SHERWIN

DUBL-CHEK

PENETRANT PROCESS

INCORPORATED

MATERIALS GUIDE

PRODUCTS	CLASSIFICATION TO AMS-2644	BIODEGRADABLE	DESCRIPTION	TYPICAL APPLICATION	SPECIAL FEATURES
FLUORESCENT PENETRANT Water-washable (Method A & C)					
TRI-A	N/A		surfactant-based	ceramic, plastic, and porous parts	crack detection without staining or use of developer
HM-1	Level 1/2		low sensitivity	non-ferrous metal casting	excellent washability, low penetrant consumption due to low viscosity, excellent electrostatic spray capability flash point over 200 degrees F
HM-2D	Level 1		low sensitivity		
HM-220	Level 1	X	low sensitivity		
HM-3A	Level 2		medium sensitivity	welds, castings forging and extrusions of automotive and aerospace, ferrous and non-ferrous, air frame and turbine engine components	
HM-406	Level 2		medium sensitivity		
HM-412	Level 2		high level 2 sensitivity		
HM-440	Level 2	X	medium sensitivity		
HM-602	Level 2	X	medium sensitivity		
HM-430	Level 3		high sensitivity	turbine engine components including turbine blades and critical welds, castings, forging and extrusions	resists over-washing, low background and excellent electrostatic spray capability flash point over 200 degrees F
HM-604	Level 3	X	high sensitivity		
HM-607	Level 3	X	high sensitivity		
HM-704	Level 4	X	ultra-high sensitivity		
HM-707	Level 4	X	ultra-high sensitivity		
FLUORESCENT PENETRANT Post-Emulsifiable (Method B, C & D)					
RC-29	Level 1		low sensitivity	welds, castings, forging in automotive, airframe and turbine engine	low penetrant consumption due to low viscosity, excellent electrostatic spray capability, superior heat resistance, fully approved and proven over two decades flash point over 200 degrees F
FP-228	Level 2		medium sensitivity		
RC-50	Level 2		medium sensitivity		
RC-65	Level 3		high sensitivity	critical turbine engine components, e.g. turbine blades, turbine engine rotating parts, discs, fan-blades	
RC-77	Level 4		ultra-high sensitivity		
RC-88	Level 4		ultra-high sensitivity		
FLUORESCENT PENETRANT Water-based (Method A & C)					
I-319 Water-based	N/A	X		liquid oxygen applications	water-base, LOX compatible
WB-100 Water-based	Level 1	X	low sensitivity	castings, forging in automotive airframe and turbine engine	first approved water-based fluorescent penetrants biodegradable, resists over-washing, non-flammable
WB-200 Water-based	Level 2	X	medium sensitivity		
EMULSIFIERS					
ER-83A	Method D	X	hydrophilic	use with P.E. penetrants and DP-40	qualified to 30% max. concentration – high tolerance to contamination
ER-85	Method B		lipophilic	use with P.E. penetrants and DP-40	slow diffusion with lower risk of over-emulsification
DEVELOPERS					
D-90G	form a		dry powder	dust chamber – hand application, or powder bulb	stabilizes and enhances brilliance to indications
D-90G.1					
D-90H					
D-100	form d & e		nonaqueous alcohol	aerosol, sprayer	refined white particles give thin, more uniform layer refined white particles, dries fast into uniform layer nonhazardous, economical developer for testing large number of parts
D-104A	form d & e		nonaqueous acetone/alcohol	aerosol, sprayer	
D-106	form d & e		nonaqueous acetone	aerosol, sprayer	
D-110A.1	form c		water-suspendible	dip tank	
D-113G.1	form b		water-soluble	dip tank	
CLEANERS / REMOVERS					
DR-60	Class 2		hydrocarbon based	use with all visible or fluorescent	excellent solvent action- pre-cleaner and remover more volatile than DR-60, excellent pre-cleaner
DR-62	Class 2		hydrocarbon based		
LA-1 Cleaner	N/A		hot tank - alkaline	dilution, spray or immersion	non-corrosive, non-toxic, sodium-free
VISIBLE DYE PENETRANT					
DP-40	Method B & C & D		P.E. type	welding, castings, forging and extrusions of both ferrous and non-ferrous components and some plastics and ceramics	sharp indications through high color content resist over-washing, high color content flash point over 200 degrees
DP-50	Method A & C		water washable		
DP-51	Method A & C		water washable		
DP-52	N/A		water washable		
DP-54	Method A & C	X	easily water washable	rough castings	easy wash-off for use on heavily textured parts
BY-LUX	N/A		visible and fluorescent	second look with black light	no second application when closer look needed
HIGH TEMPERATURE SYSTEM					
K-017 Penetrant	Method A & C	X	high temp. visible dye	welding, castings, forging at high temperature	inspection on hot surfaces, no need to cool down parts reducing processing time and inspection costs dwell up to 350 degrees
K-019 Remover	Class 2		high temp. remover		
D-350 Developer	form d & e		high temp. developer		

SHERWIN GUIDE TO PENETRANT PROCESSES

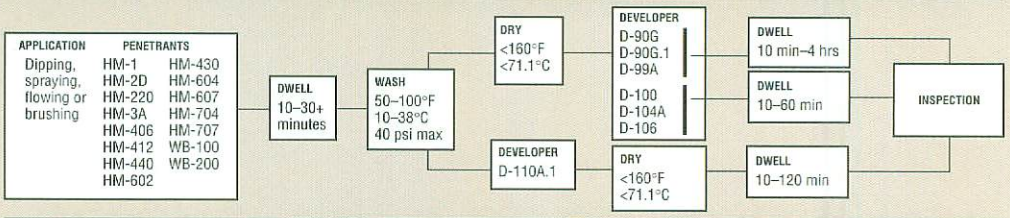
SHERWIN penetrant materials are listed in the Qualified Product List (QPL) of MIL-I-25135E and AMS-2644-1

*NOTE: Some **specialty** products do not meet requirements and are only used for special inspections.*

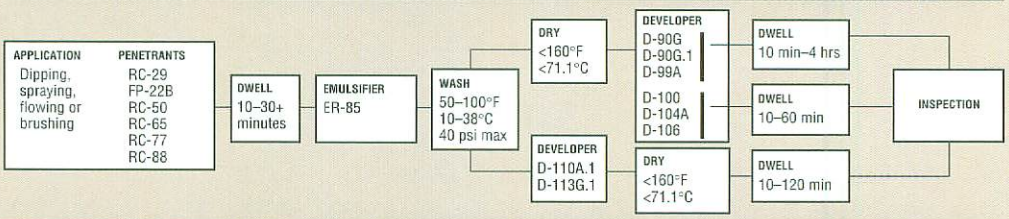
Rolls-Royce
Pratt & Whitney
General Electric
Snecma DMC
Aerospatiale
Turbomeca
FIAT Aviazone
Augusta
MTU
Garrett EMS
Allison
Douglas DMS
Airbus Industry
Boeing BAC 5423
Sikorsky Aircraft
Lockheed
General Dynamics
Northrop
ASME Code Sec V
RDT-F3-6T
AMS/SAE 2647
AMS-3155
AMS-3156
AMS-3157
Embraer
Bombardier

