Rules for Classification and Construction

VI Additional Rules and Guidelines

7 Guidelines for the Performance of Type Approvals

8 Test Requirements for Components and Systems of Mechanical Engineering and Offshore Technology
The following Guidelines come into force on 1 August 2013.

Alterations to the preceding Edition are marked by beams at the text margin.

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Section 1 General Requirements

A General

A.1 Scope

A.1.1 This Guideline defines how type approval tests for components and systems of mechanical engineering and offshore technology have to be technically performed.

A.1.2 The structure of the administrative and commercial procedure for the performance of the type approval tests is defined in GL Guidelines for Procedure (VI-7-1).

A.1.3 Which components and systems have to be type approved in the frame work of a Classification procedure for ship technology or offshore technology will be defined in the relevant Rules for Classification and Construction of GL.

On request of a client, a type approval test for components and systems for which a test is not obligatory may also be performed.

A.2 Definitions

This Guideline refers exclusively to type approval tests according to A.2.1. To define a clear delimitation to other tests, also the other tests used by GL are summarized in the following.

A.2.1 Type approval tests of components and systems

Type approval tests are performed according to the test regulations of GL.

Type approval Certificates can only be issued, if the following requirements are fulfilled:

- Examination of the drawings including material lists and the documentation for conformity with the actually valid Rules for Classification and Construction of GL and other national and international rules and standards, etc. defined in the product specification.
- Performance of the tests defined in this Guideline as well as other agreed testing procedures with the prescribed test specimens.
- Check of the quality management system by a product audit at the manufacturer. The manufacturer approval to be issued if the check is successful gets the same duration of validity as the type approval Certificate.

The duration of validity of the type approval Certificate is 5 years.

A.2.2 Approval of components and systems

Approval Certificates for components and systems can only be issued, if the following requirements are fulfilled:

- Examination of the drawings including material lists and the documentation for conformity with the actually valid Rules for Classification and Construction of GL, as far as applicable, and/or other national and international rules and standards, etc. defined in the product specification.
- Performance of the tests according to other recognized guidelines and standards, as far these can be approved by GL.
- Check of the quality management system by a product audit at the manufacturer. The manufacturer approval to be issued if the check is successful gets the same duration of validity as the approval Certificate for the product.
The duration of validity of the approval Certificate is 5 years.

### A.2.3 Design and document examination of components and systems

A Certificate for the examination of the documentation can be issued, if the following will be fulfilled:

- Examination of the drawings including material lists and the documentation for conformity with the actually valid Rules for Classification and Construction of GL, as far as applicable, and/or other national and international rules and standards, etc. defined in the product specification.

The duration of validity of this Certificate is 5 years.

### A.3 Other valid rules and guidelines

#### A.3.1 GL Rules and Guidelines

The following GL Rules are to be considered with priority:

- GL Guidelines for Procedure (VI-7-1)
- GL Rules for Machinery Installations (I-1-2)
- GL Rules for Electrical Installations (I-1-3)
- GL Rules for Automation (I-1-4)
- GL Rules for Inland Navigation Vessels (I-2)
- GL Rules for Materials and Welding (II)
- GL Rules for Offshore Technology (IV-6)
- GL Guidelines Test Requirements for Electrical / Electronic Equipment and Systems (VI-7-2)

#### A.3.2 Standards and other regulations

Standards, as e.g. ISO (International Standardization Organisation), API (American Petroleum Institute), DIN EN (Deutsche Industrie Norm / European Standard) and regulations, as e.g. IMO (international Maritime Organisation), IACS (International Association of Classification Societies), etc. may be applied. Further on regulations and standards according to the choice of the manufacturer may be included in the approval procedure, if considered suitable by GL.

### A.4 Documents to be submitted

The documents to be submitted are defined in general form in the GL Guidelines for Procedure (VI-7-1), Section 3, A. Further specific information for the different components and systems are included at the relevant position of the Rules for Classification and Construction.

### B Materials

#### B.1 Qualification of materials

The materials shall be suitable for the intended service and shall be in accordance with the Material Rules of GL according to A.3.1.

Materials according to other recognized regulations and standards may be approved by GL.

#### B.2 Components for pipe classes I and II

Components for the application in pipe classes I and II have to meet the following assumptions:

- material manufacturers have to be approved by GL
- welding may only be executed by companies approved by GL
- Material Certificates according to the GL Rules Principles and Test Procedures (II-1-1), Section 1, H have to be existing
- approvals of IACS Classification Societies or equivalent organisations may be recognized in singular cases after verification of the test results.
C Requirements to be met by the Manufacturer

C.1 The obligations of the client according to GL Guidelines for Procedure (VI-7-1), Section 2, B and C have to be guaranteed.

C.2 GL reserve the right to perform a product audit according to Annex A.

