ASNT Level II Study Guide

Liquid Penetrant Testing *Method*

second edition

by William Spaulding and Mark Hernles

The American Society for Nondestructive Testing, Inc.

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

Published by
The American Society for Nondestructive Testing, Inc.
1711 Arlingate Lane
PO Box 28518
Columbus, OH 43228-0518

Copyright © 2002 by The American Society for Nondestructive Testing, Inc. ASNT is not responsible for the authenticity or accuracy of information herein. Published opinions and statements do not necessarily reflect the opinion of ASNT. Products or services that are advertised or mentioned do not carry the endorsement or recommendation of ASNT.

1RRSP, *The NDT Technician* and www.asnt.org are trademarks of The American Society for Nondestructive Testing, Inc. ACCP, ASNT, *Level III Study Guide, Materials Evaluation, NDT Handbook, Nondestructive Testing Handbook, Research in Nondestructive Evaluation* and *RNDE* and are registered trademarks of The American Society for Nondestructive Testing, Inc.

ASNT Mission Statement
ASNT exists to create a safer world by promoting the profession and technologies of nondestructive testing.

IBN-13: 978-1-57117-092-7
ISBN-10: 1-57117-092-8

Published by the American Society for Nondestructive Testing, Inc.

PRINTED IN THE UNITED STATES OF AMERICA.

first printing 1998
second printing with revisions 10/02
third printing 08/07

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

Contents

Contents iii

Introduction vii

Chapter 1, Overview of Liquid Penetrant Testing 1
History of Liquid Penetrant Testing 1
Principles of Liquid Penetrant Testing 1
Advantages of the Penetrant Process I
Disadvantages of the Penetrant Process 1
Basics of the Penetrant Process 2
Preparation of Parts for Penetrant Testing 2
Surface Condition 2
Penetrant System 3
System Sensitivity 3
Type of Penetrant 3
Advantages of Fluorescent Liquid Penetrants 4
Advantages of Visible Dye Penetrants 4
Selection of Liquid Penetrant Material and Process 5
Fluorescent Liquid Penetrant 5
Visible Dye Liquid Penetrant 5
Penetrant Application 5
Penetrant Dwell 5
Temperature 6
Penetrant Removal Method 6
Water Washable (Method A) 6
Lipophilic Emulsifier (Method B) 7
Solvent Removable (Method C) 8
Hydrophilic Emulsifier (Method D) 8
Drying 8
Develop the Indication 8
Inspection 8
Importance of the Inspector's Evaluation 9
Penetrant Inspection Documents 9
Visual Requirements 9
Classification of Discontinuities by Origin 9
Identifying Indications 10
Postcleaning 11

Chapter 2, Penetrants, Developer and Equipment 13
Penetrants 13
Characteristics of Penetrants 13
Surface Tension 13
Wetting Ability 13
Capillary Action 13

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

Physical Properties of Penetrants 14
Viscosity 14
Volatility 14
Specific Gravity 14
Flash Point 14
Thermal Stability 14
Chemical Properties of Penetrants 14
Inertness 14
Removability 15
Water Tolerance 15
Developer 15
Dry Powder 16
Water Soluble 16
Water Suspended 16
Nonaqueous 17
Specific Application 17
Material and Process Control Tests 17
Ultraviolet Light Intensity 19
Emulsifier Concentration 19
Ambient White Light Intensity 19
Penetrant Inspection Area Cleanliness 19
Penetrant Materials Testing 19
Water Content 19
Separation of Constituents and Loss of Fluorescence 19
Washability 19
Sensitivity Comparison 19
Penetrant System Monitor 19
Equipment 20
Ultraviolet Lighting 20
Stationary Processing Equipment 21
Portable Processing Equipment 21
Automated Equipment 22

