



ELLSWORTH, KS

SPECIFICATION

BY: TM	DATE: 3-16-12	REV:	No: S-1759
CHKD: DV	APPD: DV	REV DATE:	SHEET: 1 OF 15

LIQUID DYE PENETRANT EXAMINATION PROCEDURE

APPROVED FOR PUBLIC RELEASE

BY _____

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LIQUID DYE PENETRANT EXAMINATION PROCEDURE

1.0 PURPOSE AND SCOPE

- 1.1 This procedure establishes the process requirements for Liquid Penetrant Examination.
- 1.2 This procedure will be followed by Cashco, Inc. when a customer requests Liquid Penetrant Examination to be performed in accordance with ASME Section V Article 6.
- 1.3 This procedure will be used in conjunction with applicable client specifications.
- 1.4 Liquid penetrant examination shall be performed in accordance with a written procedure which shall as a minimum, contain the requirements listed in Table 1.
- 1.5 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 requalification of the written procedure.
- 1.6 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.
- 1.7 All changes of essential or nonessential variables from the value, or range of values, specified by the written procedure shall require revision of, or addendum to, the written procedure.

2.0 REFERENCES

- 2.1 ASME Boiler and Pressure Vessel Code, Section V
- 2.2 ASME Section VIII, Appendix 8
- 2.3 ASME Section I, PG-25.2.1.2.2
- 2.4 ASME B31.3
- 2.5 ASME B31.1
- 2.6 ASTM SE-165
- 2.7 ASNT SNT-TC-1A (2006), CP-189 (2001) and ACCP (Revision 3, 1997)

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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.	X	
Surface preparation (finishing and cleaning, including type of cleaning solvent)	X	
Method of applying penetrant	X	
Hydrophilic or lipophilic emulsifier concentration and dwell time in dip tanks and agitation time for hydrophilic emulsifiers	X	
Hydrophilic emulsifier concentration in spray application	X	
Method of applying developer	X	
Minimum and maximum time periods between steps and drying aids	X	
Decrease in penetrant dwell time	X	
Increase in developer dwell time (Interpretation time)		X
Minimum light intensity	X	
Surface temperature outside 50° to 125° F (10° to 52° C) or as previously qualified	X	
Personnel qualification requirements		X
Materials, shapes, or sizes to be examined and the extent of the examination		X
Post examination cleaning technique		X

3.0 PERSONNEL QUALIFICATION

- 3.1 Personnel performing liquid penetrant examinations shall be certified to at least Level I in accordance with Section 2.0.
 - 3.1.1 A trainee may perform the cleaning and application process under the direct supervision of PT Level II.
- 3.2 Certified PT level I, II, III personnel may perform all operation necessary in accordance with this procedure to process the object being examined. Level I personnel shall receive the necessary supervision and guidance from certified PT Level II or Level III personnel.
- 3.3 Interpretation and evaluation of liquid penetrant examination results will be accomplished by personnel certified as PT Level II or III.

4.0 CALIBRATION

- 4.1 Light meters, both visible and fluorescent, shall be calibrated annually or whenever the meter has been repaired.
- 4.2 If meters have not been in use for one year or more, calibration shall be done before use.

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5.0 LIQUID PENETRANT MATERIALS

- 5.1 Intermixing of penetrant materials from different families or different manufacturers is not recommended.
- 5.2 A certification of penetrant material contaminant content for all liquid penetrant materials including all cleaning solvents used on nickel base alloys, austenitic stainless steels, and titanium will be obtained.
 - 5.2.1 These certifications will include the penetrant manufacturers' batch numbers and the test results obtained according to 1) and 2) below:

NOTE

The manufacturer's testing and documentation may be used in lieu of these tests.