C.3 Existing certifications of the quality management system according to ISO 9001 or equivalent may be recognized. GL reserve the right to inspect the manufacturing works.

C.4 Manufacturing works which have not introduced a certified quality management system have to submit for examination the procedure and working instructions for the manufacturing of the product. The practical application of the approved documentation is to be verified by an inspection tour.

D Performance of Type Approval Tests

D.1 Procedure
The general requirements of the test procedure are defined in GL Guidelines for Procedure (VI-7-1).

D.2 Tests
The tests defined in Sections 3 and 4 for the different components and systems have to be performed. The technical requirements for the standard tests are defined in Section 2. If additional tests become necessary the technical requirements for these are defined in Sections 3 and 4 at the end of the description of the components and systems.

The practical execution of the tests may be performed by the manufacturer itself or by a recognized test institute.

GL decides in which extent the presence of a GL representative is necessary during performance of the tests.

In general GL will perform a product audit according to C at the location of manufacturing.

D.3 Recognition of already executed tests
Test protocols issued by recognized test institutes for tests already performed may be considered as far as GL ascertains equivalence to this Guideline.

D.4 Additional tests
GL reserve the right for special components and systems to demand for tests in addition to these defined in Sections 2 to 4.

D.5 Number of the test specimens
The number of test specimens will be defined for the different components and systems in the Section 3 and 4.
Section 2  Definition of Standard Tests

A  General
The individual tests defined in the following are generally valid. Which of these tests have to be performed for a certain component respectively a certain system, will be defined in the test requirements of the Sections 3 and 4.

For the definition of the test requirements the operational and ambient conditions for the planned range of application are to be considered.

B  Definition of the Individual Tests
In the following standard tests are defined:

1. Visual inspection
2. Function test
3. Vibration test
4. Low temperature test
5. Dry heat test
6. Damp heat test
7. Salt mist test
8. Fire resistance test
9. Pressure and tightness tests
10. Burst pressure test

B.1 Visual inspection
The test specimen will be inspected on conformity with:
- the Rules and Guidelines of GL
- the manufacturer's specification
- the drawings including material specifications
- the specified standards

B.2 Function test
The function test is to furnish prove of the specified properties of the components resp. systems, such as characteristic curve, temperature range, allowable working pressure, etc.

B.2.1 Test procedure
The test specimens are to be presented operationally connected and in functional condition.

All operating conditions including power supply are to be demonstrated and varied within the intended range of application and to be controlled during the tests by appropriate measuring equipment. Following tests are to be carried out among others:
- function test under maximum allowable working pressure in normal mounting position
- function test after restoring the power supply after preceding break-down
- function test under ± 20 % fluctuation of the maximum allowable working pressure

Function tests are to be performed in general at room temperature.
B.2.2 Test results
The test is deemed to have been passed if the specified functions have been proved, the test results are within the specified tolerance limits and no permanent or temporary functional malfunctions at the test specimen have been detected.

B.3 Vibration test
The vibration test is to demonstrate that under the influence of externally initiated vibrations no damage is caused to the test specimen and no permanent or temporary malfunctions occur, see Fig. 2.1.

B.3.1 Test procedure
B.3.1.1 General information
The test specimens are to be tested in operationally connected and functional condition.

The tests are normally to be carried out in three mutually perpendicular levels to each other. The function of the test specimen is to be demonstrated during the vibration tests. At the beginning of the test, resonances at each level are to be determined.

If resonances at the test specimen are determined with an amplification factor $Q^1 < 2$, the test duration is 90 min at each level at a frequency of 30 Hz.

If resonances at the test specimen are determined with an amplification factor $Q^1 \geq 2$, the test duration is 90 min at each resonance frequency.

Fig. 2.1 Vibration curves

---

$Q^1$ = relation of amplitudes $a_G / a_E$

$a_G$ = acceleration amplitude of the test specimen

$a_E$ = acceleration amplitude of the stimulation
The components are to be tested according to their intended mounting position with the following accelerations and amplitudes:

**B.3.1.2 General vibration strain**
(curve 1 in Fig. 2.1)

This characteristic curve applies to components and systems which, due to their mounting position, do not have to meet stringent requirements, see Table 2.1.

**Table 2.1 General vibration strain**

<table>
<thead>
<tr>
<th>Frequency range</th>
<th>Amplitude</th>
<th>Acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 to 13.2 Hz</td>
<td>± 1.0 mm</td>
<td>–</td>
</tr>
<tr>
<td>13.2 to 100 Hz</td>
<td>–</td>
<td>0.7 g</td>
</tr>
<tr>
<td>Change of frequency</td>
<td>max. 1 octave/minute ¹</td>
<td></td>
</tr>
</tbody>
</table>

¹ Octave corresponds to a frequency interval where the upper limit is achieved by doubling the lower limit.

