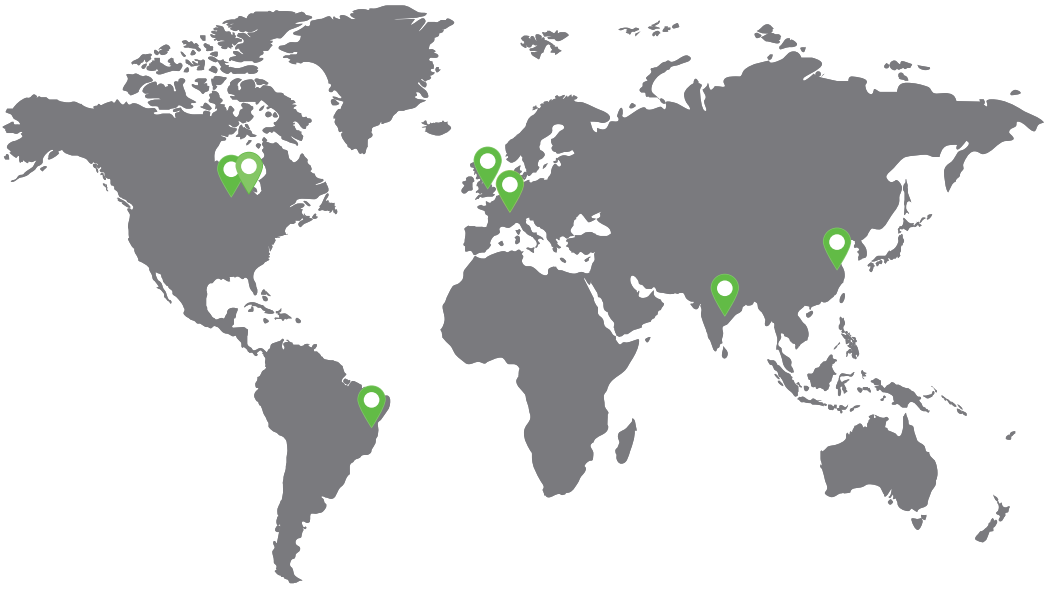

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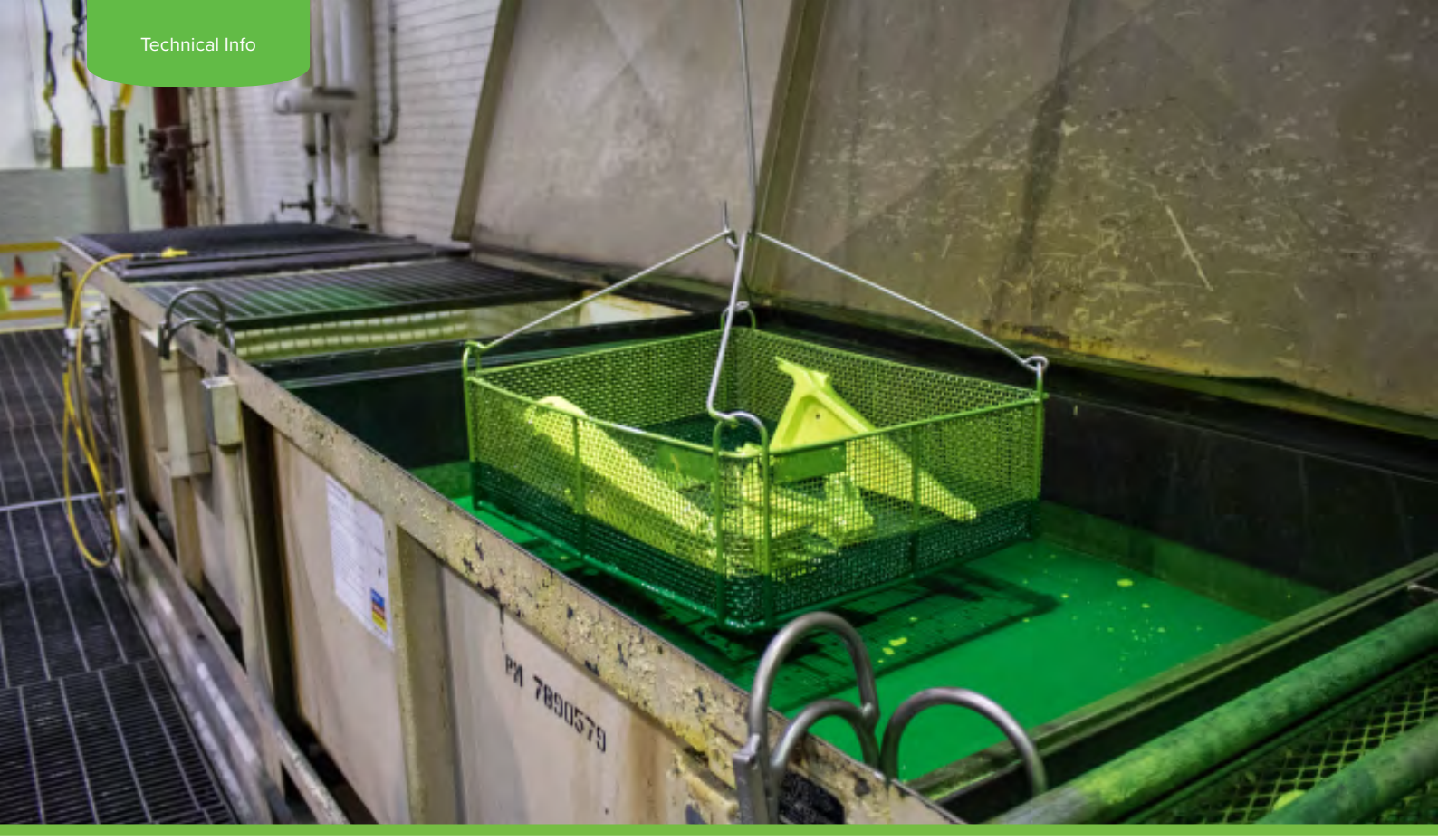
MAGNAFLUX®

