Liquid penetrant and magnetic inspection at very low or very high temperatures: safety and productivity innovations

Norwegian NDT Society Annual Conference
Stavanger, Norway, October 5th 2021
1. ISO 3452-5: Penetrant testing at temperatures higher than 50 °C

2. ISO 3452-6: Penetrant testing at temperatures lower than 10 °C

3. ASTM and ASME Standards “at non standards temperatures”

4. Magnetic particles and ultrasonic testing at very high or very low low temperatures

5. Case studies and Conclusions
About us
Quality Pioneers: 70 years of experience in NDT

➢ NDT ITALIANA works since 1952 in the field of NON-DESTRUCTIVE TESTING. The headquarters are in Italy near Milan. A large area is devoted to production and goods stocking, to guarantee quick supply to customers worldwide.

➢ NDT Italiana is certified UNI EN ISO 9001 and approved NATO AQAP-120, and is equipped with internal Chemical and Electronic Laboratories, Technical Service, Specialised Consulting at the service of our customers.

NDT founder, Mrs. Angela in 1952

NDT factory in Italy, near Milan
About us
Selling in over 100 Countries

- NDT ITALIANA with its products and instruments meets the requirements of many key industrial sectors with turn-key solutions

- NDT Italiana’s Products are sold in:
  Albania, Algeria, Angola, Argentina, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Belgium, Bolivia, Bosnia Herzegovina, Brazil, Bulgaria, Canada, Chile, China, Colombia, Congo, Croatia, Cuba, Cyprus, Czech Republic, Denmark, Ecuador, Egypt, Equatorial Guinea, Estonia, Ethiopia, Finland, France, Germany, Great Britain, Greece, Holland, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Ivory Coast, Japan, Jordan, Kazakhstan, Kenya, Kosovo, Kuwait, Latvia, Lebanon, Libya, Lithuania, Luxembourg, Malaysia, Mali, Malta, Morocco, Mexico, Nepal, New Zealand, Nigeria, North Korea, Norway, Oman, Pakistan, Panama, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Saudi Arabia, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sudan, Sweden, Switzerland, Syria, Taiwan, Thailand, Trinidad, Tunisia, Turkey, Ukraine, United Arab Emirates, United States, Venezuela, Vietnam, Zimbabwe.
NDT ITALIANA’s products are approved by international third parties

NDT ITALIANA’S products are supplied with certificates of conformity to EN-ISO, ASTM, ASME…

Inspection Certificate

Order No.: 20161483-2
Applicant: NDT

Date of Application: 27.09.2016

Test Object: Elite K71B2p
Batch: 160531P

Summary:
In view of the investigation results, the tested requirements according to the DIN EN ISO Standard 3452, Part 2, Issue March 2014, have been met by the penetrant testing material.

The test object: Elite K71B2p
Batch: 160531P

can be identified as “low in sulphur and halogens” according to the DIN EN ISO Standard 3452, Part 2.

The following sensitivity levels were determined:
- Penetrant System IIAs
  sensitivity level: 2
- Penetrant System II Ce
  sensitivity level: 2 within the product family
Safer Products – the BIO line
The new international safety markings GHS CLP

Regulation n. 1272/2008 CLP (Classification, Labelling and Packaging) and GHS (Globally Harmonized System of Classification, Labelling and Packaging) guarantee a better comparison between chemicals producers worldwide.

<table>
<thead>
<tr>
<th>Elite Bio NDT Products</th>
<th>Standard NDT Competitor Products</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="GHS02" /></td>
<td><img src="image" alt="Flammable" /></td>
</tr>
<tr>
<td>GHS02</td>
<td>Flammable</td>
</tr>
<tr>
<td><img src="image" alt="GHS07" /></td>
<td><img src="image" alt="Xi Irritant" /> <img src="image" alt="Xn Harmful" /></td>
</tr>
<tr>
<td>GHS07</td>
<td>Xi Irritant Xn Harmful</td>
</tr>
<tr>
<td><img src="image" alt="Environmental Hazard" /></td>
<td>Environmental Hazard</td>
</tr>
</tbody>
</table>

Penetrant and Magnetic Bio products are not flammable, not harmful, not even irritant for the eyes or the skin, not polluting for the environment.
Customers references
Proud suppliers of all leading companies worldwide
Penetrant testing at temperatures higher than 50 °C

Standard temperature conditions:

- Between 10°C to 50°C (EN ISO)

UNI EN ISO 3452-5:

PROCEDURE FOR QUALIFICATION

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

Testing products shall be at room temperature prior to application, unless otherwise stated by the manufacturer. During the procedure detailed below the test block temperature shall not fall by more than 10 °C.
Red Penetrant Elite K71B2p, White Developer D112A and Bio Remover/Cleaner BC1 are qualified up to +100°C (tested according to ISO 3452-5)
Standard temperature conditions (according to ASME/ASTM):

- Between 40°F and 125°F (5°C to 52°C)

ASME Art. 6 Appendix III:

the test results obtained in accordance with II-640. These records shall be maintained as required by the referencing Code Section.