**B.3.1.3 Increased vibration strain**
(curve 2 in Fig. 2.1)

This characteristic curve applies to components and equipment mounted on diesel engines, aggregates, compressors or in steering gear compartment or which are operated under similar mounting conditions, see Table 2.2.

**Table 2.2 Increased vibration strain**

<table>
<thead>
<tr>
<th>Frequency range</th>
<th>Amplitude</th>
<th>Acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 to 25.0 Hz</td>
<td>± 1.6 mm</td>
<td>–</td>
</tr>
<tr>
<td>25.0 to 100 Hz</td>
<td>–</td>
<td>4.0 g</td>
</tr>
<tr>
<td>Change of frequency</td>
<td>max. 1 octave/minute ¹</td>
<td></td>
</tr>
</tbody>
</table>

¹ Octave corresponds to a frequency interval where the upper limit is achieved by doubling the lower limit.

**B.3.1.4 Extreme vibration strain**
(curve 3 in Fig. 2.1)

This characteristic curve applies to components and equipment mounted on exhaust gas lines of medium speed and high speed diesel engines. As minimum strain the values in Table 2.3 are defined.

**Table 2.3 Extreme vibration strain**

<table>
<thead>
<tr>
<th>Frequency range</th>
<th>Temperature</th>
<th>Acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 to 2000 Hz</td>
<td>600 °C</td>
<td>10.0 g</td>
</tr>
<tr>
<td>Change of frequency</td>
<td>max. 1 octave/minute ¹</td>
<td></td>
</tr>
</tbody>
</table>

¹ Octave corresponds to a frequency interval where the upper limit is achieved by doubling the lower limit.
B.3.1.5 Components having a mass $M$ of more than 10 kg are to be designed for accelerations according to the relation 40 to $M$. However the minimum acceleration is to be 0.7 g.

Following a vibration test in each case a functional test is to be carried out.

B.3.1.6 If exceeding vibration strain is to be expected at the installation location this has to be considered for the test.

B.3.2 Test results

The test is deemed to have past if the specified functions could be demonstrated, the results are within the specified tolerance limits and no damage which limits the function has been detected at the test specimen.

B.4 Low temperature test

This test is to demonstrate that under the influence of low temperature no damage is caused to the test specimen and no permanent or temporary malfunctions occur.

B.4.1 Test procedure

B.4.1.1 General Information

The test specimen is to be placed in the test chamber at room temperature remaining connected under operating conditions during the cooling down phase and the complete test duration.

During the final 60 min of the test, several function tests are to be carried out.

The test chamber has to be designed to achieve approximately the same temperature at all locations of the chamber.

Following the low temperature test a function test has to be carried out when the test specimen has reached room temperature again.

B.4.1.2 Internal spaces of the ship

The conditions in the test chamber are defined in Table 2.4.

Table 2.4 Test chamber for components and systems in internal spaces of the ship

<table>
<thead>
<tr>
<th>Conditions in the test chamber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
</tr>
<tr>
<td>Test duration</td>
</tr>
</tbody>
</table>

The test specimen is to be cooled down from room temperature to $5 \degree C$ within half an hour and after reaching this permanent temperature it will be kept at $5 \degree C$ for two hours, compare Fig. 2.2.

B.4.1.3 Open deck/cold areas

The conditions in the test chamber are defined in Table 2.5.

Table 2.5 Test chamber for components and systems at the open deck or cold areas

<table>
<thead>
<tr>
<th>Conditions in the test chamber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
</tr>
<tr>
<td>Test duration</td>
</tr>
</tbody>
</table>

The test specimen is to be cooled down from room temperature to $-25 \degree C$ within half an hour and after reaching this permanent temperature it will be kept at $-25 \degree C$ for two hours, compare Fig. 2.2.
B.4.2 Test results
The test is deemed to have past if the specified functions could be demonstrated, the results are within the specified tolerance limits and no damage which limits the function has been detected at the test specimen.

![Temperature development graph](image)

Fig. 2.2 Temperature development

B.5 Dry heat test
This test is to demonstrate that under the influence of dry heat no damage is caused to the test specimen and no permanent or temporary malfunctions occur.

B.5.1 Test procedure

B.5.1.1 General information
The test specimen is to be placed in the test chamber and remains connected under operating conditions during the complete test.

The test chamber has to be designed to achieve approximately the same temperature at all locations of the chamber.

During the final 60 min of the test, several function tests are to be carried out. When the test specimen has reached room temperature, again a function test has to be carried out.