TYPE I-FLUORESCENT PENETRANTS

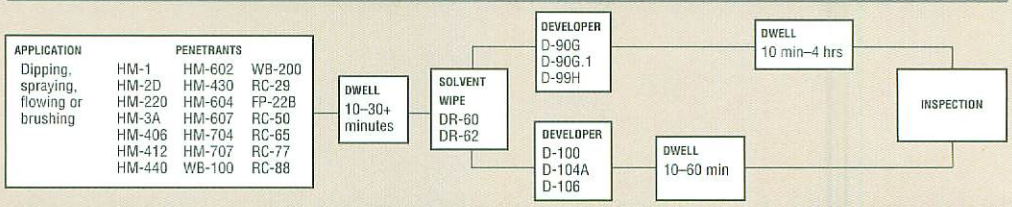
Method A – Water Washable



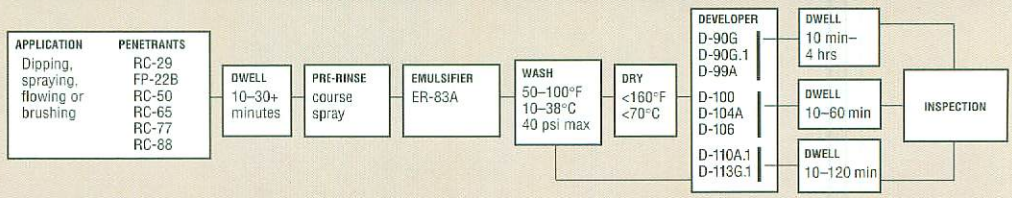
Method B – Post-Emulsifiable, Lipophilic



Method C – Solvent Removal

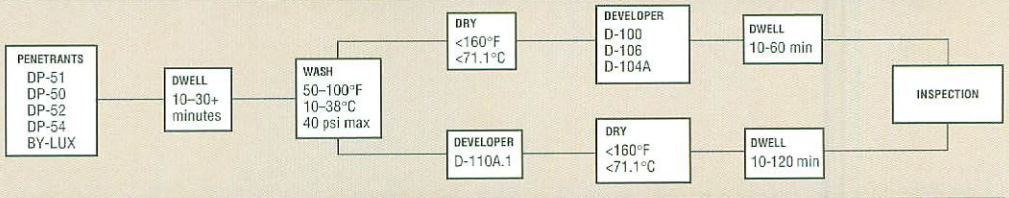


Method D – Post-Emulsifiable, Hydrophilic

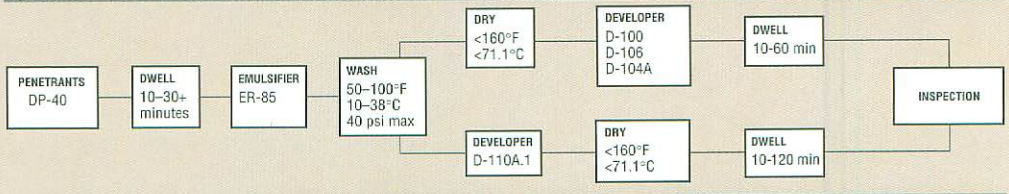


TYPE II-VISIBLE PENETRANTS

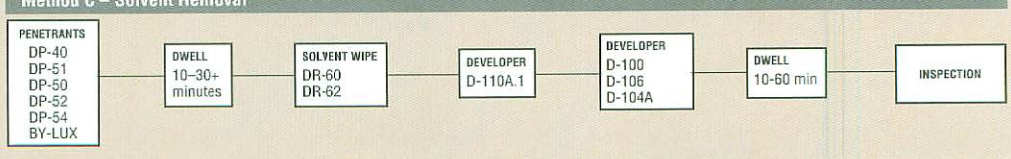
Method A – Water Washable



Method B – Post-Emulsifiable, Lipophilic



Method C – Solvent Removal



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Penetrant Classification System

Penetrants:	Type I	Fluorescent
	Type II	Visible (Red)
Removal Method:	Method A	Water Removable
	Method B	Lipophilic Emulsifier (oil base)
	Method C	Solvent Wipe
	Method D	Hydrophilic Emulsifier (water base)
Removers:	Class (1)	Halogenated (nonflammable)
	Class (2)	Nonhalogenated (flammable)
Developers:	Form a	Dry powder
	Form b	Water Soluble
	Form c	Water Suspendable
	Form d	Nonaqueous
	Form e	Nonaqueous
Fluorescent Sensitivity:	Level 1/2	Ultra Low
	Level 1	Low
	Level 2	Medium
	Level 3	High
	Level 4	Ultra High

Frequency of In-Use Penetrant Tests ASTM E-1417

Each Shift
Water Wash Pressure and Temperature

Daily
Penetrant Contamination
Dry Developer Condition
Developer Contamination (form b & c)
System Performance
Black Light: Intensity, Reflectors & Filters
Examination Area Cleanliness

Weekly
Emulsifier (hydrophilic) Concentration
Penetrant Sensitivity*
Water Content (water based)
Aqueous Developer Concentration (b & c)
Visable & Black Light Integrity

Monthly
Penetrant Water Content (method a only)
Penetrant Removability* (method a only)
Emulsifier Water Content (lipophilic only)
Emulsifier Removability*

Quarterly
Penetrant Brightness*
Calibrate Drying Oven

Semi-Annually
Calibrate Light Meter
Water Pressure Gage Calibration
Water Temperature Gage Calibration

Note: Table as it appears is not a complete summary of the required in-use material tests.

* These tests may be combined and performed during the "system performance" test in accordance with 7.8.4.

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DUBL-CHEK PENETRANT PROCESS

10/1/06

SHERWIN
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Sherwin Incorporated provides a full line of products and related services, including:

Penetrant Products

Visible & Fluorescent

Cleaners & Removers

Emulsifiers

Developers

Specialized Penetrants

Magnetic Particle Products

Test Panels

PSM-5

KDS Twin Panels

Panel Recalibration

Laboratory Services

In-Use Testing

Custom Products

Penetrant Inspection Accessories

Represented by:

DETEK

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VISIBLE DYE PENETRANT MATERIALS

DUBL-CHEK PENETRANT PROCESS

PRODUCT SUMMARY

VISIBLE PENETRANTS

Sherwin Incorporated produces two standard, visible dye penetrants; one nonwater-washable, and the other water-washable or water-removable.