APPENDIX III — QUALIFICATION TECHNIQUES FOR EXAMINATIONS AT NONSTANDARD TEMPERATURES

III-610  SCOPE

When a liquid penetrant examination cannot be conducted within the standard temperature range of 40°F to 125°F (5°C to 52°C), the temperature of the examination shall be qualified in accordance with this Appendix.

III-630  MATERIALS

A liquid penetrant comparator block shall be made as follows. The liquid penetrant comparator blocks shall be made of aluminum, ASTM B 209, Type 2024, 3/8 in.
EN ISO Standard 3452-5

Penetrant testing at temperatures up to 200 °C

Red Liquid Penetrant Elite K71HT is qualified “ IIACcde - 2/10° C- 200° C ”

**Temperature 10°C**

![Temperature 10°C Image]

**Temperature 200°C**

![Temperature 200°C Image]

Red Penetrant Elite K71HT, White Developer D200 and Remover/Cleaner RHT are qualified 10° to +200°C
Penetrant testing at temperatures lower than 10 °C

Standard temperature conditions:

- Between 10°C e 50°C (EN ISO)

UNI EN ISO 3452-6:

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.
Red Penetrant Elite K71B2p is qualified “ IIACcde - 2/-10°C + 100°C ”

Temperature -10°C

Standard Temperature (>10°C)

Red Penetrant Elite K71B2p, White Developer D112A and Bio Remover/Cleaner BC1 are qualified -10°C to +100°C
Red Penetrant Elite K71B2p, White Developer D112A and Bio Remover/Cleaner BC1 are qualified from -10 °C to +100°C (tested according to ISO 3452-5 and ISO 3452-6).

Liquid penetrants qualified for an extended temperature range:

-10°C  50 micron

+ 100°C  50 micron

-10°C  30 micron

+ 100°C  30 micron

Qualification Tests (Ref. Block Tipo 1 ISO 3452-3)
Developers must be qualified together with their companion penetrant to be able to use them at high or low temperatures. Example:

- **From -10°C to 100°C:**
  - Developer for d,e D112A can be used (solvent based wet non-acqueous)

- **Da 100°C a 200°C:**
  - Some developers are qualified especially for very high temperatures (example Elite D200) or some developers form c can be used (water based)

**6.15 Developer performance**

When applied according to the manufacturer’s recommendations, the developer shall give a fine, even, non-reflective and non-fluorescent coating. When used in conjunction with the appropriate penetrant, the developer shall increase the visibility of the penetrant indications.
Red Liquid Penetrant indications on test block
Stable and reliable indications’ sizing over time at any temperature

Penetrant «A»
Left: 10 s after application
Right: 3 min after application

Competitor equivalent «B»
Left: 10 s after application
Right: 3 min after application

Too much bleed out = generation of false cracks + missing small ones
Temperature strongly affects liquid penetrants and magnetic particles NDT.

New formulations allow for a safer testing also under extreme conditions and a higher stability of results in a large temperature range (very high and very low temperatures).

Colours available: RED, YELLOW, GRAY, BLUE, BLACK

Cracks on pipe shown at +120°C (+248°F) with dual-response fluorescent magnetic powder Elite FW1AC concentrate for water dilution.
EN ISO 9934-2 temperature resistance test

Sharp Black indications and White Contrast easy to remove

Product A at high and low temperatures

Equivalent Magnetic Product «B» at high and low temperatures
ASTM E-1135 requires the check of fluorescence for all fluorescent penetrants users and manufacturers.

EN ISO 3452 requires to test the thermal stability of fluorescent brightness: one penetrant must maintain its visibility characteristics even if it is exposed to extreme temperature situation or UV irradiance.
Temperature strongly affects liquid penetrants, magnetic particles and ultrasonic testing.

New formulations allow for a safer testing also under extreme conditions and a higher stability of results in a large temperature range (very high and very low temperatures).