Chapter 3, Testing in Primary Metals Production 23
Producing Metals and Alloys 23
Processing Discontinuities 23
Discontinuities Related to Metal Solidification 23
Discontinuities in Metal Ingots 23
Discontinuities in Metal Castings 23
Discontinuities in Blooms and Billets 23
Discontinuities in Hot Rolled Bars, Shapes, Plate or Strip 24
Discontinuities in Forgings 24
Discontinuities in Rolled and Pierced Products 24
Discontinuities in Extrusions 24
Discontinuities in Cold Worked Metal Products 24
Discontinuities in Fusion Welds 25
Discontinuities in Heat Treating Processes 25
Discontinuities in Machined and Ground Surfaces 25
Cracks During Plating or Chemical Treatment 25

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

Service Discontinuities....25
Fatigue Cracks....25
Significance of Surface Discontinuities under Repeated Loading or Vibration....25
Prevention of Fatigue Failure on Service....25
Stress Corrosion Cracking....26
Other Causes of Service Damage....26
Continuous Line Indication....27
Intermittent Line Indications....27
Rounded Areas of Indications....27
Small Dot Indications....27
Diffuse Indications....27
Edges of Indications....27

Chapter 4, Appearance of Liquid Pentrant Indications....27
Brilliance and Extent of Indications....28
Persistence of Indications....28
Other Variables Affecting Indication Appearance....28
Surface Conditions....28
Temperature....28
Dwell Time and Washing....28
Developer....29
Previous Testing....29
Common Causes of Nonrelevant and False Indications....29
Poor Process Control....29
Part Geometry and Surface Condition....30
Evaluation of Nonrelevant Indications....30

Review Questions....31

Answers....37

Appendix, Standard Terminology for the Liquid Penetrant Examination....39

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

Introduction

Overview of the Study Guide

This study guide contains basic information intended to prepare a candidate for Level II penetrant inspection examinations. This study guide does not present all of the knowledge necessary for certification; the candidate is expected to supplement this guide with the recommended references that follow.

"Recommended reading" boxes, which list additional areas of study and which Recommended References contain the information, appear throughout the text.

Acknowledgments

The authors acknowledge the support of the AlliedSignal Aerospace NDT Network and the ASNT Technical Services Department staff for assisting with the first edition of this book.

This revision was possible thanks to the contributions of Bill Chedister, William Cook, Vilma Holmgren, Bill Mooz and Thorn Schafer.

Recommended References

A. Tracy, Noel A., technical editor, Patrick O. Moore, editor, *Nondestructive Testing Handbook,* third edition: Volume 2, *Liquid Penetrant Testing,* Columbus, OH, American Society for Nondestructive Testing, Inc., 1999.

B. Boisvert, Bernie, *Principles and Applications of Liquid Penetrant Testing: A Classroom Training Text,* Columbus, OH, American Society for Nondestructive Testing, Inc., 1993.

C. General Dynamics, *Liquid Penetrant Testing Programmed Instruction Handbook,* PI-4-2, Columbus, OH, American Society for Nondestructive Testing, Inc., 1977.

Resource Materials

ASM Handbook, 9th edition, Volume 17, *Nondestructive Evaluation and Quality Control,* Materials Park, OH, ASM International, 1989.

Recommended Practice No. SNT-TC-1A, 2001, Columbus, OH, American Society for Nondestructive Testing, Inc., 2001.

ANSI/ASNT CP-189-2001: ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel, Columbus, OH, American Society for Nondestructive Testing, Inc., 2001.

ASTM International, *ASTM E 165, Standard Test Method for Liquid Penetrant Examination,* West Conshohocken, PA, ASTM, 2001.

ASTM International, *ASTM E 1208, Standard Test Method for Fluorescent Liquid Penetrant Examination Using the Lipophilic Post-Emulsification Process,* West Conshohocken, PA, ASTM, 2001.

ASTM International, *ASTM E 1209, Standard Test Method for Fluorescent Liquid Penetrant Examination Using the Water-Washable Process,* West Conshohocken, PA, ASTM, 2001.

