defect if: <ul style="list-style-type: none"> <li>The size of an individual pore exceeds 1/8 inch (3mm).</li> <li>The size of an individual pore exceeds 25% of the thinnest nominal wall thickness joined.</li> <li>The distribution of scattered porosity exceeds the concentration permitted by the Figures in 19 and 20 of API 1104.</li> <li>For cluster porosity, the diameter of the cluster exceeds 1/2 inch (13mm), or the aggregate length of CP in any continuous 12 inch (300mm) length of weld exceeds 1/2 inch (13mm).</li> </ul> </li> </ul> </li> </ul>

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ASME Section	Details
AWS D1.1	<ul style="list-style-type: none"> <li>When welds are required to be tested by the liquid penetrant method, the weld shall be acceptable if it meets the applicable requirements of Table 5.</li> </ul>

**Table 5**

Discontinuity Category and Inspection Criteria	Statically Loaded Non-Tubular Connections	Cyclically Loaded Non-Tubular Connections	Tubular Connections (All Loads)
1. Crack Prohibition: the weld shall have no cracks	X	X	X
2. Weld/Base Metal Fusion <ul style="list-style-type: none"> <li>Thorough fusion shall exist between adjacent layers of weld metal and between weld metal and base metal.</li> </ul>	X	X	X
3. Crater Cross Section <ul style="list-style-type: none"> <li>All craters shall be filled to the full cross section of the weld except for the ends of intermittent fillet welds outside of their effective strength.</li> </ul>	X	X	X
4. Weld Profiles <ul style="list-style-type: none"> <li>Weld profiles shall be in conformance with AWS D1.1, 5.24.</li> </ul>	X	X	X
5. Time of Inspection <ul style="list-style-type: none"> <li>Visual inspection of welds in all steels may begin immediately after the completed welds have cooled to ambient temperature.</li> <li>Acceptance criteria for the ATSM A514, A517, and A709 Grade 100 and 100W steels shall be based on inspection performed not less than 48 hours after completing the welds.</li> </ul>	X	X	X
6. Underrun <ul style="list-style-type: none"> <li>A fillet weld in any continuous single weld shall be permitted to underrun the nominal fillet size specified by 1/16 inch without correction provided that the undersized portion of the weld does not exceed 10% of the length of the weld. On weld-to-flange welds on</li> </ul>	X	X	X



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Discontinuity Category and Inspection Criteria	Statically Loaded Non-Tubular Connections	Cyclically Loaded Non-Tubular Connections	Tubular Connections (All Loads)
girders, no underrun is permitted at the ends for a length equal to twice the width of the flange.			
7. Undercut <ul style="list-style-type: none"> <li>(A) for material less than 1 inch thick, undercut shall not exceed 1/32 inch, except that a maximum 1/16 inch is permitted for an accumulated length of 2 inches in any 12 inch length of weld. For material equal to or greater than 1 inch thick, undercut shall not exceed 1/16 inch for any length of weld.</li> </ul>	X		
<ul style="list-style-type: none"> <li>(B) In primary members, undercut shall be no more than 0.01 inches deep when the weld is transverse to tensile stress under any design loading condition. Undercut shall be no more than 1/32 inches deep for all other cases.</li> </ul>		X	X
8. Porosity <ul style="list-style-type: none"> <li>Complete penetration groove welds in butt joints transverse to the direction of computed tensile stress shall have no visible piping porosity.</li> <li>For all other groove welds and all fillet welds, the sum of visible piping porosity 1/32 inch or greater in diameter shall not exceed 3/8 inch in any linear inch of weld and shall not exceed 3/4 inch in any 12 inch length of weld.</li> </ul>	X  X		
<ul style="list-style-type: none"> <li>(B) The frequency of piping porosity in fillet welds shall not exceed one in each 4 inches of weld length and the maximum diameter shall not exceed 3/32 inch.</li> <li>Exception: for fillet welds connecting stiffeners to web, the sum of the diameters of piping porosity shall not exceed 3/4 inch in any 12 inch length of weld.</li> </ul>		X	X
<ul style="list-style-type: none"> <li>(C) Complete joint penetration groove welds in butt joints transverse to the direction of computed tensile stress shall have no piping porosity. For all other groove welds, the frequency of piping porosity shall not exceed one in 4 inches of length</li> </ul>		X	X

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Discontinuity Category and Inspection Criteria	Statically Loaded Non-Tubular Connections	Cyclically Loaded Non-Tubular Connections	Tubular Connections (All Loads)
and the maximum diameter shall not exceed 3/32 inch.			

#### 7.7 Evaluation

7.7.1 Perform a final interpretation within 10 to 30 minutes after the developing time begins.

- a. For visible dye penetrant, a minimum white light intensity of 100 fc is required for interpretation and evaluation.
- b. For fluorescent dye penetrant, use ultraviolet light (black light) with a minimum intensity of 1000 uW/cm<sup>2</sup> as measured at the examination (or at the maximum distance from the examination surface to be used).

#### 7.8 Indication Photos

7.8.1 If able and accessible, photo quality and quantity of confirmed indications should provide enough detail to understand the location and size of the indication to assist engineering or specialists in making sound repair decisions. Detailed and close up photos should include a ruler or tape measure for reference. An overall photo(s) of the unit or equipment should be taken along with the utilization of photo editing tools to further elaborate the location of the indication(s).

#### 7.9 Reporting

7.9.1 Document the record of the liquid penetrant examination using Attachment 1 WP 347-06, "Liquid Penetrant Inspection Report".

