

LIQUID PENETRANTS USER'S MANUAL in accordance to specifications: EN 571, ASTM E 1417, AMS 2644, MIL, ASME, DIN, UNI, BS, AFNOR, etc..

The liquid penetrant examination method is an effective means for detecting and locating quickly, economically and accurately, surface flaws such as cracks, porosities and laps.

The dyes in penetrants are either red, visible under white light or fluorescent visible under ultra-violet light.

In order to understand the method correctly three terms which are fundamental have to be defined:

1. Signal: it evidences discontinuities in the materials. Some signals could be irrelevant or false
2. Flaw: a break in the normal physical structure or configuration of a part, like, for instance, a crack, a forging lap, a drawing groove, an inclusion or a porosity. The existence of a discontinuity does not necessarily prevent the use of the part
3. Defect: it is a flaw which is deemed unacceptable according to the specifications followed, because it interferes with the use of the piece

PROCEDURE

In order to make the inspection reliable and of high quality, ensuring homogenous and reproducible results, a personalised procedure has to be drawn up.

To this purpose, please make use of the information hereinafter provided and take into consideration Tab. 1 "Products Classification", Tab. 2 "Procedures" and Tab. 3 "Minimum Dwell Time". For each group of products Technical Cards (available upon request) showing the characteristics of each product as well a "Sample " of the Examination Certificate have been prepared

1. SURFACE PRE-CLEANING AND PREPARATION

A proper cleaning is essential to obtain reliable indications. To detect defects the penetrant has to reach even in a microscopic crack. It's clear that imbedded foreign materials such as oil, dirt, water, paint, oxide and residual matters can seal off voids from the penetrant. The cleaning technique to be used depends on the type of the residue.

1.1 Cold cleaning with fast evaporating solvents

ELITE BC1

Products are flammable so proper fire precautions have to be observed when operating next to flames or other sources of ignition.

The solvent has to be sprayed over the dirty surface to such an extent that the area to be examined is covered completely. 10/30 seconds must elapse before cleaning the area with a cloth prior to complete evaporation of the solvent.

1.2 Hot cleaning with aqueous detergents

ELITE 20 Protective Detergent

This product works on the basis of electronic affinity so it can remove oily residues not only from the surface but also from the inside of the cracks.

It is a neutral product suitable for every type of metals, to be used at a temperature of 50-60 °C .

Rinsing with cold water allowing the self-drying of parts can be avoided because eventual residues of products are compatible with penetrant liquids because it allows the penetration and does not cause false indications.

1.3 Mechanical cleaning

To remove paint, oxidation, deposits or similar foreign matters from the surface the use of the sandblasting, aluminium or stainless steel wire brush or grinding could be needed. This cleaning process tends to mask discontinuities limiting the efficacy of the penetrant.

Sandblasting through special abrasive plastic substances (Plastic Media) is a process now approved in the aeronautical field as well because it does not alter the finish, the surface hardness and it does not seal off possible cracks. NDT Italiana provides different units, permanent as well as mobile, designed in view of users' and abrasive Plastic Media specific needs.

2. PENETRANT APPLICATION

The penetrant has to be applied to the entire surface to be inspected by adopting whatever method assuring a complete coverage of the area under examination such as dipping, spraying or brushing. All surfaces must be completely wet with penetrant in order to have it drained back into discontinuities by capillary effect. Dwell time needed to have an optimal penetration can be determined through Tab. 3 or by adopting applicable specifications.

If penetrant is applied by dipping, the piece has to be removed from the tank and left dripping during penetration time; if necessary because the presence of blind holes or the geometry cause the liquid to be stagnant, the piece must be dipped again in the tank.

Liquids and surfaces temperatures must be in a range between +10°C and + 38°C. The method with penetrants can be adopted even at a temperature out of this range if specific procedures and/or products are used (see our relevant cards).

3. EXCESS PENETRANT REMOVAL

During checking process, a too intense washing of pieces removes the penetrant from the discontinuities; conversely a scarcely accurate washing or a penetrant scarcely washable leaves an excessive residue which could mask indications.

Commonly the suitability of washing is determined by visual inspection during the operation.

When using red penetrant the removal of the visible colorant indicates the completion of the washing phase.

When using fluorescent penetrant, the rinse has to be performed under ultra-violet light, stopping the washing phase as soon as the basic fluorescence has been removed.

Washing waters have to be properly conditioned before being discharged (see relevant cards).

3.1 Water Washable Penetrants

Generally excess penetrant is removed by flushing with low-pressure water (no more than 280 kPa) at a temperature ranging from + 10°C to + 38 °C.

3.2 Solvent Removable Penetrants

Excess solvent removable penetrants shall be removed by wiping the surface under examination with a dry cloth or absorbent paper. Remaining traces shall be removed with another cloth slightly moistened with a quick evaporating solvent remover ELITE BC1.

3.3 Emulsifiers Removable Penetrants

Commonly excess post-emulsifying penetrant is removed by dipping the piece into an emulsifier for a determined period of time and subsequently by spray washing the area under examination or dipping it in a tank of water.

