
**Non-destructive testing — Penetrant
testing —**

**Part 6:
Penetrant testing at temperatures lower
than 10 °C**

Essais non destructifs — Examen par ressusage —

Partie 6: Examen par ressusage à des températures inférieures à 10 °C



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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 3452-6 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 138, *Non-destructive testing*, in collaboration with ISO Technical Committee TC 135, *Non-destructive testing*, Subcommittee SC 2, *Surface methods*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

ISO 3452 consists of the following parts, under the general title *Non-destructive testing — Penetrant testing*:

- *Part 1: General principles*
- *Part 2: Testing of penetrant materials*
- *Part 3: Reference test blocks*
- *Part 4: Equipment*
- *Part 5: Penetrant testing at temperatures higher than 50 °C*
- *Part 6: Penetrant testing at temperatures lower than 10 °C*

Introduction

Temperatures lower than 10 °C can affect the properties of penetrant test materials. The use of penetrant materials and the testing of penetrant materials within the temperature range 10 °C to 50 °C are the subject of EN 571-1 and ISO 3452-2. This part of ISO 3452 addresses materials and their use at lower temperatures than 10 °C.

This part of ISO 3452 introduces the concept of process times being linked to working temperatures and accordingly users are recommended to ensure that testing products are correctly associated with process parameters in written instructions (procedures).

Testing products may be specifically developed and qualified for low temperature use but testing products qualified for use at normal temperatures, in some cases, may also be suitable for lower temperature use.



Non-destructive testing — Penetrant testing —

Part 6: Penetrant testing at temperatures lower than 10 °C

1 Scope

This part of ISO 3452 specifies the testing requirements particular to applications at low temperatures (lower than + 10 °C) as well as the method for qualification of suitable testing products. It applies only to materials qualified for the relevant temperature range used in accordance with the manufacturer's instructions.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3059, *Non-destructive testing — Penetrant testing and magnetic particle testing — Viewing conditions*

ISO 3452-1, *Non-destructive testing — Penetrant testing — Part 1: General principles*

ISO 3452-2, *Non-destructive testing — Penetrant testing — Part 2: Testing of penetrant materials*

ISO 3452-3, *Non-destructive testing — Penetrant testing — Part 3: Reference test blocks*

3 Low temperature penetrant testing

3.1 General principles

The general principles of ISO 3452-1 shall apply unless otherwise stated in this part of ISO 3452 or in the manufacturer's instructions.

Qualification tests are carried out by the manufacturer and if products are used within the stated range, no further tests are needed on site.

3.2 Technical principles

Depending on the temperature range, some specific problems might be encountered:

- a) moisture, or even ice, on the test object;
- b) lower evaporation rate of solvents and of non-aqueous wet developers than at higher temperatures;
- c) when spray cans are used, pressure and spray quality may be affected;
- d) some penetrants may precipitate — in such a case tests shall be carried out within the standard temperature range (10 °C to 50 °C) if the penetrants are to be used in this standard temperature range.

3.3 Safety precautions

All relevant European, national and local regulations pertaining to health and safety, environmental requirements etc. shall be observed.

Depending on the temperature range, some specific rules shall be enforced:

- a) when heaters are used (either to warm up the test object, materials or the work environment), precautions shall be taken not to have vapours or spray of materials in contact with flames or hot surfaces;
- b) users shall wear clothes and gloves able to protect them from contact with very low temperature parts. Gloves used shall allow for applying materials without impairing the test;
- c) in very low temperature environment, some pieces of equipment (pens, cameras, etc.) may not properly work. Action shall be taken, either to keep them at an acceptable temperature until use (for instance by keeping them under clothing, close to the user's body) or by using equipment capable of functioning in such an environment.

3.4 Reference blocks/test panels

Care shall be taken while using reference block/test panels. It could be tempting to put these panels in a freezer, and to take them out when they have reached the targeted temperature for materials testing. Doing so places cold parts in contact with a warmer atmosphere, causing moisture to condense on these parts and the temperature to rise very quickly.

Therefore, tests shall be carried out in "real conditions": parts, users and testing materials are either outside or in a "climatic room" in which the temperature and humidity is capable of duplicating real conditions.

3.5 Viscosity and penetrant testing

If it is the case that the lower the temperature, the higher the liquid or gas viscosity, then note that higher viscosity is not a drawback to penetrant testing.

Capillary effect is far more powerful than the effect of the viscosity – very viscous, even jellified penetrants, can lead to very good crack detection.

3.6 Personnel qualification

Personnel carrying out testing in accordance with this part of ISO 3452 shall be suitably certified (see e.g. ISO 9712, EN 473). They shall also be knowledgeable of the special considerations for testing at lower temperatures (e.g. time limitations for inspection, special considerations of materials).