DP-40 Dye Penetrant (nonwater-washable): Approved Type II, Method B post-emulsifiable and Method C solvent wipe-off penetrant MIL-I-25135 and AMS-2644. (Also, approved Group I and II under MIL-I-25135-C.) Intense red color for maximum color contrast. Meets all applicable codes and standards; ASTM E-1417, ASME, NAVSHIPS, MIL-STD-6866, etc.

DP-51 Dye Penetrant (water-washable): Approved Type II, Method A water-washable or water wipe-off and Method C solvent wipe-off penetrant under MIL-I-25135 and AMS-2644. A water-removable visible dye penetrant with sensitivity equivalent or superior to most nonwater-washable Type II penetrants. Meets all applicable codes and standards; ASTM E-1417, ASME, NAVSHIPS, MIL-STD-6866, ASTM E-1417, etc.

K0-17 HI-TEMP® Penetrant: Visible dye penetrant, approved under MIL-I-25135 and AMS-2644. Finds flaws on surfaces at elevated temperatures, up to 350°F. Saves time; for weldment inspection before complete cooling (maintain pre-heat temperature); in-service inspection of chemical processing equipment, etc. Used with Hi-Temp KO-19 Remover and either D-100 or Hi-Temp D-350 Developer. ASME Code qualification procedure compliance.

(Under certain circumstances, two other Sherwin Incorporated visible dye penetrants, **DP-50** and **By-Lux** may be appropriate. **DP-50** is similar to **DP-51**, but less bright; and may be appropriate for dip tank procedures. By-Lux may be useful in operations that combine visible and black light procedures. See "Product Summary — Specialty Penetrant Materials" for a description of these and other specialty products.)

REMOVER/CLEANERS

Three standard "Remover/Cleaners" are provided. All are volatile solvents. Two are nonchlorinated solvents and flammable. A third "Remover/Cleaner" is specially formulated for use on hot surfaces.

DR-60 Cleaner/Remover: Clear solvent. Method C, Class (2) Remover (nonchlorinated) MIL-I-25135/AMS-2644. Flash point about 110°F. Used both for cleaning prior to penetrant application and for penetrant removal by wipe-off method. Evaporates clean without residue. Meets applicable codes and specifications.

DR-62 Cleaner/Remover: Clear solvent. Method C, Class (2) Remover (nonchlorinated) MIL-I-25135 and AMS-2644. Use both to clean prior to penetrant application and to remove penetrant by wipe-off method. Evaporates more rapidly than DR-60. Leaves no residue. Meets applicable codes and specifications.

KO-19 FOAM Remover: Used for removal of both Type I and II penetrants when shallow, wide cracks are suspected. Foam — similar to shaving lather — is emitted from the KO-19 spray can directly on the penetrant treated surface. Foam lifts penetrant from the surface, but not from the cracks. Dry toweling is used to wipe surface clean.

EMULSIFIERS

Two emulsifiers are offered. **ER-85**, a "lipophilic" type, is oil-based and used full strength, and **ER-83A**, a "hydrophilic" type, is detergent-based and used highly diluted with water.

ER-85 Emulsifier (Lipophilic): For use with nonwater-washable visible dye (and fluorescent) penetrants (Method B, MIL-I-25135/AMS-2644). Applied full strength as an over-layer to penetrant following penetrant dwell. Makes possible the removal of nonwater-washable penetrant with water spray.

ER-83A Emulsifier (Hydrophilic): Hydrophilic emulsifier (Method D) is also offered for use with nonwater-washable penetrants including **DP-40**. Process includes a plain water pre-wash before **ER-83A** application. Process provides greater reliability where shallow flaws are suspected.

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DEVELOPERS

Sherwin Incorporated offers three nonaqueous (volatile solvent carrier) developers. **D-100,** is more sensitive, uses alcohol as the carrier, and is flammable. **D-106** is a nonchlorinated solvent based developer that dries more quickly than **D-100**. **D-350** is designed to be used at high temperatures.

D-100 Developer (nonaqueous): Approved MIL-I-25135/AMS-2644 for both Type I and II penetrants. (Also, approved Groups I through VII.) Adsorbent white particles suspended in volatile solvent (alcohol). Maximum sensitivity. Lays on surface in thinner, more uniform coat. Flash point about 60°F. Apply by spraying. Meets all applicable codes and standards.

D-106 Developer (nonaqueous): Approved MIL-I-25135-E/AMS-2644 for Type I and Type II penetrants. Adsorbent white particles suspended in volatile solvent. Lays on surface in thinner, more uniform coat. Apply by spraying. Meets all applicable codes and standards.

D-350 HI-TEMP® Developer: Nonaqueous. Hi-Temp D350 is used with Hi-Temp K0-17 Penetrant and Hi-Temp KO-19 Remover. White adsorbent particles suspended in nonchlorinated, volatile solvent (alcohol). Available only in spray cans. Performs on elevated temperature surfaces; 200°F to 350°F. Approved Group I and III under MIL-I-25135-C.

PRECAUTIONARY INFORMATION

Materials described on this Product Summary should be used in accordance with instructions. Use with adequate ventilation and away from sparks, fire and open flame. Avoid contact with skin. Avoid breathing vapors or spray mist. Do not get in eyes. Do not take internally.

The products listed are for industrial use by qualified personnel only. Like all nondestructive testing methods, the penetrant process has limitations and no penetrant manufacturer claims that the use of these materials will show all dangerous cracks or defects under all conditions.

LIMITED WARRANTY

Buyer agrees that if any of these products are defective, manufacturer's and seller's only obligation shall be to replace the product or refund its purchase price.

FLUORESCENT PENETRANT MATERIALS

DUBL-CHEK PENETRANT PROCESS

MIL-I-25135 - TYPE 1

PRODUCT SUMMARY

Fluorescent penetrants show surface cracks and porosity as glowing lines or dots in a darkened area under "black" (ultra-violet) light. A developing agent is not always necessary but is generally required to amplify the glowing lines or dots.

Fluorescent penetrants come in two basic formulas: "water-washable" and "nonwater-washable." Water-washable penetrants have an integral emulsifying agent and can be removed from the surface by washing with plain water. Nonwater-washable penetrants are not water-miscible and, while a plain water pressure wash will mechanically remove most of the penetrant, a separate emulsifying step is needed for a clean surface.