- 1) When examining nickel base alloys, all materials must be analyzed individually for sulfur content as follows:
 - (a) An individual sample of the penetrant material with exception of cleaners will be prepared for analysis by heating 50 g of the material in a 150 mm nominal diameter glass Petri dish at a temperature of 194°F to 212°F for 60 minutes.
 - (b) Analysis of the residue will be as follows:
 - (1) If the residue is less than 0.0025 g, the material is acceptable without further analysis.
 - (2) If residue is 0.0025 g or more, the procedure shown in 4.2.1.1)(a) will be repeated and the residue analyzed in accordance with ASTM D 129 or ASTM D 1552.
 - (3) Alternately, the material may be decomposed in accordance with ASTM D 129 and analyzed in accordance with ASTM D 516 Method B.
 - (4) The sulfur content must not exceed 1% of the residue by weight.
- 2) When examining austenitic stainless steel or titanium, all materials must be analyzed individually for chlorine and fluorine content as follows:
 - (a) An individual sample of penetrant materials with the exception of cleaners will be prepared for analysis by heating 50 g of the material in a 150 mm nominal diameter glass Petri dish at a temperature of 194°F to 212°F for 60 minutes.
 - (b) Analysis of the residue will be as follows:
 - (1) If the residue is less than 0.0025 g, the material is acceptable without further analysis.
 - (2) If the residue is 0.0025 g or more, the procedure showing 4.2.1.2)(a) will be repeated and the residue analyzed in accordance with ASTM D 808 or SE-165 Annex 2 for chlorine and SE-165 Annex for fluorine.
 - (3) The chlorine plus fluorine content must not exceed 1% of the residue by weight.
 - (c) An individual sample of the cleaner / remover material will be prepared for analysis by heating 100 g of the material in a 150 mm nominal diameter Petri dish at a temperature of 194°F to 212°F for 60 minutes.

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(d) Analysis of the residue will be as follows:

- (1) If the residue is less than 0.005g, the material is acceptable without further analysis.
- (2) If the residue is 0.005g or more, the procedure shown in 4.2.1.2)(c) will be repeated and the residue analyzed in accordance with ASTM D 808 or SE-165 Annex 2 for chlorine and SE-165 Annex 3 for fluorine.
- (3) The chlorine plus fluorine content must not exceed 1% of the residue by weight.

6.0 PREPARATION FOR EXAMINATION

6.1 In general, satisfactory results may be obtained when the surface of the part is in the as-welded, as-rolled, as-cast, or as-forged condition.

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

6.1.2 Abrasive cleaning (blasting, sanding) barrel vibratory finishing, buffing and burnishing, impregnation or plating, or shot peening will not be allowed.

6.1.2.1 Some sandblasting will be considered acceptable if it is proven by procedure demonstration and qualification to not obscure discontinuities.

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

6.3 Typical cleaning agents which may be used are detergents, organic solvents, descaling solutions, and paint removers.

6.3.1 Degreasing and ultrasonic cleaning methods may also be used.

6.3.2 Cleaning solvents must meet the requirements of 4.2.1.

6.4 After cleaning, drying of the surfaces to be examined will be accomplished by normal evaporation or with forced hot air, as appropriate.

6.4.1 A minimum of five (5) minutes evaporation time will be allowed, prior to application of the penetrant, to assure the surface to be examined is dry.

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6.5 The temperature of the penetrant and the surface of the material to be examined must not be below 50°F nor above 125°F during the penetrant process, or the procedure (application technique) must be qualified in accordance with section 10 of this procedure, for the nonstandard temperature.

6.5.1 Local heating and cooling is permitted provided the temperature of the surface being examined is maintained in the range of 50°F to 125°F during the examination.

7.0 COLOR CONTRAST SOLVENT REMOVABLE PENETRANT (OPTIONAL)

7.1 This section establishes the method for examining parts and materials using the Color Contrast Solvent Removable Penetrant Process. Except as prohibited in paragraphs 1.3 and 4.0, any equipment or materials listed in this section may be replaced with an equivalent if the corporate Level III approves and documents the change.

7.2 Color contrast solvent removable penetrant materials will be:

7.2.1 Magnaflux Spotcheck Penetrant SKL-SP2, or equivalent

7.2.2 Magnaflux Spotcheck Cleaner/Remover SKC-S, or equivalent

7.2.3 Magnaflux Spotcheck Developer SKD-S2, or equivalent

7.3 The "Penetrant" will be applied by brushing or spraying.

7.3.1 The penetrant dwell time must be a minimum of 10 minutes.

7.3.1.1 If conditions dictate, the dwell time may be increased as required to a maximum of 60 minutes.

7.3.1.2 In any event, the surface being examined must be kept completely moist for the full duration of the penetrant time.