ASTM International, *ASTM E 1210, Standard Test Method for Fluorescent Liquid Penetrant Examination Using the Hydrophilic Post-Emulsification Process,* West Conshohocken, PA, ASTM, 2001.

ASTM International, *ASTM E 1219, Standard Test Method for Fluorescent Liquid Penetrant Examination Using the Solvent-Removable Process,* West Conshohocken, PA, ASTM, 2001.

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

ASTM International, *ASTM E 1219, Standard Test Method for Fluorescent Liquid Penetrant Examination Using the Solvent-Removable Process,* West Conshohocken, PA, ASTM, 2001.

ASTM Internationa], *ASTM E 1220, Standard Test Method for Visible Penetrant Examination Using Solvent-Removable Process,* West Conshohocken, PA, ASTM, 2001.

ASTM Internationa], *ASTM E 1417, Standard Practice for Liquid Penetrant Examination,* West Conshohocken, PA, ASTM, 2001.

ASTM International, *ASTM E 1418, Standard Test Method for Visible Penetrant Examination Using the Water-Washable Process,* West Conshohocken, PA, ASTM, 2001.

SAE International, *SAE AMS 2644, Inspection Materials, Penetrant,* Warrendale, PA, SAE (Society of Automotive Engineers) International, 2002.

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

Chapter 1

Overview of Liquid Penetrant Testing

History of Liquid Penetrant Testing

Liquid penetrant testing is one of the oldest methods of nondestructive testing. Its origin is generally attributed to the inspection of wheel axles in the railroad industry in the 1890s. It was noticed that after oil was wiped off of a part surface, the oil would reappear where a crack or other type of discontinuity was located. This discovery led to the oil-and-whiting test. Parts were immersed in oil and then wiped with rags dampened with kerosene. Powdered chalk was used to dust the surface to increase the visibility of any oil leaking back onto the part surface. Today's liquid penetrant testing evolved from the oil-and-whiting test through continual improvements to the type of oil used, the addition of dyes and the creation of special removers and developers.

Principles of Liquid Penetrant Testing

Liquid penetrant testing is based on the ability of a liquid to seep into cavities that are open to the surface and remain in the cavity when the excess liquid is removed. The liquid remaining in the cavity is then drawn out to form an indication that is much more visible than the cavity itself. Liquid penetrant testing is used to detect surface discontinuities in solid, nonporous materials. It is used on wrought, cast metal and metal alloys; weldments, powdered metals, plastics, ceramics and glass. A variety of materials and application methods allow for some adjustment of the process sensitivity to certain types of discontinuities, surface conditions and material types.

Liquid penetrant testing is one of the most widely used nondestructive testing methods in industry. It is able to detect small discontinuities open to the surface regardless of their orientation or the shape of the part. With proper sequencing of the process in manufacturing and the use of appropriate cleaning methods with trained and certified operators, liquid penetrant testing is a very reliable, accurate and effective surface inspection process.

Advantages of the Penetrant Process

The following are advantages of the liquid penetrant process:

1. very small surface discontinuities can be detected,
2. a wide variety(sự đa dạng) of materials can be tested,
3. complex geometrical shapes can be inspected in a single operation,
4. various sensitivities and processing methods are available,
5. it is relatively (tương đối)easy to use,
6. it can be portable(xách tay, di chuyển được), and
7. when compared to other testing methods, it has a low cost.

Disadvantages of the Penetrant Process

The following are disadvantages of the liquid penetrant process:

1. porous(xốp) materials cannot be tested;
2. surfaces must be clean and free of paint, coatings, soil, moisture(hơi ẩm) and contaminants;
3. it cannot be used following metal smearing operations such as shot peening, sand blasting, certain machining operations (unless material is acid etched to remove smeared metal);
4. some materials (rubber and plastics) may be adversely affected by the penetrant's petroleum base;
5. it is very dependent on operator skill; and
6. some penetrant products use ingredients that may cause skin irritation under prolonged contact if proper protective clothing is not worn.