Water-washable fluorescent penetrants are classified under MIL-I-25135 as Type 1, Method A, while nonwater-washables are classified as Type 1, Method B and/or Method D, depending upon whether a lipophilic (oil base) or hydrophilic (water base) emulsifier is designated. Both water-washable and nonwater-washable penetrants can be classified as Method C, as this solvent wipe-off method is effective with both.

Fluorescent penetrants are also classified according to their "sensitivity," or their ability to detect the smallest flaws, with Level 1/2 being the least sensitive and Level 4 being the highest. The presecribed sensitivity level depends on manufacturing specifications.

WATER-WASHABLE PENETRANTS - METHOD A and C

SENSITIVITY LEVEL 1/2

HM-1 Fluorescent Penetrant — (approved Group V, MIL-I-25135-D & E) For relatively noncritical work. Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Low cost.

SENSITIVITY LEVEL 1

HM-2D Fluorescent Penetrant — (approved Group V, MIL-I-25135-D & E) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Recommended for magnesium and aluminum castings with difficult surfaces.

HM-220 Fluorescent Penetrant — (approved Group V, MIL-I-25135-C, D & E) Flash Point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Very free rinsing for extremely difficult surfaces. Does **not** contain petroleum distillates and **more** likely to be accepted by sewage treatment facilities.

SENSITIVITY LEVEL 2

HM-3A Fluorescent Penetrant — (approved Group V, MIL-I-25135-C, D & E) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Versatile, general purpose material; used extensively on aluminum and magnesium castings. Competitively priced.

HM-406 Fluorescent Penetrant — (approved Group VI, MIL-I-25135-C, D & E) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Well recognized penetrant, approved and used by prime aerospace contractors on magnesium, aluminum and titanium castings and extrusions. More sensitive than HM-3A.

HM-412 Fluorescent Penetrant — (approved Group V, MIL-I-25135-D & E) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. General purpose penetrant, used on aluminum, magnesium, and titanium castings and extrusions. More sensitive than HM-406.

HM-440 Fluorescent Penetrant — (approved Group VI, MIL-I-25135-C, D & E) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Free rinsing. Does **not** contain petroleum distillates and **more** likely to be accepted by sewage treatment facilities.

SENSITIVITY LEVEL 3

HM-420C Fluorescent Penetrant — (approved Group V, MIL-I-25135-D & E) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Low viscosity, Level 3 penetrant designed for machined, smooth surfaces.

HM-430 Fluorescent Penetrant — (approved Group V, MIL-I-25135-D & E) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. High sensitivity penetrant, formulated for rough surfaces; the four wheel drive penetrant for rough terrain.

HM-604 Fluorescent Penetrant — (approved Group VI, MIL-I-25135-C, D & E) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Where water-washable Level 3 penetrant is designated, **HM-604** is favored, as it does not leave an interfering fluorescent background. Competitively priced! Does **not** contain petroleum distillates and **more** likely to be accepted by sewage treatment facilities.

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SENSITIVITY LEVEL 3

HM-430 Fluorescent Penetrant — Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. High sensitivity penetrant, formulated for rough surfaces; the four wheel drive penetrant for rough terrain.

HM-604 Fluorescent Penetrant — (Group VI) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Where water-washable Level 3 penetrant is designated, **HM-604** is favored, as it does not leave an interfering fluorescent background. Competitively priced! Does **not** contain petroleum distillates and is more likely to be accepted by sewage treatment facilities. Resists over-washing.

HM-607 Fluorescent Penetrant — (Group VI) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Similar to HM-604 in formulation but more sensitive, not quite as free rinsing, and somewhat more expensive. Does **not** contain petroleum distillates and is more likely to be accepted by sewage treatment facilities. Resists over washing.

SENSITIVITY LEVEL 4

HM-704 Fluorescent Penetrant — Flash Point 200°F, OSHA Class IIIB. Low sulfur and low halogen. Ultra-high sensitivity penetrant used on very smooth surfaces. Does **not** contain petroleum distillates and is more likely to be accepted by sewage treatment facilities.

NONWATER-WASHABLE PENETRANTS - METHODS B, & D, and C

The following nonwater-washable penetrants, RC-29, RC-50, RC-65 and RC-77, are approved as Method B with ER-85 Emulsifier, Method D with ER-83A Emulsifier, or as Method C with any approved "cleaner/ remover."

SENSITIVITY LEVEL 1

RC-29 Fluorescent Penetrant — (Group V) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Competitively priced.

SENSITIVITY LEVEL 2

RC-50 Fluorescent Penetrant — (Group V) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Approved by major turbine engine manufacturers in addition to DoD.

SENSITIVITY LEVEL 3

RC-65 Fluorescent Penetrant — (Group VI, VIA, & VII) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Approved by major turbine engine manufacturers in addition to DoD.

SENSITIVITY LEVEL 4

RC-77 Fluorescent Penetrant — (Group VI, VIB, & VII) Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Approved by major turbine engine manufacturers in addition to DoD.

RC-88 Fluorescent Penetrant — Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Ultra-high sensitivity penetrant formulated for critical inspections; increases the visibility of microscopic flaw indications.

EMULSIFIERS FOR FLUORESCENT PENETRANTS - METHODS B & D

Two emulsifiers are offered. One, a lipophilic type, or Method B, is oil based and used full strength. The other, a hydrophilic type, or Method D, is detergent based and used highly diluted with water.

ER-85 Emulsifier (lipophilic): Method B Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. For use with all of the above listed nonwater-washable, fluorescent penetrants. Used in the post-emulsification process. Relatively viscous. Minimizes over-emulsification risk by slow diffusion properties.

ER-83A Emulsifier (hydrophilic): Method D Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. For use with all of the above listed nonwater-washable, fluorescent penetrants. Used in the pre-wash hydrophilic emulsifier process. **ER-83A** is "non-aggressive" with minimum solvent action. It provides greater reliability. A majority of major turbine engine manufacturers have selected **ER-83A** together with RC-77 Penetrant for use on their most critical rotating parts.

ER-83A is diluted with water before use. As shown on the Qualified Products List, **ER-83A** Emulsifier may be used at a solution strength as high as 30% in water by volume. Normally, it is used at a lower strength than the 30% maximum, and for immersion applications, a 20% solution strength is typical. In the spray mode, the solution strength varies from less than 1% to no higher than 5%. (See Product Bulletin **ER-83A** for details.)

Note: QPL-25135 and AMS-2644 specifications do not establish a minimum emulsifier solution concentration, only a maximum. The maximum for **ER-83A** is 30% when used with all of the nonwater-washable penetrants listed above. User established minimum concentrations vary according to surface conditions and pre-wash completeness. For example, smooth surfaces, which accommodate effective pre-washes, may only require a 5% solution.