Fluorescent Liquid Penetrant Inspection

Penetrants, Emulsifiers, Developers, & Removers



The Importance of Liquid Penetrant Inspection

Liquid penetrant inspection is a nondestructive test method which does not harm the parts being inspected. The testing methods detect cracks, fractures, laps, seams and other flaws that are open to the surface that may have been caused by fatigue, impact, quenching, machining, grinding, forging or overload. The process is used on machined parts, castings, forgings and other items that will be placed into service or already in service requiring maintenance.

The process involves applying a penetrant chemical, visible or fluorescent, directly to the part that's to be inspected. The excess penetrant is removed and a developer is applied to draw the penetrant deep from the cracks to the surface of the part. The penetrant contrasts with the surface of the part so the crack is identified more easily. Fluorescent penetrants are used under an ultraviolet light that makes penetrant fluoresce. The chemical, equipment and NDT accessory choices have grown but the fundamentals and benefits of liquid penetrant inspection have endured the test of time.

Versatile material uses and applications

Liquid penetrant inspection can be performed on most materials that are not extremely rough or porous, including material composition that is metallic or nonmetallic, magnetic or nonmagnetic and conductive or nonconductive.

Rapidly inspect large areas and high volumes of parts

Liquid penetrant inspection is a fast, easy and efficient means of surface inspection. Large quantities of parts or materials can be inspected quickly. Parts of almost any shape, size and geometry can be inspected.

Identify small surface discontinuities with high sensitivity

Sensitivity levels are a classification system specifically for fluorescent liquid penetrants that are not applied to visible penetrants. Higher sensitivity penetrants have the capability to detect smaller cracks and defects.

Selecting the Correct Penetrant Method Per AMS 2644

Penetrant Types

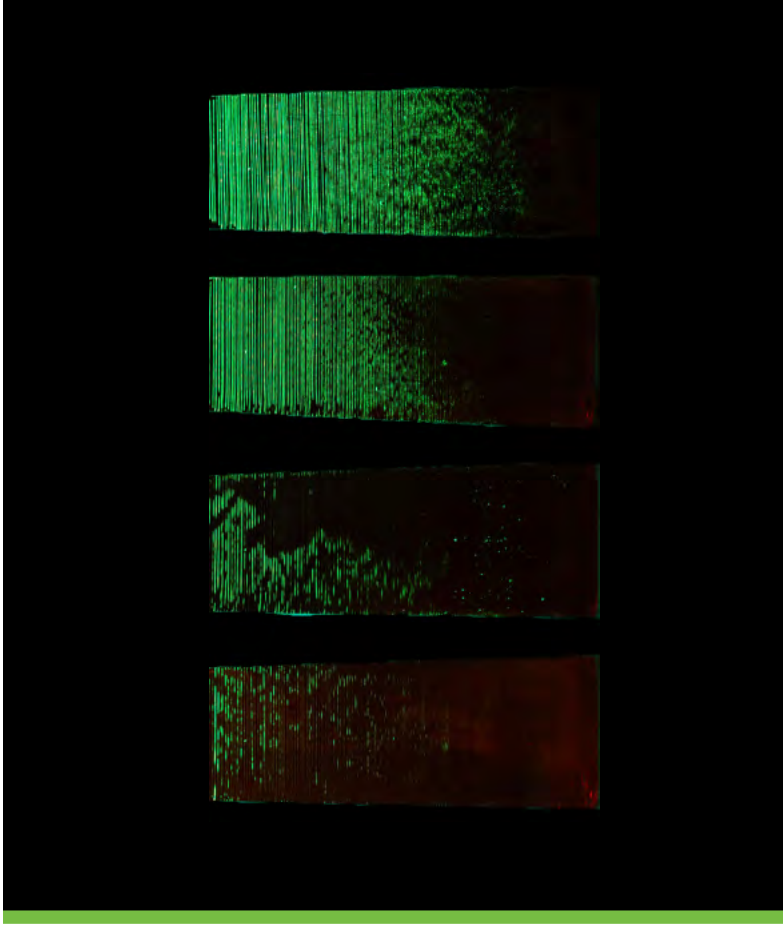
- Type 1: Fluorescent dye
- Type 2: Visible dye

