

PT

LIQUID PENETRANT TESTING TOPICAL OUTLINES

Liquid Penetrant Testing Level I Topical Outline

1.0 Introduction

- 1.1 Brief history of nondestructive testing and liquid penetrant testing (PT)
- 1.2 Purpose of PT
- 1.3 Basic principles of PT
- 1.4 Types of liquid penetrants commercially available
- 1.5 Method of personnel qualification

2.0 Liquid Penetrant Processing

- 2.1 Preparation of parts
- 2.2 Adequate lighting
- 2.3 Application of penetrant to parts
- 2.4 Removal of surface penetrant
- 2.5 Developer application and drying
- 2.6 Inspection and evaluation
- 2.7 Postcleaning

3.0 Various PT Methods

- 3.1 Current ASTM and ASME standard methods – ASTM E165, E1208, E1209, E1210, and E1417
- 3.2 Characteristics of each method
- 3.3 General applications of each method

4.0 PT Equipment

- 4.1 PT units
- 4.2 Lighting for PT equipment and light meters
- 4.3 Materials for PT
- 4.4 Precautions in PT

Liquid Penetrant Testing Level II Topical Outline

1.0 Review

- 1.1 Basic principles
- 1.2 Process of various methods
- 1.3 Equipment

2.0 Selection of the Appropriate Liquid Penetrant Testing Method

- 2.1 Advantages of various methods
- 2.2 Disadvantages of various methods

3.0 Inspection and Evaluation of Indications

- 3.1 General
 - 3.1.1 Discontinuities inherent in various materials
 - 3.1.2 Reason for indications

- 3.1.3 Appearance of indications
- 3.1.4 Time for indications to appear
- 3.1.5 Persistence of indications
- 3.1.6 Effects of temperature and lighting [white to ultraviolet (UV)]
- 3.1.7 Effects of metal smearing operations (shot peening, machining, etc.)
- 3.1.8 Preferred sequence for penetrant inspection
- 3.1.9 Part preparation (precleaning, stripping, etc.)

3.2 Factors affecting indications

- 3.2.1 Precleaning
- 3.2.2 Penetrant used
- 3.2.3 Prior processing
- 3.2.4 Technique used

3.3 Indications from cracks

- 3.3.1 Cracks occurring during solidification
- 3.3.2 Cracks occurring during processing
- 3.3.3 Cracks occurring during service

3.4 Indications from porosity

3.5 Indications from specific material forms

- 3.5.1 Forgings
- 3.5.2 Castings
- 3.5.3 Plate
- 3.5.4 Welds
- 3.5.5 Extrusions

3.6 Evaluation of indications

- 3.6.1 Human factors
- 3.6.2 Continuity of inspection
- 3.6.3 True indications
- 3.6.4 False indications
- 3.6.5 Relevant indications
- 3.6.6 Nonrelevant indications
- 3.6.7 Process control
 - 3.6.7.1 Controlling process variables
 - 3.6.7.2 Testing and maintenance materials

4.0 Inspection Procedures and Standards

- 4.1 Inspection procedures (minimum requirements)
- 4.2 Documentation of inspection/test
- 4.3 Standards/codes
 - 4.3.1 Applicable methods/processes
 - 4.3.2 Acceptance criteria

Liquid Penetrant Testing Level III Topical Outline**1.0 Principles/Theory**

- 1.1 Principles of PT process
 - 1.1.1 Process variables
 - 1.1.2 Effects of test object factors on process
- 1.2 Theory
 - 1.2.1 Physics of how penetrants work
 - 1.2.2 Control and measurement of penetrant process variables
 - 1.2.2.1 Surface tension, viscosity, and capillary entrapment
 - 1.2.2.2 Measurement of penetrability, washability, and emulsification
 - 1.2.2.3 Contrast, brightness, and fluorescence
 - 1.2.2.4 Contamination of materials
 - 1.2.2.5 Proper selection of penetrant levels for different testing (sensitivity)
- 1.3 Proper selection of PT as method of choice
 - 1.3.1 Difference between PT and other methods
 - 1.3.2 Complementary roles of PT and other methods
 - 1.3.3 Potential for conflicting results between methods
 - 1.3.4 Factors that qualify/disqualify the use of PT
 - 1.3.5 Selection of PT technique
- 1.4 Liquid penetrant processing
 - 1.4.1 Preparation of parts
 - 1.4.2 Applications of penetrants and emulsifiers to parts
 - 1.4.3 Removal of surface penetrants
 - 1.4.4 Developer application and drying
 - 1.4.5 Evaluation
 - 1.4.6 Postcleaning
 - 1.4.7 Precautions