7.3.1.3 Should the penetrant material thicken, congeal, or dry, the surface being examined must be re-cleaned and the penetrant must be re-applied.

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- 7.4 Excess penetrant, insofar as possible, will be removed by wiping with clean, dry, lint-free cloths.
 - 7.4.1 A clean cloth will then be moistened with SKC-S remover and the surface will be wiped lightly.
 - 7.4.1.1 This operation will be repeated until most traces of penetrant have been removed.
 - 7.4.1.2 Care must be exercised to limit the removal of penetrant from any discontinuity to as little as possible.
 - 7.4.1.3 Flushing the surface with solvent following the application of the penetrant prior to developing is prohibited.
 - 7.4.2 Drying prior to development must be accomplished by allowing a minimum of 5 minutes for normal evaporation.
 - 7.4.2.1 Blotting, wiping, or force air may be used to aid drying.
- 7.5 The developer must be applied after drying (5 minutes) and not more than 10 minutes following the penetrant removal operation.
 - 7.5.1 The developer must be the pressurized spray can type and must be thoroughly agitated prior to application.
 - 7.5.2 The developer will be sprayed on in a thin uniform coating.
 - 7.5.3 The examiner will observe the surface during the application of the developer in order to characterize and determine the extent of indications which might tend to bleed out profusely.
 - 7.5.3.1 White light at the surface being examined will be adequate to distinguish the contrast between the developer and any penetrant bleedout. A minimum of 100 foot candles at the examination site is required.
 - 7.5.4 Final interpretation will be made after allowing a development time of at least 10 minutes and not more than 30 minutes.
 - 7.5.4.1 Development time starts as soon as the wet developer coating is dry.

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8.0 COLOR CONTRAST WATER-WASHABLE PENETRANT

8.1 This section establishes the method for examining parts and materials using the Color Contrast Water-Washable Penetrant Process. Except as prohibited in paragraphs 1.3 and 4.0, any equipment or materials listed in this section may be replaced with an equivalent if the Corporate PT Level III approves and documents the change.

8.2 Color contrast water-washable materials will be:

8.2.1 Magnaflux Spotcheck Penetrant SKL-WP2, or equivalent

8.2.2 Magnaflux Spotcheck Cleaner/Remover SKC-S, 123, or equivalent

8.2.3 Magnaflux Spotcheck Developer SKD-S2, or equivalent

8.3 The "Penetrant" will be applied by dipping, brushing, or spraying.

8.3.1 The penetrant dwell time must be a minimum of 10 minutes.

8.3.1.1 If conditions dictate, the dwell time may be increased as required to a maximum of 60 minutes.

8.3.1.2 In any event, the surface being examined must be kept completely wet for the full duration of the penetration time.

8.3.1.3 Should the penetrant material thicken, congeal, or dry, the surface being examined must be re-cleaned and the penetrant must be re-applied.

8.4 Excess penetrant, insofar as possible, will be removed by a coarse water spray.

8.4.1 The water pressure must not exceed 50 psi, and the water temperature will be a minimum 50°F and not exceed 110°F.

8.4.1.1 Care must be exercised to limit the removal of penetrant from any discontinuity to as little as possible.

8.4.2 Surface drying prior to developing will be accomplished by blotting with paper towels or clean lint-free cloths, or circulating warm air, provided the temperature of the surface is not raised above 125°F.

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8.5 The developer must be applied within 10 minutes following the surface drying operation. Non-aqueous developer shall be applied only to a dry surface.

8.5.1 The developer must be the pressurized spray can type and must be thoroughly agitated immediately prior to application.

8.5.2 The developer will be sprayed on in a thin uniform coating.

8.5.3 The examiner will observe the surface during the application of the developer in order to detect the nature of certain indications which might tend to bleed out profusely.

8.5.3.1 White light at the surface being examined will be adequate to distinguish the contrast between the developer and any penetrant bleedout.

8.5.3.2 A minimum intensity of 100 foot candles at the examination site is required.

8.5.4 Final interpretation will be made after allowing a development time of at least 7 minutes and not more than 30 minutes.