CLEANER/REMOVERS FOR FLUORESCENT PENETRANTS - METHOD C

Two standard "Remover/Cleaners" are provided. They are nonchlorinated solvents and are flammable

DR-60 Cleaner/Remover: Clear solvent. Method C, Class 2 Remover (nonchlorinated). Flash point about 110°F. Used both for cleaning prior to penetrant application and for penetrant removal by wipe-off method. Evaporates clean without residue. Meets applicable codes and specifications.

DR-62 Cleaner/Remover: Clear solvent. Method C, Class 2 Remover (nonchlorinated). Used both for cleaning before penetrant application and for penetrant removal by wipe-off method. Evaporates more rapidly than DR-60. Leaves no residue. Meets applicable codes and specifications.

Special Note: In accordance with MIL-I-25135/AMS-2644 and MIL-STD-6866/ASTM E-1417, the Class 1 and Class 2 Removers are outside of the "family," or same brand, concept. Sherwin's Cleaner/Removers DR-60, and DR-62 may be used with any QPL-approved penetrants.

DEVELOPERS FOR FLUORESCENT PENETRANTS

Dry Powder

D-9OG Developer: Approved "form a." Low sulfur and low halogen. Excellent surface cling.

NonAqeous Developers

Sherwin Incorporated offers two nonaqueous (volatile solvent carrier) developers. One, **D-100**, uses alcohol as the carrier, and is flammable, but gives higher sensitivity performance. The other, **D-106**, is a non- chlorinated solvent carrier formulation, and flammable. It dries more rapidly than the alcohol solvent carrier developer.

D-100 Developer: Approved for both Type I and Type II penetrants. Adsorbent white particles suspended in volatile solvent (alcohol). Maximum sensitivity performance. Lays on surface in thinner, more uniform coat. Flash point about 60°F. Apply by spraying. Meets all applicable codes and standards.

D-106 Developer: Approved for Type I and II penetrants. Adsorbent white particles suspended in volatile solvent. Lays on surface in thinner, more uniform coat. Apply by spraying. Meets all applicable codes and standards.

Water Soluble

D-113G.1 Developer (water soluble): Approved "form b." Low sulfur and low halogen. A powder which dissolves completely in water, typically one pound per gallon. After application and drying, it forms a uniform, thin white coat on the surface. Normally, only used with nonwater-washable penetrants.

Water Suspendable

D-110A.1 Developer—approved "form c" developer. Low sulfur and low halogen. A powder typically mixed with water at one pound per gallon to form a suspension. After application and drying, **D-110A.1** leaves a uniform, thin, white coating on the surface. Exercise care in choosing the proper circulating equipment for keeping developer particles in suspension.

Special Note: In accordance with MIL-I-25135/AMS-2644, MIL-STD-6866, and ASTM E-1417, developers are outside of the "family," or same brand, concept. All Sherwin developers may be used with <u>any</u> QPL-approved penetrant systems.

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FLUORESCENT PENETRANT MATERIALS

PRODUCT SUMMARY

PRECAUTIONARY INFORMATION

The materials described on this Product Summary should be used in accordance with instructions. Use with adequate ventilation and away from sparks, fire and open flame. Avoid contact with skin. Avoid breathing vapors or spray mist. Do not get in eyes. Do not take internally.

The products listed are for industrial use by qualified personnel only. Like all nondestructive testing methods, the penetrant process has limitations and no penetrant manufacturer claims that the use of these materials will show all dangerous cracks or defects under all conditions.

LIMITED WARRANTY

Buyer agrees that if the product proves to be defective, the manufacturer's and seller's only obligation shall be to replace the the product or refund its purchase price.

HI-TEMP® PENETRANT INSPECTION SYSTEM

DUBL-CHEK PENETRANT PROCESS

PRODUCT INFORMATION

Description: Sherwin Incorporated's **Hi-temp®** Penetrant System is designed to work at temperatures above which ordinary penetrants are ineffective. Three products comprise the system: **K-019** Remover, **K-017** Penetrant, and **D-350** Developer.

Special Features: The **Hi-temp®** Penetrant System is effective at higher temperatures. Using the system can *reduce inspection costs*; waiting times are reduced.

Temperatures rise during welding processes. They also rise under normal operating conditions for certain kinds of equipment, such as pressure vessels, or simply, when inspection work is done in the sun. Often, before moving to a new piece, welders must wait for the current piece to cool before inspecting it. Similarly, some fabrication processes require as much as 24 hours between steps because parts must cool enough to allow inspection with ordinary penetrants. Waiting for parts to cool — generally to less than 140°F— increases processing time, and production costs.

Heat actually enhances the **Hi-temp®** Penetrant System's performance. Heat drives contaminants from flaws; and heat-expanded flaws trap more penetrant, giving stronger indications after developer is applied. Additionally, **Hi-temp® K-017** Penetrant requires less dwell time than ordinary penetrants in order to locate equivalent sized flaws. Finally, **Hi-temp® K-017** Penetrant is water washable, so removing excess penetrant does not require a "remover" under most conditions, and post-cleaning of spillage and over-spray is easy.

The **Hi-temp®** Penetrant System reduces processing time and production costs.

Container Sizes:
case of 12 spray cans
one-gallon cans
case of 4 one-gallon cans
five-gallon pails

Basic Instructions: (These instructions describe the basic process. They may be amended by the user to comply with applicable specifications and/or inspection criteria provided by the contracting agency.)

1. **Cleaning:** Cleaning may be unnecessary prior to applying **Hi-temp® K-017** Penetrant because the penetrant itself is highly detergent and dissolves organic contaminants, especially on heated surfaces. In addition, at higher temperatures certain contaminants, such as oils, greases, and waxes, will liquify and be easily displaced, while other contaminants, such as water and solvents, will evaporate. Even so, it may be necessary to use **Hi-temp® K-019** Remover before applying the penetrant.

   a. **K-019** Application: Spray or brush **Hi-temp® K-019** Remover on the surface and allow to dwell for 1 to 4 minutes; use shorter times for higher temperatures and less contamination.

      Wipe **K-019** Remover from the surface with clean, dry cloth or paper towels. Then, wipe with water saturated towels. A final wipe with dry towels in order to speed drying may be required at lower temperatures.

      Repeat the application/wiping procedure if necessary. Wire brushing may be required to remove scale or other deposits. Paint is generally removed with a torch.

   b. **Drying:** The part must be dry before applying **Hi-temp® K-017** Penetrant. Hotter parts dry more quickly than cooler parts.

2. **Apply Penetrant:** Spray or brush **Hi-temp® K-017** Penetrant on a limited area. It is important that the area to which the penetrant is applied not be too large so processing can be completed within penetrant and developer dwell time restraints. The acceptable area size will vary with inspection temperatures, part geometry, and operator experience.

