1 Scope

This document should be used as an additional information with the description of the quality assurance procedures in production. It describes the non-destructive tests during the production and quality control of thermometers and thermowells.

2 Possible nondestructive testing of thermowells

Following nondestructive tests can be performed at thermowells. This is a list of possible tests.

<table>
<thead>
<tr>
<th>Test Procedure</th>
<th>Description</th>
<th>Standards</th>
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</thead>
</table>
| Hydrostatic Test | Pressure and strength test of components | Based on ASME B31.3  
External pressure test (thermowells with flanges):  
Max test pressure 1,5 x nominal pressure  
Thermowells with length up to 900mm and a diameter up to 34mm → max. test pressure 690bar  
Thermowells longer than 900mm and a diameter up to 53mm → max. test pressure 400bar  
Internal pressure test (thermowells):  
Test pressure max. 500bar  
Test duration 3 min. (or according to customer specifications)  
Execution:  
Following internal work instruction (test procedure), by trained worker. |
| Helium Leak Test | Sensitive test procedure for detecting very small leakage rates using Helium tracer gas.  
Integral test can determine discrete leakage rates, while local testing allows to localize a leak. | DIN EN 1779 - Non-destructive testing - Leak testing - Criteria for the method and technique selection  
Vacuum process:  
- A1 (integral)  
- A2 (partiell)  
- A3 (lokal)  
EN 13185 - Non-destructive testing - Leak testing - Tracer gas method  
Execution:  
Following internal work instruction (test procedure), created by level 3 personal, by trained worker. |
<table>
<thead>
<tr>
<th>Test Procedure</th>
<th>Description</th>
<th>Realisation:</th>
<th>Evaluation:</th>
<th>Execution:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dye/Liquid Penetration Inspection</td>
<td>Detection of fine surface cracks and pores at welding-seams.</td>
<td>DIN EN 3452</td>
<td>DIN EN ISO 23277 - Non-destructive testing of welds - Penetrant testing - Acceptance levels</td>
<td>Following internal work instruction (test procedure), created by level 3 personal, by certified inspectors Level 1 and 2.</td>
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<tr>
<td>Ultrasonic testing</td>
<td>Ultrasonic testing full penetration weld</td>
<td>ASME Code VIII Div. 1 Appendix 12 and ASME Code Section V, Art. 4</td>
<td></td>
<td>Following internal work instruction (test procedure), created by level 3 personal, by certified inspectors Level 1 to 3</td>
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<td></td>
<td>Internal and external weld seam faults</td>
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<td>Ultrasonic Measurement of Drilling Movement</td>
<td></td>
<td></td>
<td>based on ASME B40.9</td>
<td>Following internal work instruction (test procedure), by trained worker.</td>
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<tr>
<td>X-Ray Examination</td>
<td>Investigation for inhomogeneous defects within materials (cracks, shrink holes, cavities, ...)</td>
<td>Full / Partial Penetration Welding according to EN</td>
<td>DIN EN ISO 5817 : Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections</td>
<td>Following internal work instruction (test procedure), created by level 3 personal, by certified inspectors Level 1 to 3.</td>
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<td>Full / Partial Penetration Welding according to ASME</td>
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<td></td>
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<td>Realisation: ASME Section V, Article 2</td>
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<td>Evaluation: ASME Code Section VIII Division 1, Paragraph UW 52</td>
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<tr>
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<td>Execution:</td>
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</tbody>
</table>
| PMI Test (Positive Material Identification) | Test for mixed-up materials according to one of the following methods:  
| a) OES (Optical Emission Spectrometer)  
| b) RFA (X-Ray Fluorescence Analysis) | OES: At the OES the material is stimulated to the emission of characteristic radiation due to glow discharge or inductively coupled plasma.  
**Identifiable elements OES:**  
- steel: C, Si, Mn, P, S, Cr, Ni, Mo, Ti, Nb, Cb, Cu, Fe, Al, W  
- copper alloys: Cu, Sn, Zn, Pb, Be, Fe, Ni, Co, Mn, Zr, Al, Si, P, S  
RFA: At RFA the electrons are released out of the inner orbital by bombarding with high-energy X-rays.  
When the electrons fall back the emission of material characteristic x-rays (fluorescent) is induced.  
DIN 51001 Testing of oxidic raw materials and basic materials  
**Identifiable elements RFA:**  
- steel: Mn, Cr, Ni, Mo, Ti, Nb, Cb, Cu, Fe, W  
- copper alloys: Cu, Sn, Zn, Pb, Fe, Ni, Co, Mn, Zr  
Execution:  
Following internal work instruction (test procedure), by trained worker. |