Penetrant Methods

- Method A: Water washable
- Method B: Post emulsifiable, lipophilic
- Method C: Solvent removable
- Method D: Post emulsifiable, hydrophilic

Developer Forms

- Form a: Dry powder
- Form b: Water soluble
- Form c: Water suspendible
- Form d: Nonaqueous Type 1 fluorescent
- Form e: Nonaqueous Type 2 visible dye



This image compares penetrant with different sensitivity levels on NiCr panels.

Differences Between Sensitivity

AMS 2644 Penetrant Sensitivity Levels

Sensitivity levels are a classification system for fluorescent liquid penetrants which is outlined in AMS 2644 Inspection Material, Penetrant specification. Sensitivity levels are not applied to visible penetrants.

- Level ½: Ultra low sensitivity
- Level 1: Low sensitivity
- Level 2: Medium sensitivity
- Level 3: High sensitivity
- Level 4: Ultra high sensitivity

How to Determine Which Sensitivity Level to Use

The primary consideration when deciding on which sensitivity level penetrant to use is the guidance provided by governing specifications. The penetrant sensitivity level is stated in the working specifications for the process. This is particularly true when penetrant inspection involves safety critical parts. The specifications and standard operating procedures will dictate the penetrant sensitivity to be used.

If the penetrant sensitivity level is not already established by a specification or procedure, evaluation on actual parts with a few penetrants is strongly recommended. A lower sensitivity penetrant works well on rough surfaces, while a higher sensitivity penetrant is suitable for highly machined surfaces. Penetrant evaluation on actual parts is important to confirm proper sensitivity with acceptable background fluorescence to detect the type of defects typically found on the parts. Penetrant evaluation on actual test parts can also confirm proper processing parameters such as dwell time and rinse time.

It is possible that more than one penetrant sensitivity level will be used in a facility because of different parts, processes, and customer specifications in use at a given location.

Common Applications

Aerospace processes commonly use **Method D Level 4** penetrants for safety critical rotating parts including turbine blades.

Automotive processes commonly use **Method A Level 1** penetrants to inspect non ferrous components such as steering knuckles and subframes.

Power Generation commonly uses **Method A Level 2** penetrants to inspect non ferrous parts such as large castings, forgings, impeller blades, and more.

Common Terms

Background – the surface of the test part against which the indication is viewed. It may be the natural surface of the test part or the developer coating on the surface.

Bleedout – the action of an entrapped liquid penetrant in surfacing from discontinuities to form indications.

Developer – a material that is applied to the test surface to accelerate bleedout and to enhance the contrast of indications.

Developing Time – the elapsed time between the application of the developer and the examination of the part.

Dwell Time – the total time that the penetrant or emulsifier is in contact with the test surface, including the time required for application and the drain time.

Inspection – visual examination of the test part after completion of the liquid penetrant processing steps.

Liquid Penetrant Testing – a nondestructive test that uses liquid penetrant materials to penetrate and detect various types of discontinuities open to the surface.

Liquid Penetrant – a solution of dye with the ability to penetrate into fine openings.

Precleaning – the removal of surface contaminants from the test part so that they will not interfere with the examination process.

Sensitivity Level – the descriptive term for identifying the capability of a penetrant system to indicate the presence of a surface-connected discontinuity.