Emulsifiers recommendable to make penetrants water-soluble are classified into two categories:

1. Lipophylic or oily products
2. Hydrophylic or aqueous products

Emulsifying time is critical; normally it ranges from 30 sec to 3 min; not only washing time but also pressure and temperature of the water affect the emulsifying process.

Parameters vary according to the chemical formulation of the emulsifier and in accordance with its emulsifying characteristics.

Before applying the hydrophylic emulsifier, a pre-cleaning by dipping into water or spraying is useful to remove most of the excess penetrant.

Final cleaning, with both emulsifying products, is to be performed by flushing with clean water at a pressure not higher than 280 kPa and at a temperature ranging from + 10°C to + 38°C.

4. DRYING

Surfaces have to be accurately dried before applying the developer. Drying can be accomplished by natural evaporation in free air or accelerated by filtered forced air, with clean and dry cloths or by warm air stream, also inside recirculation type ovens if necessary.

In the latter case air must not exceed 71°C and the temperature of the piece has to reach no more than 38°C.

5. WHITE DEVELOPER APPLICATION

White developer serves the function of bringing out to surface the penetrant entrapped in the cracks after washing and spreading it over the surface to enlarge also indications regarding the smallest discontinuities.

It evidences red indications in contrast with a white background as well as the yellow-green ones under ultra-violet light for fluorescent penetrant.

A too long developing time could broaden too much the indication provided by the penetrant resulting in a lack of definition. Developing time should range from 10 to 30 min. however, for some specific applications, developing time could vary. In this case it must be defined in advance.

Developing time starts:

- After drying if a liquid developer is being used;
- After application if a dry developer is being used.

5.1 Quick evaporating developer

The white powder of the developer is suspended into a quick evaporating solvent. Said solvent serves the function of bringing out the entrapped penetrant from the discontinuity and speeding up drying time so that a further drying is unnecessary. The application of two thin layers of liquid is recommended, allowing drying time between the two applications.

Spray can or gun are the most advisable methods to create this thin layers. To make it work properly the spray can has to be stored at a temperature not lower than + 15°C. At lower temperature the result is a not uniform coating, a lengthened evaporating time, dripping or entrapment risks. Shake properly the Developer before using and, once the process has terminated, turn the spray can up side down and continue spraying till only gas exists.

5.2 Aqueous Wet Developer

Two types of Aqueous Wet Developer are commonly in use: in one of them the powder is suspended in water in the other one it is completely soluble in water. Aqueous Wet Developer can be applied by dipping, brushing or spraying. Heavy quantity of developer must be avoided because it might mask indications. Before use, the Developer has to be shaken vigorously to restore full suspension of the particles.

Commonly Aqueous Wet Developer is applied to the surface when it is still wet after excess penetrant has been rinsed off. When using these types of products dipping instead of spraying is recommendable in order to avoid a not uniform distribution of the Developer due to residual drops of washing water.

With respect to the drying of the Developer hot air is preferable or alternatively the pieces can be put into recirculation type ovens as previously indicated under point 4. "Drying".

5.3 Dry Developer

Dry Developer differentiates from Aqueous Wet Developer because of the softness of the powder and the very low weight in spite of its great volume.

Dry Developer is blown over the surface after penetrant removal and drying. The excess is removed by not compressed air or by shaking the piece.

Dried parts may be also dipped in a tank filled in with powder and the powder may be applied by a soft brush.

By adhering to the surface the small particles of the Developer tend to absorb the penetrant bringing it out from the discontinuity. Following the application

indications appear within few minutes while penetrant is absorbed by the Developer.

6 INSPECTION

When scheduled developing time has terminated, the surface is ready to be inspected and evaluated. The type of light used depends on the type of penetrant used.

- White light: minimum 1000 lux intensity if a method with red penetrants is adopted;
- Ultraviolet light with fluorescent penetrants: minimum light intensity 1000 microWatt/cm² on the surface of the part being examined, with white-ambient light not exceeding 20 lux.

Should a new inspection of pieces already treated with penetrant liquids be required, the Developer has to be removed first and oil must be wiped off from the piece. The process shouldn't be repeated more than two times. Applying fluorescent penetrant over pieces already treated with the red ones is prohibited.