AVA Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

Basics of the Penetrant Process

The basic penetrant process can be divided into three steps: application of the penetrant, removal of the excess surface penetrant and development of the indication. However, the process must be preceded by appropriate surface preparation and cleaning methods, parts must be dried after penetrant removal, indications must be evaluated after processing and parts must be cleaned after testing.

Preparation of Parts for Penetrant Testing

Final examination by the penetrant process should be performed following all operations that may cause or expose discontinuities on the part surface. Examples of these operations are heat treating, machining, welding, bending and straightening.

The penetrant process should be performed before any treatments that smear the surface of the part such as: honing, lapping, sanding, deburring, sand blasting or vapor honing. If these types of operations have been performed, the parts must be chemically etched before the penetrant process in order to obtain any meaningful results.

Penetrant inspection also should be performed before operations such as peening, plating, painting, anodizing, or any other surface coating operations.

Surface Condition

The surface condition of a part must be evaluated before the penetrant process begins. The condition of the surface plays a critical role in the success or failure of the liquid penetrant test to form an indication from a discontinuity.

Coatings such as paint and plating interfere with the penetrant's ability to enter a discontinuity by covering or filling the cavity. Indications produced on coated surfaces are generally from discontinuities in the paint or plating rather than those in the base material. Anodized coatings are very porous. Absorption of the penetrant can mask discontinuities by making relevant indications indistinguishable from the anodized surface of the part.

Operations that deform the surface, such as grinding, cutting, shot peening, sand blasting and vapor honing, can cover discontinuities by smearing a thin layer of metal over the opening, reducing its size or sealing it completely. Because liquid penetrant testing cannot detect anything not open to the surface, this thin coating of metal prevents the penetrant liquid from entering the cavity and forming an indication. These operations also can cause discontinuities in the material and performing the liquid penetrant test before the metal smearing operation is not always an option. In such cases, the material should be chemically etched following the mechanical operation and before the liquid penetrant test.

The most common surface condition that adversely affects the liquid penetrant testing process is the presence of contaminants such as oils, grease, dirt, rust, scale, carbon deposits or others. These materials may prevent the penetrant from entering the discontinuity, absorb the penetrant and mask indications, or chemically react with the penetrant materials reducing the penetrant's effectiveness. Precleaning of components using the appropriate method before liquid penetrant testing is critical. Table 1.1 lists common contaminants that affect the penetrant process.

Recommended reading

Subject	Reference*
history of liquid penetrant testing	**A,B,C**
basic principles of liquid penetrant testing	A,B,C
advantages and disadvantages of liquid penetrant testing	**A,B,C**

*See *introduction* for explanation of references.

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

Penetrant System

Liquid penetrant testing is defined by the materials used to perform the process. The variations in the testing process produce several system sensitivities and types of penetrants.

System Sensitivity

The sensitivity of a system is defined as a measure of the smallest discontinuity that will produce a discernible indication. The sensitivity of a system must meet the needs of the circumstances. If a system is too sensitive, the results may be misleading and time will be wasted in the evaluation process. If the system is not sensitive enough, rejectable defects could remain undetected. The cost of materials can be directly related to system sensitivity and the use of a sensitivity higher than required would increase the cost unnecessarily.

The appropriate liquid penetrant testing system is determined by considering the following:

1. governing standard or specification - certain industries require specific penetrant methods, or specify restrictions on the materials that may be used;
2. surface condition and the type of discontinuities associated with the part - rough surfaces, threads, keyways, internal cavities, wide, shallow or tight crack discontinuities are conditions that can affect the optimum choice for a penetrant system; and
3. location, size of the part, quantity and coverage required - field inspections are most often performed with solvent removable visible dye and nonaqueous developer because of portability and no special lighting is needed.

Type of Penetrant

Penetrant can be fluorescent, visible or dual mode dye that has both visible and fluorescent properties.