   The penetrant must dwell on the part in order to penetrate surface flaws. At higher temperatures, penetration occurs more quickly. The following table suggests how **K-017** dwell times vary with temperature. Allowances must be made for contamination levels and flaw sizes.

225° - 350°F	30 seconds to 1 minute
175° - 225°F	1 - 2 minutes
125° - 175°F	2 - 3 minutes
75° - 125°F	3 - 10 minutes
50° - 75°F	10 - 30 minutes

3. **Remove Excess Penetrant:** It is important that all excess penetrant be removed, otherwise the developer step may be adversely affected.

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a. **Wipe Surface:** Remove as much **Hi-temp® K-017** Penetrant as possible using paper or soft, clean cloth towels to wipe the surface.

b. **Apply Remover:** Use **Hi-temp® K-019** Remover to clean remaining penetrant from the surface. **K-019** may be directly sprayed in a thin coat and immediately wiped from the surface. If part surfaces are smooth, using **K-019** may be unnecessary. In either case, as a final step, the part should always be wiped with a water saturated towel or cloth to remove the last traces of penetrant. Immediately follow water wipe with a dry wipe.

Note: The surface must be completely free of both penetrant and remover, or **Hi-temp® D-350** Developer will not lay in an even coat. Generous water usage is suggested.

c. **Drying:** Use paper or cloth toweling to dry the part's surface thoroughly. Special drying time before applying developer to heated parts should not be required.

4. **Apply Developer:** Two non-aqueous developers may be used with the **Hi-temp®** system: **D-100**, a conventional developer which is recommended for temperatures from 50° - 250°F, and **D-350** which is recommended for temperatures between 175°F and 350°F. When temperatures exceed 175°F, and the more they approach 250°F, the more **D-350** is preferred. (A separate information sheet is available for **D-100**.)

The developer should be sprayed on the part surface from a distance of 6-8 inches immediately after the excess penetrant has been removed and the part has dried. Apply a thin even coat over the entire surface to which **K0-17** Penetrant was originally applied; two or three thin coats are preferred to a single, heavy coat. If penetrant removal is incomplete, the developer will not go evenly on the part.

5. **Observe Indications:** Observe the surface for defect indication formation while the developer is applied.

At high temperatures, flaw indications appear almost instantly. Color depth is greatest within a few seconds after applying developer. Therefore, final surface examination should begin within a minute or two after developer application.

At high temperature, developed indications have a tendency to spread and lose their definition more rapidly. Moreover, some color fading with extended development times must be anticipated. Surface examination should be completed as quickly as practical, and within ten or fifteen minutes.

Red lines usually indicate cracks or lack of fusion. Red dots in a line or curved pattern usually indicate a tight crack. And, scattered dots usually denote porosity.

General Information: Do not attempt to inspect large areas that cannot be processed quickly. Permitting the penetrant to dwell longer than maximum times produces color degradation and excess vapors. Also, penetrant indications loose their resolution and tend to fade when exposed to heat.

At high temperatures, **D-350** Developer may be removed by simple brushing. However, at lower temperatures, complete removal may require wiping with towels dampened with water or **K-019** Remover.

PRECAUTIONARY INFORMATION

All **Hi-temp®** Penetrant System products —**K-017**, **K-019**, **D-350**, and **D-100**— should be used with adequate ventilation and away from sparks and flame, especially when these products are applied to heated surfaces.

D-350 and **D-100** are flammable. Their vapors may cause drowsiness or unconsciousness. Victims should be removed to fresh air; commence CPR if necessary; seek medical attention. In the event of a **D-350** or **D-100** spill, eliminate all sources of ignition, stand-by with fire extinguisher, and contact authorities.

Be careful not to place spray cans containing **Hi-temp®** Penetrant System materials on heated surfaces; heated containers may explode. Never burn, puncture, or heat spray cans: store at less than 120°F; keep out of direct sun.

Wear protective clothing and equipment. Eye contact will cause severe pain and may result in injury. Flush eyes with water and seek immediate medical attention.

K-017 and **K-019** have strong detergent properties and may cause severe skin irritations. Promptly remove from skin by washing with water. Do not wear clothes contaminated with **Hi-temp®** Penetrant System products.

Read and follow safety instructions presented on container labels and on the manufacturer's Material Safety Data Sheets.

QUESTIONS AND ANSWERS ABOUT USING THE HI-TEMP® SYSTEM

Do Hi-temp® penetrants meet sulfur and halogen restrictions of specifications such as ASME Codes III and V, RDT F3-6T, and NAVSHIPS 250-1500?

Definitely. Analyses by a recognized laboratory yielded the following determinations, well below the 1.00% (10,000 ppm) and 0.50% (5,000 ppm) limits:

Hi-temp® Material	Halogens (ASTM D808)	Sulfur (ASTM D129)
K-017Dye Penetrant	0.002% (20 ppm)	0.02% (200 ppm)
K-019Remover	0.002% (20 ppm)	0.01% (100 ppm)
D-100 Developer	0.002% (20 ppm)	0.01% (100 ppm)
D-350 Developer	0.005% (50 ppm)	0.01% (100 ppm)

Complete certification available upon request.

Does the Hi-temp® Dye Penetrant process conform to Article 6, paragraph T-660, "Qualification of Procedures for Nonstandard Temperatures" of ASME Code Section V, as well as comparable paragraphs in Section III and RDT F3-6T?

Yes. An independent laboratory confirmed that K-017Visible Penetrant at elevated temperatures performs as well as conventional visible dye penetrants perform at ambient temperature. After tests, the laboratory concluded that the sensitivity yield of K-017Dye Penetrant with K-019Remover and D-100 Developer on surfaces maintained at 250°F was equivalent to the Mil-I-25135 Group I "Standard" on ambient (about 80°F) surfaces. (Aluminum block comparators, cut into two sections, were used in these tests.)

Similar tests with equally good results have been performed on surfaces of 350°F using **Hi-temp®** K-017Dye Penetrant and K-019Remover, but substituting D-350 Developer for D-100.

What are the provisions for using the Hi-temp® Penetrant System on NAVSHIPS contracts?

The system is now used in the NAVSHIPS program. Contractors can arrange to use the **Hi-temp®** process by demonstrating the system's efficacy under a particular contract. The U.S. Military has shown substantial interest in processes which improve performance and lower costs.

In a multi-pass weldment situation, what is the effect of residues from Hi-temp® products on the subsequent weld layer?

In one NAVSHIPS approval program, tests were made where heavy residues of all material were purposely left between weld layers. Subsequent microsectioning and examination revealed no harmful effect.