Fluorescent Liquid Penetrant Testing

Method A
Water Washable

1. Preclean with Aqueous Cleaner

2. Apply Penetrant
Dwell 10–30 min.

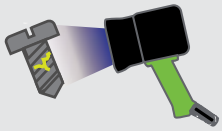
3. Rinse
10–38°C at < 2.75 bar

Form a

4. Dry
60°C

5. Apply Developer
Dwell 10 min. – 4 hr.

6. Inspect



Form b/c

4. Apply Developer

5. Dry
60°C
Dwell 10 min. – 2 hr.

Method B/D
Post Emulsifiable

1. Preclean with Aqueous Cleaner

2. Apply Penetrant
Dwell for 10–30 min.

Method B

3. Apply Emulsifier

Method D

3. Rinse
10–38°C at < 2.75 bar

Apply Emulsifier

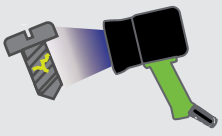
4. Rinse
10–38°C at < 2.75 bar

Form a

5. Dry
60°C

6. Apply Developer
Dwell 10 min. – 4 hr.

7. Inspect



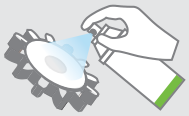
Form b/c

5. Apply Developer

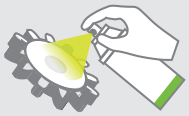
6. Dry
60°C
Dwell 10 min. – 2 hr.

Method C
Solvent Removable

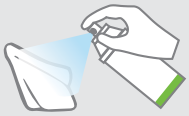
1. Preclean



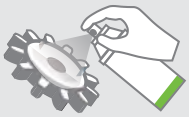
2. Apply Penetrant
Dwell 10–30 min.



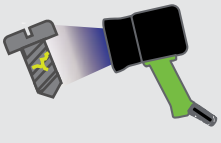
3. Remove Excess Penetrant
Apply cleaner on cloth and then wipe the part



4. Apply Developer
Dwell 10–60 min.



5. Inspect



1 Select Method

2 Select Penetrant

3 Select Emulsifier

A

Product Name	Method	Level	Removal Type	Part Numbers
ZL-15B	A C	½	Water Washable	25 litres ..... 056C061 200 litres 056C062
ZL-19		1		25 litres ..... 056C185 200 litres 056C186
ZL-60C		2		Aerosol case ... 008A008 25 litres ..... 056C205 200 litres 056C206
ZL-60D*		2		25 litres ..... 056C010 200 litres 056C011
ZL-67B*		3		25 litres ..... 056C034 200 litres 056C035
ZL-56		4		25 litres ..... 056C201 200 litres 056C202

C

B

Product Name	Method	Level	Removal Type	Part Numbers
ZL-2C	B C D	2	Post Emulsifiable	25 litres ..... 056C079 200 litres 056C080
ZL-27A*		3		Aerosol case ... 008A002 25 litres ..... 066C017 200 litres 066C016
ZL-37*		4		25 litres ..... 066C020 200 litres 066C019

Product Name	Method	Emulsifier	Part Numbers
ZE-4B	B	Lipophilic	25 litres 065C025

D

Product Name	Method	Emulsifier	Part Numbers
ZR-10C*	D	Hydrophilic	25 litres ..... 065C002 200 litres 065C003

**Commonly used product*

4 Select Developer

Product Name	Method	Form	Description	Part Numbers
SKD-S2	A C	d	Solvent-based	Aerosol case ..... 008A007 5 litres x 4 ..... 055C014
ZP-4B*		a	Dry Powder	1 Kg ..... 055C022 5 Kg 055C023
ZP-5B		c	Water Suspendible	5 Kg 055C022
ZP-9F*		d	Solvent-based	Aerosol case 008A010
ZP-14A†		b	Water-Soluble	5 Kg 055C010

†Generally not used with Method A

Product Name	Method	Form	Description	Part Numbers
SKD-S2	B C D	d	Solvent-based	Aerosol case ..... 008A007 5 litres x 4 ..... 055C014
ZP-4B		a	Dry Powder	1 Kg ..... 055C022 5 Kg 055C023
ZP-9F		d	Solvent-based	Aerosol case 008A010
ZP-5B		c	Water Suspendible	5 Kg 055C022
ZP-14A		b	Water-Soluble	5 Kg 055C010

5 Select Cleaner/Accessories

Product Name	Description	Part Numbers
SKC-S	Solvent-based Cleaner, Class 2	Aerosol case ..... 008A100 5 litres x 4 ..... 054C007 25 litres 054C008

Product Name	Description	Part Numbers
UV Lamps	UV technology developed exclusively for nondestructive testing	ST700 Stationary: 628244 EV6000 Handheld: 628000
Applicators	Sprayers for penetrants, developers, cleaners, and water	Air-Wash Spray Gun: 04G003 Water Spray Gun: 004G015