2.0 Equipment/Materials

- 2.1 Methods of measurement
- 2.2 Lighting for PT
 - 2.2.1 White light intensity
 - 2.2.2 Ultraviolet radiation intensity, warm-up time, etc.
 - 2.2.3 Physics and physiological differences
- 2.3 Materials for PT
 - 2.3.1 Solvent-removable
 - 2.3.2 Water-washable
 - 2.3.3 Postemulsifiable
 - 2.3.3.1 Water base (hydrophilic)
 - 2.3.3.2 Oil base (lipophilic)
 - 2.3.4 Dual sensitivity
- 2.4 Testing and maintenance of materials

3.0 Interpretation/Evaluation

- 3.1 General
 - 3.1.1 Human factors
 - 3.1.2 Continuity of inspection
 - 3.1.3 Appearance of penetrant indications
 - 3.1.4 Persistence of indications
- 3.2 Factors affecting indications
 - 3.2.1 Preferred sequence for penetrant inspection
 - 3.2.2 Part preparation (precleaning, stripping, etc.)

- 3.2.3 Environment (lighting, temperature, etc.)
- 3.2.4 Effect of metal smearing operations (shot peening, machining, etc.)

- 3.3 Indications from discontinuities
 - 3.3.1 Metallic materials
 - 3.3.2 Nonmetallic materials
- 3.4 Relevant and nonrelevant indications
 - 3.4.1 True indications
 - 3.4.2 False indications

4.0 Procedures

- 4.1 Foreword (scope, reference documents)
- 4.2 Personnel
- 4.3 Apparatus to be used, including settings
- 4.4 Product (description or drawing, including area of interest and purpose of the test)
- 4.5 Test conditions, including preparation for testing
- 4.6 Detailed instructions for application of the test
- 4.7 Recording and classifying the results of the test
- 4.8 Reporting the results

5.0 Safety and Health

- 5.1 Toxicity
- 5.2 Flammability
- 5.3 Precautions for ultraviolet radiation
- 5.4 Material safety data sheets (MSDS)

LIQUID PENETRANT TESTING LEVEL I, II, AND III TRAINING REFERENCES

- ASM. 1989. *Nondestructive Evaluation and Quality Control*. vol. 17. *ASM Handbook*. Metals Park, OH: ASM International.
- ASNT. 2016. *Liquid Penetrant Testing*. 4th ed. vol. 1. *Nondestructive Testing Handbook*. Columbus, OH: American Society for Nondestructive Testing Inc.
- ASNT, latest edition, *ASNT Level II Study Guide: Liquid Penetrant Testing*, American Society for Nondestructive Testing Inc., Columbus, OH
- ASNT, latest edition, *ASNT Level III Study Guide: Liquid Penetrant Testing*, American Society for Nondestructive Testing Inc., Columbus, OH
- ASNT, latest edition, *ASNT Questions & Answers Book: Liquid Penetrant Testing Method*. American Society for Nondestructive Testing Inc., Columbus, OH
- ASNT. 2019. *Liquid Penetrant Testing Classroom Training Book*, PTP Series. Columbus, OH: American Society for Nondestructive Testing Inc.
- ASNT. 2018. *Liquid Penetrant Testing Programmed Instruction Book*, PTP Series. Columbus, OH: American Society for Nondestructive Testing Inc.
- ASNT. 2020. *Principles and Applications of Liquid Penetrant Testing*. Columbus, OH: American Society for Nondestructive Testing Inc.
- ASTM. 1985. *Standard Reference Photographs for Liquid Penetrant Inspection: Adjunct to ASTM E 433*. Philadelphia, PA: American Society for Testing Materials.
- ASTM, latest edition, *Annual Book of ASTM Standards*, Vol. 03.03 *Nondestructive Testing*. ASTM International, Philadelphia, PA.
- AWS, latest edition, *Welding Handbook*, Vol. 1. American Welding Society, Miami, FL.
- Lovejoy, D. 1991. *Penetrant Testing: A Practical Guide*. New York: Chapman & Hall.
- Mix, P., 2005. *Introduction to Nondestructive Testing: A Training Guide*, second edition, John Wiley & Sons, New York.

* Available from The American Society for Nondestructive Testing Inc., Columbus, OH.