8.5.4.1 Development time starts as soon as the wet developer coating is dry.

9.0 PROCEDURE QUALIFICATION FOR NONSTANDARD TEMPERATURES

9.1 When it is not practical to conduct a liquid penetrant examination within the temperature range of 50°F to 125°F, the examination procedure at the proposed lower or higher temperature range requires qualification.

9.1.1 The qualification of the nonstandard temperature requires the use of a quench cracked aluminum block which is described in ASME Section V, Article 6, and is designated as a liquid penetrant comparator block.

9.1.1.1 For use with this procedure, the liquid penetrant comparator block will be cut in half and one-half will be designated block "A" and the other, block "B".

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9.1.2 Qualification of a liquid penetrant examination for use at a temperature of less than 50°F will be accomplished as follows:

9.1.2.1 The proposed procedure will be applied to block "B" after the block and all penetrant materials have been cooled and held at the purposed examination temperature until the comparison is complete.

9.1.2.2 The standard temperature procedure as described in this procedure will be applied to block "A" in the 500 F to 1250 F temperature range.

9.1.2.3 Both blocks "A" and "B" will be processed at the same time so that the indications of the cracks in the two blocks can be compared at the completion of the development time for both.

9.1.2.4 If the indications obtained under the proposed conditions on block "B" are essentially the same as obtained on block "A" during the examination at 50°F to 125°F, the proposed procedure will be considered qualified for use.

9.1.2.5 A procedure qualified at a temperature lower than 50°F will be qualified from that temperature to 50°F.

9.1.2.6 All the proposed conditions of the nonstandard low temperature procedure will be documented, along with the results of this comparison, and the nonstandard low temperature procedure will be attached to this procedure for use when required.

9.1.3 Qualification of a liquid penetrant examination for use at a temperature above 125°F will be accomplished as follows:

9.1.3.1 The proposed procedure will be applied to block "B" after the block and all penetrant materials have been heated and held at the proposed examination temperature until the comparison is completed.

9.1.3.2 The standard temperature procedure as described in this procedure will be applied to block "A" in the 500 F to 1250 F temperature range.

9.1.3.3 Both blocks "A" and "B" will be processed at the same time so that the indication of the cracks in the two blocks can be compared at the completion of the development time for both.

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9.1.3.4 If the indications obtained under the proposed conditions on block "B" are essentially the same as obtained on block "A" during the examination at 50°F to 125°F, the proposed procedure will be considered qualified for use.

9.1.3.5 To qualify a procedure for temperatures above 125°F, the upper and lower temperature limits will be established and the procedure will be qualified at these temperatures.

9.1.3.6 All the proposed conditions of the nonstandard high temperature procedure will be documented, along with the results of this comparison, and the nonstandard high temperature procedure will be attached to this procedure for use when required.

10.0 EVALUATION OF INDICATIONS

10.1 Mechanical discontinuities at the surface will be indicated by bleeding out of the penetrant; however, localized surface imperfections, such as those occurring from machining marks or surface conditions, may produce similar indications which are non-relevant to the detection of unacceptable discontinuities.

10.2 Any indication which is believed to be non-relevant must be regarded as a defect and will be further examined to verify whether or not actual defects are present.

10.2.1 Visual examination or another examination method may be used for verification of non-relevant indications.

10.2.2 Surface conditioning may precede the reexamination.

10.2.3 Non-relevant indications and broad areas of pigmentation which would mask indications of defects are unacceptable, and such areas shall be cleaned and reexamined.

10.2.4 Inadequate cleaning may leave an excessive background, making interpretation difficult.

10.2.5 When using color-contrast penetrants, indications with a light pink color may indicate excessive cleaning.

10.3 Relevant indications are indications which result from mechanical discontinuities.

10.3.1 Linear indications are indications in which the length is more than three times the width.

10.3.2 Round indications are indications which are circular or elliptical with length less than three times the width.

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10.3.3 An indication of a discontinuity may be larger than the discontinuity that caused it; however, the size of the indication and not the size of the discontinuity is the basis of acceptance or rejection.