Cracks on pipe shown at +120°C (+248°F) with dual-response fluorescent magnetic powder Elite FW1AC concentrate for water dilution.
Company Case Studies  
Liquid Penetrants: high temperatures procedure  
UNI EN ISO 3452-5

1. Apply red penetrant K71HT on hot welding
   ▪ Tested up to 220°C
   ▪ The only high temperature penetrant available also in spray
   ▪ Very short penetration time
   ▪ Remove excess penetrant according to manufacturer’s recommendations (Elite RHT1)

2. Apply white developer Elite D200
   ▪ Tested up to 220°C
   ▪ The only high temperature developer available in spray
   ▪ Developing times are greatly reduced at high temperatures

3. Inspection
   ▪ Inspect under light conditions according to ISO 3059
   ▪ Indications will appear almost immediately
Eni: case study of application of Elite K71B2p at high temperatures offshore
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Offshore Application - AST (2G Position)
Eni: case study of application of Elite K71B2p at high temperatures offshore

Offshore Application - Firing Line (5G Position)
Conclusions: Eni case study of application of Elite K71B2p at high temperatures offshore

### Cycle Time Comparison

**Hot Temperature vs Standard Temperature**

<table>
<thead>
<tr>
<th>ATTIVITÀ</th>
<th>K71B2p + D112A + BC1</th>
<th>K71HT + D200 + RHT1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Inspection Cleaning</td>
<td>15&quot;</td>
<td>15&quot;</td>
</tr>
<tr>
<td>Warming up to 90°C÷110°C</td>
<td>120&quot;</td>
<td>NA</td>
</tr>
<tr>
<td>Penetrant application</td>
<td>20&quot;</td>
<td>20&quot;</td>
</tr>
<tr>
<td>Dwell Time</td>
<td>30&quot;</td>
<td>420&quot;</td>
</tr>
<tr>
<td>Cleaning</td>
<td>20&quot;</td>
<td>20&quot;</td>
</tr>
<tr>
<td>Developing</td>
<td>30&quot;</td>
<td>300&quot;</td>
</tr>
<tr>
<td>Inspection</td>
<td>20&quot;</td>
<td>20&quot;</td>
</tr>
<tr>
<td>Post-Inspection Cleaning</td>
<td>15&quot;</td>
<td>15&quot;</td>
</tr>
<tr>
<td>Cooling</td>
<td>60&quot;</td>
<td>NA</td>
</tr>
<tr>
<td>Total Cycle Time</td>
<td>330&quot; = 5' 30&quot;</td>
<td>810&quot; = 13' 30&quot;</td>
</tr>
<tr>
<td>Δ (Cycle Time)</td>
<td>480&quot; = 8'</td>
<td></td>
</tr>
</tbody>
</table>
**Company Case Study – Ultrasonic Inspection**

**Ultrasonic testing at high or low temperatures**

### Couplant specific for Ultrasonic Testing

- Safe for operator and environment
- Fast to apply and remove
- Anti-rust protection
- Higher quality of the signal (lower background noise): up to +30%

### Couplant not specific for Ultrasonic Testing (example: glue, grease, oil…)

- No Safety Data Sheet or Certificate of Analysis
- Difficult to prepare (see above) and remove
- Probe and piece not protected
- Lower quality of the signal force the operator to increase the gain with higher background noise
Ultrasonic testing at high or low temperatures

Company Case Study – Ultrasonic Inspection

➢ UT couplants line up to 520 °C

➢ Matrix couplants allows to gain as much as 5 dB compared to water or glue on circular surfaces (pipes) with flat wedges and irregular surface

➢ Matrix performs a lot better on high frequencies (10 MHz)

➢ Matrix remains a soft gel usable for a very long time (weeks) without the need to re-apply
Ultrasonic testing at high or low temperatures

Real temperature ranges and operative performances

**Specific UT High Temp Couplant** (e.g. Elite MHT, UHT, C200)
- ✓ Optimal signal intensity
- ✓ No harmful smoke
- ✓ Easy post examination cleaning of probe and piece
- ✓ Certificated from -50°C up to +520°C

**Un-specific UT UT High Temp Couplant** (e.g. grease, oils)
- × Significantly lower signal intensity
- × High smoking potentially harmful
- × «Frying» and dripping leaving residues on probe and piece very hard to clean
- × No tested temperature range
Michele Cevenini

Linkedin Page «NDT Italiana»
Facebook Page «NDT Italiana»

NDT ITALIANA Proudly Supports Beat Leukemia Foundation
www.beat-leukemia.org
"The difference between difficult and impossible is that impossible takes longer. Miracles just require faith"