TABLE 1

PRODUCT CLASSIFICATION					
Penetrant Liquid		Penetrant Removal		Developer	
Type	Description	Method	Description	Form	Description
1/I	Fluorescent Penetrant Liquid	A	Water	a	Dry type
		B	Lipophylic Emulsifier	b	Water Soluble
2/II	Red Penetrant Liquid	C	Solvent	c	Water Suspension
		D	Hydrophylic Emulsifier	d/e	Quickly evaporating solvent base

TABLE 2

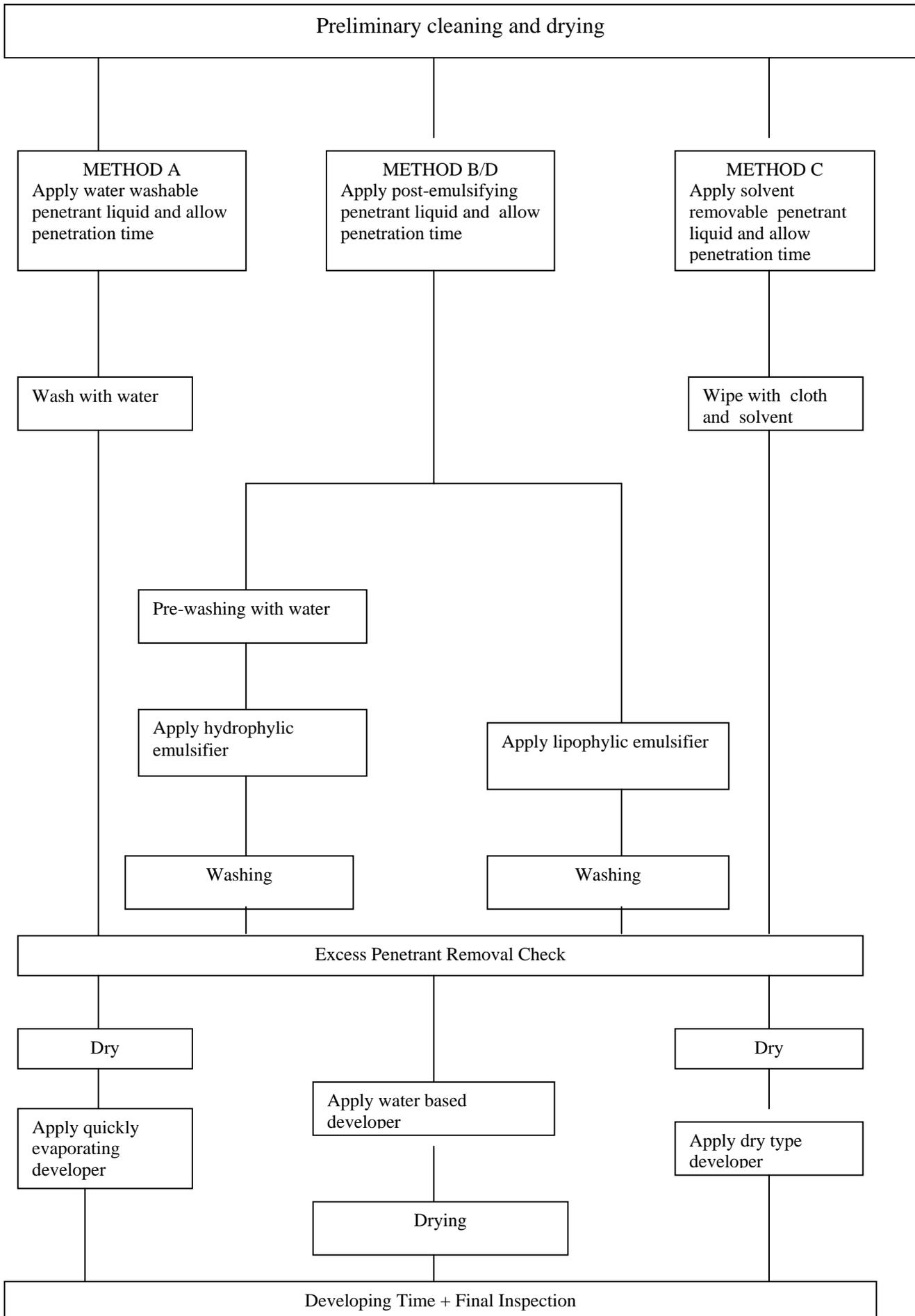


TABLE 3

Recommended Penetration Times		
Material	Form	Penetration Time
Aluminium and Magnesium	Casting	From 5 up to 15 min.
	Others	From 5 up to 15 min.
Carbon Steel	Casting	From 5 up to 15 min.
	Others	From 10 up to 20 min.
Brass and bronze	All	From 5 up to 15 min.
Titanium, Stainless Steel, Austenitic alloys, Low alloy Steel	All	From 10 up to 30 min.

1 SURFACE PRE-CLEANING AND PREPARATION	1.1  Fast evaporating solvent ELITE BC1	1.2  Hot cleaning detergent ELITE 20	1.3  Plastic Media sand blasting
2 PENETRANT APPLICATION	 Spray	 Brush	 By dipping
3 EXCESS PENETRANT REMOVAL	3.1  With water (+ U.V. light for fluorescent)	3.2  Manually with fast evaporating solvent BC1	3.3  By dipping in emulsifier
4 DRYING	 Natural evaporation or compressed air	 With cloths	 With hot air
5 WHITE DEVELOPER APPLICATION	5.1  Spray	5.2  By dipping	5.3  Dry (for fluorescent)
6 INSPECTION	 White light	 U.V. Light (for fluorescent)	OBSERVABLE DEFECTS 