7.9.2 Record the following information, as a minimum, on the Liquid Penetrant Report:

- Project and unit number identification
- Applicable code reference
- Weld or component identification (number, or name, or etc.)

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#### 7.9.2 (continued)

- Examination procedure and revision number
- Examiner's name and certification level
- Examination date
- Examination results (including location and dimensions of all reportable indications)
- Penetrant materials manufacturer, brand or type (visible or fluorescent), and batch numbers
- Component temperature
- Materials and thickness
- Lighting equipment

### 8. Governing Documents

N/A

### 9. Records

9.1 See Section 7.9

### 10. Compliance Requirement/Regulatory Commitment

N/A

### 11. References

- 11.1 WP 347-01, "Written Practice for the Qualification and Certification of NDE Personnel"
- 11.2 ASME Boiler and Pressure Vessel Code, Section V.
- 11.3 ASME Boiler and Pressure Vessel Code, Section III



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11.4	ASME Boiler and Pressure Vessel Code
11.5	ASME/ANSI B31.1 Power Piping
11.6	ASME/ANSI B31.3 Process Piping
11.7	ASTM E165-01, "Standard Guide for Liquid Penetrant Examination"

N/A

13.1 Attachment 1 Rev. 0, WP 347-06, "Liquid Penetrant Inspection Report"

14.1 WP 347-06 Rev. 1, "Liquid Penetrant Testing"

**Document Contact** [REDACTED], Engineering Technician II, ATS NDE



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#### Revision Notes

Revision Number	What Changed?
2	<ul style="list-style-type: none"> <li>Minor changes and reference updates throughout the work procedure</li> <li>Removed section 6.3 ATS QA leader responsibility</li> <li>Added section 7.8 for indication photos</li> </ul>



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## LIQUID PENETRANT INSPECTION REPORT

<b>Location:</b>		<b>Date</b>		Click here to enter a date.	
<b>Component:</b>		<b>ATS Report #</b>			
<b>Line:</b>		<b>GPS Latitude:</b>		<b>Longitude:</b>	
<b>Procedure No. / Rev.:</b>					
<b>Component Details</b>					
<b>Item:</b> Choose an item.		<b>Material Type:</b>		<b>Size / Diameter:</b>	
<b>Circumference:</b>		<b>Temperature:</b>		<b>Surface Condition:</b>	
<b>Thickness:</b>					
<b>PT Technique</b>					
<b>Fluorescent</b> <input type="checkbox"/> <b>Visible</b> <input type="checkbox"/> <b>Solvent Removable</b> <input type="checkbox"/> <b>Water Washable</b> <input type="checkbox"/>					
<b>Consumables</b>					
<b>Manufacturer:</b>					
<b>Cleaner Batch #:</b>		<b>Type:</b>		<b>Drying Time:</b>	
<b>Penetrant Batch #:</b>		<b>Type:</b>		<b>Dwell Time:</b>	
<b>Developer Batch #:</b>		<b>Type:</b>		<b>Development Time:</b>	
<b>Light Verification</b>					
<b>Brand:</b>		<b>Model:</b>		<b>Serial No.:</b>	
<b>Calibration Due Date:</b>		<b>Detector Serial No.:</b>			
<b>Visible Light Intensity:</b>		<b>Foot Candles</b>		<b>Ultraviolet Light Intensity:</b>	
				<b>microwatt/cm<sup>2</sup></b>	
<b>Inspection Results</b>					
<b>Part/Weld/Component #</b>	<b>Accept</b>	<b>Reject</b>	<b>Remarks</b>		
	<input type="checkbox"/>	<input type="checkbox"/>			
	<input type="checkbox"/>	<input type="checkbox"/>			
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<b>Comments</b>					
<b>Examiner</b>		<b>Level:</b>		<b>Date:</b>	

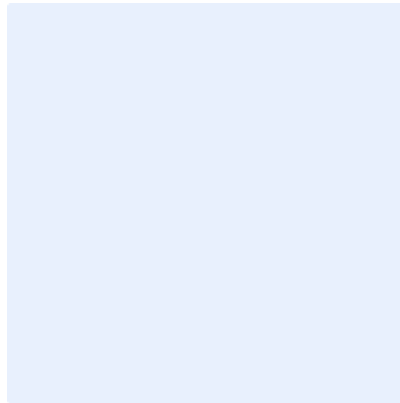


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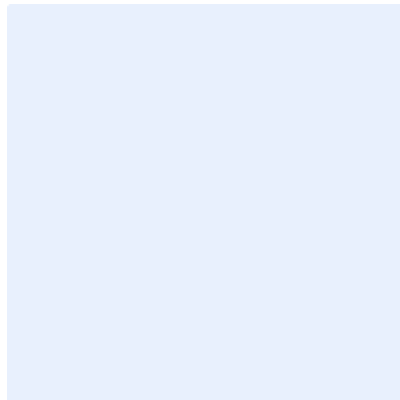
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## **LIQUID PENETRANT INSPECTION REPORT**

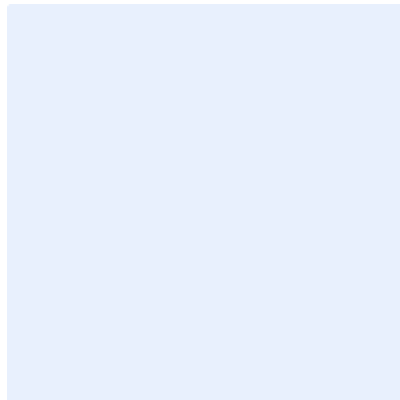
### **PICTURES**



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