Fluorescent penetrant is further defined by a *sensitivity level* category. The sensitivity of a penetrant is related to the brightness of an indication when measured with a photometer and compared to a standard. There are five levels of sensitivity for fluorescent dyes:

1. Level 1/2: ultralow sensitivity,
2. Level 1: low sensitivity,
3. Level 2: medium sensitivity,
4. Level 3: high sensitivity, and
5. Level 4: ultrahigh sensitivity.

Fluorescent penetrant contains a dye that is visible under UV-A light. To view the indications, inspection is performed in a darkened area with an ultraviolet light source.

Visible penetrant uses a red, orange or purple dye that is highly visible when contrasted against a white developer coating the part surface. Inspection must be performed under white light.

Table 1.1: Precleaning

Contaminant	Effects on the Penetrant Process	
Carbon, varnish	Bridge/fill voids, produce residual background, cause false indications	
Heavy oils	Fill voids, fluoresce	
Light oils	Fill voids, fluoresce	
Oil with solid particles	Fill voids, fluoresce, cause false indications	
Paint	Bridge voids, produce residual background, cause false indications	
Penetrant material residue	Fill voids, interfere with indication formation	
Scale, oxide, corrosion	Bridge/fill voids, produce residual background, cause false indications	
Smeared metal	Bridge/fill voids	

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

Dual mode penetrants contain dyes that are both colored under white light and fluorescent under ultraviolet light. However, the intensities are less than the single mode penetrants.

Tables 1.2 and 1.3 compare the types of penetrant and sensitivities.

Advantages of Fluorescent Liquid Penetrants

Fluorescent indications viewed in a dark test booth are more readily seen than indications produced by visible dye liquid penetrants under normal light conditions. This is especially true in the case of liquid penetrant indications of minute cracks or pinholes. Because fluorescent liquid penetrant indications are more visible, it is generally accepted that fluorescent liquid penetrant testing is more sensitive to small discontinuities than visible dye. Also, because luminous discontinuity marks can be located easily, the fluorescent dye lends itself to faster readout. Aerospace industry specifications often call for fluorescent testing of critical parts because very small discontinuity indications must be detected reliably.

Advantages of Visible Dye Penetrants

Though its overall performance is considered lower and production testing of small parts is slower, the visible dye liquid penetrant process has some advantages of its own. It does not require a darkened area or a source of electric power for illumination. For this reason, it is more often used as a portable testing tool in the shop or field. Large test parts, difficult to move to a dark booth, can be

Table 1.2: Comparison of fluorescent penetrant sensitivity levels

Level	Primary Uses and Advantages	Disadvantages
1/2 and **1**	In process inspection - minimal background Complex geometry Porous surfaces	Least sensitive
2	In process inspection Final inspection	May produce moderate background on rough surfaces
3	In process and final inspection Sensitive to small, tight discontinuities	High background on rough surfaces
4	In process and final inspection Very sensitive to small, tight discontinuities	High background on rough surfaces

Table 1.3: Comparison of penetrant types

Type	Primary Uses and Advantages	Disadvantages
1	In process and final inspections Wide, shallow and tight crack discontinuities Failure analysis	Requires special lighting Requires electricity
2	In process inspection of surfaces machined in further processing. Field inspections with portable kit Localized area of large parts	Less sensitive than Type 1 Does not perform well for wide, shallow discontinuities

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

inspected where they are located with visible dye liquid penetrants. The visible dye liquid penetrant is widely used for inspection of weldments both in the shop and in the field.

Selection of Liquid Penetrant Material and Process

The techniques capable of the greatest sensitivity are often the most costly and many tests require the ultimate sensitivity. However, high sensitivity is frequently not required and may even produce misleading results.