10.4 All indications will be evaluated in terms of the appropriate acceptance standards (paragraph 14.0).

10.5 A Liquid Penetrant Examination Report will be used to record examination results.

10.5.1 The customer will be provided with a copy of this report which will include as a minimum:

10.5.1.1 Customer name, contract or job number, and report date.

10.5.1.2 Signature and certification level of penetrant inspector,

10.5.1.3 Vessel, tank, part, or weld number.

10.5.1.4 Extent of examination.

10.5.1.5 Liquid Penetrant Examination Technique (Visible, Fluorescent, water-washable....).

10.5.1.6 Equipment and materials used including:

- a) Penetrant cleaner and developer manufacturer, brand, number or letter designation and batch number.
- b) Manufacturer, model number and serial number of the temperature measuring instrument, if applicable.
- c) Black light manufacturer, model number, serial number and output at 15 inches, if applicable.
- d) UV/ white light meter manufacturer, model number, serial number and calibration date, if applicable.

10.5.1.7 Conditions of the examination, including:

- a) Surface condition.
- b) Temperature of the surface and penetrant.
- c) Pre-cleaner evaporation time.
- d) Penetrant dwell time. Drying time after penetrant removal and prior to developer application.
- e) Development time.
- f) Post cleaning.

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- 10.5.1.8 Interpretation of each penetrant indication noting relevant and significant non-relevant indications.
- 10.5.1.9 Evaluation of each penetrant indication noting acceptance or rejection.
- 10.5.1.10 Reference to this procedure and the appropriate acceptance standard.

11.0 POST-EXAMINATION CLEANING

- 11.1 All components having been examined by the liquid penetrant method will be thoroughly cleaned by wiping with dry cloths and then with solvent dampened cloths.
- 11.2 For examinations using fluorescent penetrant materials the surface will be inspected with black light to verify the effectiveness of the cleaning.

12.0 ACCEPTANCE STANDARDS

- 12.1 The acceptance standards will be as stated in the referencing code.
 - 12.1.1 The edition of the code used for acceptance will be the latest issue in affect at the time of the evaluation of the penetrant results or the edition specified by the customer.
- 12.2 When performing penetrant evaluations, the PT Level II or III will have available during evaluation a copy of the acceptance standard from the referencing code available for reference.

NOTE (...Request to a specific code changes the requirements of the test..)

The following sections apply to Visible and Fluorescent Methods

- 12.3 For **welds and materials** per ASME Section VIII, Appendix 8 (July 2003, page 366).
 - 12.3.1 Indications with major dimensions greater than 1/16" shall be considered relevant.
 - 12.3.2 The following relevant indications are unacceptable:
 - 12.3.2.1 All relevant linear indications.
 - 12.3.2.2 Rounded indications greater than 3/16" (4.8 mm).
 - 12.3.2.3 Four or more rounded indications in a line separated by 1/16" (1.6 mm) or less edge to edge.

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12.4 For **steel castings** per ASME Section I, PG-25.2.1.2.2.

12.4.1 The technique for examination shall be in accordance with Article 6 of Section V.

12.4.2 The following relevant indications are unacceptable:

12.4.2.1 All cracks and hot tears.

12.4.2.2 Any group of more than 6 linear indications other than those in (a.), in any rectangular area of 1½" by 6" or less, or any circular area having a diameter of 3½" or less, these areas being taken in the most unfavorable location.

12.4.2.3 Other linear indications more than ¼" long for the thicknesses up to ¾" inclusive, more than 1/3rd of the thickness in length for thicknesses from ¾" to 2¼" and more than ¾" long for thicknesses over 2¼". (Aligned acceptable indications separated from one another by a distance equal to the length of the longer indication are acceptable.)

12.4.2.4 All imperfections of non-linear indications which have any dimensions exceeding 3/16".

12.5 For **welds and materials** per ASME B31.3.

12.5.1 For all Categories of Fluid Service and Conditions:

12.5.1.1 No cracks.

12.6 For **welds** per ASME Section VIII, UHT-57

12.6.1 For vessels constructed of SA-333 Grade 8, SA-334 Grade 8, SA-353, SA-522, SA-553 Grades A and B, and SA-645 materials, welds not examined with radiography shall be examined by the Liquid Penetrant method.

12.6.2 Indications with major dimensions greater than 1/16" shall be considered relevant.

12.6.3 The following relevant indications are unacceptable:

12.6.3.1 Cracks and crack-like indications.

12.6.3.2 Any linear indications greater than 1/16".

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REVISION LOG:

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DESCRIPTION

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