What are the personal hazards when using the Hi-temp® System?

Wear suitable gloves for protection against contact with heated surfaces during wipe-off step.

At higher temperatures, some irritating vapors will be produced. Where practical, a fan should direct the vapors away from the technician, and, to minimize any adverse effects, small part segments should be inspected at a time. Considering the small area inspected and the brief penetrant dwell before wipe-off —30 to 60 seconds— vapor quantities will be minimal.

In addition, K-017and K-019have strong detergent properties and should immediately be flushed from skin and eyes with fresh water.

What about the fire hazard?

Again, very small areas and quantities of material are involved. For example, less than one half ounce of **Hi-temp®** K-017 Penetrant is required to paint 20 linear feet of 1.5 inch wide weldment. Such small quantities should not alarm safety engineers. Also, **Hi-temp®** K-017 Penetrant and **Hi-temp®** K-019 Remover have flash points in the 400°F range. Both developers, D-100 and D-350, are invariably applied from pressurized spray cans, so, even though they are alcohol based, quantities of exposed flammable material in the area are negligible.

The greatest personnel risk would be from leaving a pressurized can on a heated surface.

Why are there two developers, D-100 and D-350? What is the difference between the two?

D-100 Developer, Sherwin Incorporated's standard, normal temperature developer, is effective with the **Hi-temp®** process on surfaces as hot as 250°F. However, above 250°F, the developer's white particles tend to flake from the surface, so the effective limit of D-100 Developer is 250°F.

SPECIALTY PENETRANT MATERIALS

DUBL-CHEK PENETRANT PROCESS

PRODUCT SUMMARY

The products listed on this summary have been specially formulated by Sherwin Incorporated to meet non-routine penetrant application requirements; i.e., when our more general purpose products may be inappropriate. Descriptions of Sherwin Incorporated's more general purpose products are described in other product summaries.

VISIBLE DYE PENETRANTS

DP-50 Dye Penetrant (Water-Washable): Widely accepted for use without developer to find cracks on surfaces of light colored technical ceramics. Has unusual affinity for ceramic surfaces. Also used extensively on metal surfaces, including weldments. Removable by water-spray, water wipe-off and by solvent wipe-off. Not as sensitive as DP-51—a non-specialty—visible dye penetrant for metal surface inspection. Approved Group III under MIL-I-25135-C. Flash point approximately 160°F.

DP-54 DYE PENETRANT (Water-Washable): Approved Type II, Method A and C, MIL-I-25135-E. "Biodegradable." Contains **no** petroleum distillates and is more likely to be accepted by sewage treatment facilities. Flash point over 200°F, OSHA Class IIIB. Low sulfur and low halogen. Removable by water spray; water wipe-off; or solvent wipe-off. Free rinsing.

DUAL RESPONSE PENETRANT

BY-LUX™ PENETRANT #1: Approved Group III, MIL-I-25135-C. Remove with water. Flaw marks show red on white D-100 Developer background under normal, or "white light," and glow orange under "black light." Provides two levels of sensitivity. Flash point over 200°F. Also may be used with the hydrostatic leak test. (See "Hydrostatic Leak Detection" below.)

WATER-BASE FLUORESCENT PENETRANT

I-319 FLUORESCENT PENETRANT: Water-washable, water-base penetrant. Uses distilled water; no petroleum solvents or distillates. Considered insensitive to liquid oxygen in its diluted state, so-called "LOX-Compatibility." Has good acceptance for use on plastics. Meets most sanitation districts effluent disposal requirements. Not recommended for finding shallow, or wide cracks. Approved Group VI, MIL-I-25135-C.

HIGH TEMPERATURE PENETRANT MATERIALS

K0-17 HI-TEMP® PENETRANT: Visible dye penetrant, approved Groups I and III, MIL-I-25135-C, D & E. Finds flaws on surfaces at elevated temperatures, up to 350°F. Saves time; for weldment inspection before complete cooling (maintain pre-heat temperature); in-service inspection of chemical processing equipment, etc. Used with Hi-Temp KO-19 Remover and either D-100 or Hi-Temp D-350 Developer. ASME Code qualification procedure compliance.

KO-19 HI-TEMP® REMOVER: For use with Hi-Temp KO-17 Penetrant. Approved Group I remover, MIL-I-25135-C, D & E. Use as a wipe-off remover.

D-350 HI-TEMP® DEVELOPER: Nonaqueous. Hi-Temp D350 is used with Hi-Temp K0-17 Penetrant and Hi-Temp KO-19 Remover. White adsorbent particles suspended in nonchlorinated, volatile solvent (alcohol). Available only in spray cans. Performs on elevated temperature surfaces; 200°F to 350°F. Approved Group I and III under MIL-I-25135-C.

FOAM REMOVER

KO-19 FOAM REMOVER: Used for removal of both Type I and II penetrants when shallow, wide cracks are suspected. Foam — similar to shaving lather — is emitted from the KO-19 spray can directly on the penetrant treated surface. Foam lifts penetrant from the surface, but not from the cracks. Dry toweling is used to wipe surface clean.

(OVER)

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FOAM REMOVER

KO-19 FOAM REMOVER: Used for removal of both Type I and II penetrants when shallow, wide cracks are suspected. Foam — similar to shaving lather — is emitted from the KO-19 spray can directly on the penetrant treated surface. Foam lifts penetrant from the surface, but not from the cracks. Dry toweling is used to wipe surface clean.

HYDROSTATIC LEAK DETECTION

A-416 FLUORESCENT ADDITIVE: Additive for hydrostatic leak testing; provides fluorescent color to the water. When wet, water fluoresces blue; after drying, water fluoresces yellow. A-416 also lowers surface tension and increases water's penetration capability. (A-416 does not contain corrosion inhibiting agents.) Requires "black light" and semi-darkened conditions.

BY-LUX™ PENETRANT #1: By-Lux™ Penetrant is essentially a colorless liquid that turns bright red in contact with water. In hydrostatic leak testing, By-Lux™ enhances leak visibility. By-Lux™ is applied to the seams of the vessel after it is charged with water. By-Lux™ turns bright red where there are even only traces of water seepage.

HOT TANK CLEANER

LA-1 CLEAR CLEANER®: An aqueous cleaner. Use it to replace solvent-based pre-cleaners in the penetrant process and for general cleaning where solvent cleaners might otherwise be used.

PRECAUTIONARY INFORMATION

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The products listed are for industrial use by qualified personnel only. Like all nondestructive testing methods, the penetrant process has limitations and no penetrant manufacturer claims that the use of these materials will show all dangerous cracks or defects under all conditions.

LIMITED WARRANTY

Buyer agrees that if the product proves to be defective, manufacturer's and seller's only obligation shall be to replace or refund the purchase price of such product.