4 Low temperature penetrant testing process

4.1 General rules

The following rules apply:

- a) surface and discontinuities shall be free of any contaminant, even those stemming from the surface preparation;
- b) penetrant is applied on the part as per the most convenient means;
- c) when dwell time has elapsed, excess of penetrant will be wiped from the surface with clean, lint-free rags or cloths and a penetrant remover according to the manufacturer's recommendation (water should be avoided due to low temperatures);

- d) low temperature penetrant testing generally is not carried out in installations. A non-aqueous wet (solvent-based) developer will then be sprayed on the test object. In low temperature conditions, solvents evaporate far slower than usual. Therefore, care shall be taken that the solvent evaporation time be short enough so as to get accurate indications;
- e) viewing conditions shall comply with the requirements of ISO 3059.

4.2 Special requirements

4.2.1 Surface preparation

Within the +10 °C to –5 °C range, the main trouble comes from water, either as liquid (moisture), frost or even ice.

Water is detrimental to the process. To get rid of it:

- a) gently warm the surface for several minutes to make water evaporate from discontinuities;
and/or
- b) use a volatile, water soluble solvent, such as acetone or isopropyl alcohol (generally degreasers used before penetrant applications are hydrocarbon-based and do not in any way remove water);
- c) allow some minutes for evaporation, ensuring evaporation does not cool down the surface of the part enough to have water condensing on it again.

When the temperature is lower than –5 °C, check that there is no frost or ice. Any frost or ice shall be removed.

4.2.2 Penetrant application/dwell time

Penetrant may be sprayed from a spray can, provided pressure is sufficient. Any other convenient means of application may be used.

It is recommended to let the penetrant act twice as long as for 10 °C to 50 °C range, as water is generally not completely removed from the discontinuities and can make it more difficult for the penetrant to enter.

4.2.3 Excess penetrant removal

Even if a water washable penetrant has been applied, the use of lint free cloth or wipes and a volatile penetrant remover according to the manufacturer's recommendation is a better choice than water.

First wipe as much penetrant as possible with clean lint free cloth or wipes.

Then use lint free cloth or wipes lightly moistened with the solvent to remove the remaining penetrant.

As a final step, use dry lint free cloth or wipes to take out the traces of penetrant/solvent.

Allow some minutes for solvent evaporation.

4.2.4 Developer application

Non-aqueous wet (solvent-based) developer is most suitable.

As it shall be sprayed, the most convenient means is a spray can.

The spray can shall be kept at 10 °C minimum to ensure an effective spray giving a thin, even layer.

The solvent shall evaporate within maximum 3 min. Otherwise, indications could become dim, leading to difficulty in interpretation.

Solvent evaporation may be sped up by a gentle flow of warm air (not by an infrared heater) to meet this requirement.

Developing time should be increased by a factor of two, depending on previous tests.

4.2.5 Viewing

The viewing conditions shall comply with the requirements of ISO 3059.

5 Testing of low temperature penetrant testing materials

5.1 Preliminary notice

Many penetrants and developers used at 10°C to 50°C temperature range may be used at low temperatures.

Degreasers/removers shall be specified since the degreaser shall be water soluble and quick to evaporate, and the remover also quick to evaporate.

It is the manufacturer's responsibility to state the minimum temperature acceptable for their products.

At the minimum stated temperature, penetrants shall not separate.

5.2 Test panels (reference test blocks)

Panels as described in ISO 3452-3 are used.

5.3 Test temperature

Test shall be carried out at the lowest temperature claimed as acceptable by the manufacturer.

5.4 Test process

5.4.1 Reference test block cleaning

Before use the reference blocks shall be cleaned using suitable means, and tested for absence of indications with a suitable non-aqueous wet developer. Absence of indications confirms that the panel is suitable for use. The developer shall be removed and the panel shall not be touched by bare hands throughout the process (to avoid contamination). Clean, white cotton, or other materials meant for temperature-rating gloves, may be used to assist with handling.

5.4.2 Panels temperature setting

Panels shall remain at least 10 min at the test temperature.

A "climatic room" shall be used. Personnel may enter the room just before applying the penetrant, then leave, then re-enter to wipe the excess penetrant, allow for solvent evaporation and apply the developer.

During development time, it is recommended to check every 10 min how the indications appear.

5.4.3 Viewing conditions

Viewing conditions shall comply with the requirements of ISO 3059.

6 Results

Sensitivity levels are as defined in ISO 3452-2.

Bibliography

- [1] ISO 9001, *Quality management systems — Requirements*
- [2] ISO 9712, *Non-destructive testing — Qualification and certification of personnel*
- [3] ISO 12706, *Non-destructive testing — Terminology — Terms used in penetrant testing*
- [4] ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*
- [5] EN 473, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*

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