The following factors should be considered before deciding on the type of liquid penetrant testing system to install and/or use:

1. composition of parts to be inspected;
1. number of parts or test areas to be inspected per unit of time;
2. size and weight of parts to be handled;
2. location at which testing is required (that is, receiving department, in process along a production line, during assembly, as final inspection, in the field during erection, at maintenance facilities or in service);
3. types of discontinuities to be expected, for example, porosity, cracks, seams or laps;
4. size of discontinuities to be detected (for example, small, deep, large, shallow, clustered or scattered);
5. surface condition of parts to be inspected (such as as-cast, as-forged, machined, ground, lapped, polished, plated, painted, corroded, oily, covered with combustion, scratched or scaled parts); and
6. condition to which parts will be subjected after testing (for example, medical, nuclear or oxygen systems; welding, plating or finishing operations; high temperature, aerospace, industrial or transportation uses; inaccessible locations; or consumer products).

The selection may be influenced by specification requirements, education and experience of personnel and the quality level of test required. The quality of the test parts to be inspected should never be allowed to influence the quality level of testing. The test quality is determined by the nature of test parts and the service conditions for which they are intended.

Fluorescent Liquid Penetrant

The regular performance water washable, fluorescent liquid penetrant is generally more practical for rough surface parts such as sand castings. The higher performance liquid penetrants are favored for inspecting forgings, machined surfaces and more critical load carrying parts.

Visible Dye Liquid Penetrant

The selection of a visible dye liquid penetrant is relatively uncomplicated when compared to selecting fluorescent liquid penetrants. If the test is to take place in the field, a portable system using a solvent remover wipe-off technique is usually the first choice. Selection of a visible dye liquid penetrant is largely dependent on economic factors and the facilities available. The visible dye liquid penetrant class is not divided into performance grades as is fluorescent liquid penetrants.

The visibility of the indications with respect to the white developer background is a key factor in successfully revealing tight discontinuities. The visibility of colored contrast liquid penetrants depends on the color dye concentration. Because visible dye liquid penetrants are not categorized with respect to visibility or performance, these dyes are selected based on need.

Penetrant Application

Penetrant may be applied by various methods as listed in Table 1.4. Care should be taken to ensure complete coverage of the areas of interest, regardless of how the penetrant is applied. Brushing and spraying can fail to cover areas completely and immersion can trap air and prevent penetrant (or emulsifier when rinsing) from contacting the part surface.

Penetrant Dwell

The total time the penetrant remains on the part surface is the penetrant dwell. The time required for a penetrant to enter a discontinuity is dependent on temperature, the type of discontinuity and the possibility of contaminants entrapped within discontinuities. Large, shallow discontinuities require less dwell time than small, tight cracks. Discontinuities free from contaminants require less dwell time than discontinuities with entrapped soil because it is easier for the penetrant to enter them.

The standard minimum dwell is 5 min unless testing in service parts. If service fatigue cracks are

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007

suspected, the minimum dwell time required is often 2 h, but for stress corrosion up to 4 h may be required. When the dwell exceeds 1 h, applying fresh penetrant every hour improves the rate of penetration.

It is important to allow sufficient time for the appearance of minute indications from fine discontinuities, such as tight fatigue cracks. To use the time required for an indication to develop as a measure of the extent of the discontinuity, other variables such as type of liquid penetrant, sensitivity of technique, temperature of part, dwell time and condition of examination must be controlled.

Fine liquid penetrant indications usually denote fine discontinuities, however, fine indications may also be caused by insufficient dwell time.

Temperature

The temperature of the penetrant materials and the part must be within an acceptable range for processing. ASTM E 1417 specifies a temperature range of 4 to 52 °C (40 to 125 °F).

The viscosity of most liquids, including penetrants, increases at low temperatures. If a part is quite cold, under 16 °C (60 °F) for example, the liquid penetrant may become chilled and thickened when applied, making the dwell time for very fine discontinuities longer than for parts at higher temperatures. If a part or liquid penetrant is too hot, the volatile components of the liquid penetrant may evaporate, changing the ability for revealing small discontinuities. Material temperatures from 10 to 52 °C (50 to 125 °F) produce optimum results with conventional liquid penetrants, however, special penetrants developed for aerospace and nuclear power programs can be used in extremely cold or relatively high temperatures.