With the 350°F preheat temperature required for most multi-pass welds, there is a critical need for a process effective at this higher temperature. D-350 Developer fills this need. With D-350 Developer, the **Hi-temp®** System performs at temperatures slightly in excess of 350°F; D-350 adheres to the surface at this higher temperature.

When should D-100 be used and when should D-350 be used?

The recommendation is to use D-100 Developer from normal temperatures to 250°F, and D-350 from 175°F to 350°F.

There is an overlap between the two developers. Which should be used at, say, 200°F?

If D-100 is already being used with Sherwin Incorporated's normal temperature process, continue using D-100. Otherwise, D-350 is preferred.

Can D-350 Developer be used at temperatures lower than 175°F, say as low as 70°F?

D-350 is not recommended for use at temperatures lower than 175°F. At lower temperatures, D-350 dries more slowly. Also, the particles are more adhering at lower temperatures and require greater effort to remove upon completion of the inspection process. Removing D-350 requires wiping with water dampened toweling.

Is the Hi-temp® System effective at normal temperatures?

Yes. **Hi-temp®** K-017Dye penetrant with K-019 Remover and D-100 Developer do an excellent job of finding cracks at normal and even low temperatures. K-017does a better job of showing the shallow flaw than conventional penetrants, but the penetrant is not as fluid at lower temperatures. Thus, penetration time should be longer. Also, in a manual wipe (Group I) method, at lower temperatures, the penetrant removal step is too laborious for routine use.

Can chemical processing plants or refineries gain from using the Hi-temp® System?

Absolutely. Such facilities circulate hot fluids. Leaks occur in equipment which produces revenue of hundreds of dollars per hour, or more. Allowing the equipment to cool to 125°F in order to pinpoint and repair leaks as is required by conventional penetrants may take hours. Finding a leak and verifying the repair without cooling saves valuable production time.

Why is the Hi-temp® penetrant dwell time so short —30 to 60 seconds— when conventional penetrants require 10 minutes?

At elevated temperatures, such as 250°F, molecular movement greatly speeds penetration.

If K-017 Penetrant dwelled on a 250°F surface for 10 minutes, what would happen? Would the penetrant volatilize? Would the color be destroyed?

There was no discernible difference between sections of an aluminum comparative test block maintained at 250°F when K-017 dwelled on one section for a full 11 minutes, and on the other section for only 60 seconds. K-017 on both sections was equally fluid and easily removed. Color depth was identical. Sensitivity was the same. The longer dwell time seems to have little effect, either harmful or beneficial. However, 15 minutes is the suggested maximum penetrant dwell time at higher temperatures.

How are developed flaw indications affected by high temperatures?

At high temperatures, flaw indications develop almost instantly. The initial deep red color of an indication is greatest within a few seconds after developer is applied. After a few minutes, the indication tends toward an orange-red shade. However, even after 30 minutes with surfaces maintained at 250°F, flaw marks are still pronounced and well defined with good color contrast.

Do Hi-temp® materials come in spray cans as well as gallons and pails?

Yes. **Hi-temp®** K-017 Penetrant, K-019 Remover, and both D-100 and D-350 Developers are packaged in gallons, pails, and spray cans.

NONDESTRUCTIVE TESTING

LIQUID PENETRANT INSPECTION RANGE

All ARDROX® products meet AMS 2644 requirements.

PENETRANTS

Type	Classification	Sensitivity	Product	Remover/Emulsifier	Developer
Type 1, Fluorescent	Water Washable	Level 1	**Ardrox 970P22**	- Method A: Water - Method C: Ardrox 9PR50, Ardrox PR1	All developers except Ardrox 9D75
		Level 1+	**Ardrox P131E***		
		Level 2	**Ardrox P133D**		
		Level 2+	**Ardrox 970P24**		
		Level 2+	**Ardrox P134E***		
		Level 3	**Ardrox 970P25E†**		
		Level 3+	**Ardrox P6F4***		
		Level 4	**Ardrox P136E***		
	Post Emulsifiable	Level 2	**Ardrox 985P12**	- Method B: Ardrox 9PR3 - Method C: Ardrox 9PR50, Ardrox PR1 - Method D: Ardrox 9PR12 (10% concentration)	All developers
		Level 3	**Ardrox 985P13**		
		Level 4	**Ardrox 985P14†**		
		Level 3+	**Ardrox P7F3***	- Method C: Ardrox 9PR50, Ardrox PR1 - Method D: Ardrox E1 (10% concentration)	All developers except Ardrox 9D75
Type 2 Visible	Water Washable	NA	**Ardrox P6R†** **Ardrox 906†**	- Method A: Water - Method C: Ardrox 9PR50, Ardrox PR1	Ardrox 9D1B Ardrox NQ1
	Post Emulsifiable	NA	**Ardrox 996†**	- Method C: Ardrox 9PR50, Ardrox PR1	

EMULSIFIERS & REMOVERS

Removal Method	Product
Method B: Post Emusifiable, lipophilic	**Ardrox 9PR3**
Method C: Solvent removable	**Ardrox 9PR50†** **Ardrox PR1†**
Method D: Post Emulsifiable, hydrophilic	**Ardrox 9PR12** **Ardrox E1**

DEVELOPERS

Form	Product
Form a: Dry powder	**Ardrox 9D4A**
Form b: Water soluble	**Ardrox 9D75**
Form c: Water suspendible	**Ardrox 9D76**
Form d: Nonaqueous (solvent based)	**Ardrox 9D1B†**
Form e: Nonaqueous (solvent based)	**Ardrox NQ1†**

*Volatile Organic Compound free (VOC-free) and Ozone Layer Depleting Substance free (OLDS-free) products. †Available in aerosols.

MAGNETIC PARTICLE INSPECTION RANGE

All ARDROX® products meet AMS and Military standards.

Inspection Description	Product	Form	Bath Vehicle / Solvent Carrier
Fluorescent	**Ardrox 8800**	Powder	Ardrox Base Oil HF or Water & Ardrox 8771
	Ardrox 8800A	Aerosol	Ardrox Base Oil HF
	Ardrox 8800B	Premixed Bath	Ardrox Base Oil HF
	Ardrox 8810	Powder	Water
	Ardrox 8810L	Liquid Concentrate	Water
Water Conditioner	**Ardrox 8771**	Liquid	Water
Visible Black	**Ardrox 800/3**	Aerosol	Ardrox Base Oil HF
White Background	**Ardrox 8901W**	Aerosol	NA
Petroleum Bath Vehicle	**Ardrox Base Oil HF**	Liquid	NA

Chemetall Oakite

QS-9000 / ISO 9001

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