Penetrant Removal Method

Excess penetrant is removed by water wash, hydrophilic emulsification, lipophilic emulsification, or solvent wipe.

The penetrant must be removed from the part surface without removing it from within a discontinuity. An optimum amount of removal must be obtained. Too little removal will cause an excessive penetrant background and indications will be indistinguishable from the part surface. If too much is removed from the discontinuity, a weak indication or no indication will be formed. The methods for removing surface penetrant and the SAE AMS 2644 designation are:

1. Method A - Water Washable
2. Method B - Lipophilic Emulsifier
3. Method C - Solvent Removable
4. Method D - Hydrophilic Emulsifier

Fluorescent penetrant should be removed in a darkened area equipped with ultraviolet lighting regardless of the removal method.

Table 1.5 lists the advantages and disadvantages of the various removal methods.

Water Washable (Method A)

Water washable penetrants contain emulsifying agents that make the oil miscible (mixable) with water. The penetrant may be removed with a manual or automatic coarse water spray, by immersion in an air agitated water wash or by manually wiping.

Table 1.4: Penetrant application

Type of Penetrant	AMS-2644 Designation	Method of Application*	Dwell Time Min./Max.	Lighting Required
Fluorescent	**1**	Spray, dip, brush,	10min/2h	Ultraviolet
Visible	**2**	Spray, dip, brush	10min/2h	Visible
Dual mode		Spray, dip, brush	10 min/2 h	Visible/ Ultraviolet

* Spray may be manual, pressurized or electrostatic.

Documents
Document Sharing Hub
Full document details: ASNT 6101 2007

The size of the droplets, pressure, temperature and angle of a water spray rinse can affect removal of the penetrant. Most industry and military specifications limit acceptable water temperature to 10 to 38 °C (50 to 100 °F) at a pressure not to exceed 276 kPa (40 psi). The spray nozzle should be a minimum of 30 cm (12 in.) from the part at an angle between 45 and 70 degrees.

An air agitated immersion rinse is a removal method that must maintain adequate water circulation and air agitation. Experiments to determine the amount of rinsing required for specific processes should be performed before the actual inspection. The water temperature requirements are the same as for the water spray method.

The rinsing operation must be monitored closely to avoid overwashing. Washing should be stopped as soon as an acceptable background level is observed.

Lipophilic Emulsifier (Method B)

Removal is performed by introducing an oilbased emulsifier as a separate process step. Lipophilic emulsifier diffuses in to the surface penetrant. It is usually applied by immersion; brushing or wiping may cause streaking due to uneven emulsification and are not recommended. This system offers more control and has fewer problems with over and under washing compared to the water washable method. The emulsifier dwell may be anywhere between 5 s up to 5 min.

Table 1.5: Method of removal

Remover Material	AMS-2644 Designation	Advantages and Primary Uses	Disadvantages
Water	**A**	Fewer processing steps Reduced processing time Lower cost Elimination of the emulsifier station	No control of emulsifier Critical rinse time Effects of water contamination
Lipophilic Emulsifier	**B**	Wide, shallow discontinuities Supplied ready for use	Extra processing steps Critical rinse time Poor results on rough surfaces Water and penetrant contamination
Solvent	**C**	Portable Localized areas, field applications Wash station not required	Over-removal of penetrant Time consuming for large parts or high volume May be flammable
Hydrophilic Emulsifier	**D**	Small, tight discontinuities Wide, shallow discontinuities Post rinse time less critical Reduced background on rough surfaces Emulsifier touchup during final rinse	Extra processing steps Must maintain concentration levels Contamination from penetrant

Documents
Document Sharing Hub

Full document details: ASNT 6101 2007