5.1.2 Without increased heat load
The conditions in the test chamber are defined in Table 2.6.

Table 2.6 Test chamber for components and systems in areas without increased heat load

<table>
<thead>
<tr>
<th>Conditions in the test chamber</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>$55 , ^\circ C \pm 2 , ^\circ C$</td>
</tr>
<tr>
<td>Air humidity at test temperature</td>
<td>$&lt; 50 %$</td>
</tr>
<tr>
<td>Test duration</td>
<td>16 h</td>
</tr>
</tbody>
</table>

The test specimen is to be heated up from room temperature to $55 \, ^\circ C$ within half an hour and after reaching this permanent temperature it will be kept at $55 \, ^\circ C$ for 16 hours, compare Fig. 2.3.

B.5.1.2 With increased heat load/on open deck
The conditions in the test chamber are defined in Table 2.7.
Table 2.7 Test chamber for components and systems in areas with increased heat load or on open deck

<table>
<thead>
<tr>
<th>Conditions in the test chamber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
</tr>
<tr>
<td>Air humidity at test temperature</td>
</tr>
<tr>
<td>Test duration</td>
</tr>
</tbody>
</table>

The test specimen is to be heated up from room temperature to 70 °C within half an hour and after reaching this permanent temperature it will be kept at 70 °C for 2 hours, compare Fig. 2.3.

B.5.2 Test results

The test is deemed to have past if the specified functions could be demonstrated, the results are within the specified tolerance limits and no damage which limits the function has been detected at the test specimen.

B.6 Damp heat test

This test is to demonstrate that under the influence of humidity and heat no damage is caused to the test specimen and no permanent or temporary malfunctions occur at the test specimen.

B.6.1 Test procedure

B.6.1.1 Two test cycles of 24 hours each are to be performed.

B.6.1.2 The test specimen has to be placed in the test chamber at room temperature remaining connected under operating condition during the whole test.

The temperature in the test chamber is to be raised from room temperature to 55 °C ± 2 °C in 3 ± ½ hours, whereas the relative humidity is to be kept between 95 % and 100 %, see Fig. 2.4.

After reaching the test temperature of 55 °C ± 2 °C, the relative humidity has to be kept between 90 % and 96 % for a period of 12 ± ½ hours.

Fig. 2.3 Development of test temperature
Cooling down to room temperature shall be at relative humidity between 80% and 100% and a temperature of 55 °C within 3 to 6 hours.

The test specimen at room temperature is to be kept at relative humidity between 95% and 100% until completion of 24 hours of the cycle.

B.6.1.3 The second test cycle has to be performed in analogous manner.

B.6.1.4 Several function tests are to be performed at test temperature within the first 2 hours of the first and within the last 2 hours of the second test cycle. When the test specimen has reached room temperature after the second cycle, the functional test has to be repeated.

B.6.2 Test results
The test is deemed to have passed if the specified functions could be demonstrated, the results are within the specified tolerance limits and no damage which limits the function has been detected at the test specimen.

B.7 Salt mist test
The test is to demonstrate that the test specimen has sufficient corrosion resistance under the influence of saline atmosphere and that the function is not impaired.

This test is to be performed on components and systems to be installed on open deck.

B.7.1 Test procedure
Before the test a functional test is to be performed.
During the test, the test specimen is to be operationally connected, but not put into operation.

The basic requirements are defined in Table 2.8, the conditions in the spray and damp chambers are summarized in Table 2.9 and B.2.10. A test severity level 1 according to the IEC Publication 60068-2-52, test Kb has to be applied for the test.

On the 7th day of each storage period functional tests are to be performed.

After completion of a salt mist test, a function test is to be carried out.

**Table 2.8 Basic requirements**

<table>
<thead>
<tr>
<th>Test severity level</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sprays</td>
<td>4</td>
</tr>
<tr>
<td>Storage time in damp chamber between sprays</td>
<td>7 days after each spray</td>
</tr>
</tbody>
</table>

**Table 2.9 Spray chamber**

<table>
<thead>
<tr>
<th>Conditions in the spray chamber</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of spray</td>
<td>2 hours</td>
</tr>
<tr>
<td>Temperature</td>
<td>+ 25 °C ± 10 °C</td>
</tr>
<tr>
<td>Saline solution</td>
<td>5 % sodium chloride (NaCl) pH-value 6.5 % to 7.2 % at 20 °C ± 2 °C</td>
</tr>
</tbody>
</table>

**Table 2.10 Damp chamber**

<table>
<thead>
<tr>
<th>Conditions in the damp chamber</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>40 °C ± 2 °C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>93 % ± 2 % / – 3 %</td>
</tr>
</tbody>
</table>

**B.7.2 Test results**

The test is deemed to have past if the test specimen shows no corrosive damage to be visually observed, the specified functions could be demonstrated and the results are within the specified tolerance limits.

**B.8 Fire resistance test**

The fire resistance test for hose lines and rubber compensators is to be performed according to ISO 15540 and ISO 15541. Fittings, slip-on joints, pipe unions and other pipe connecting elements which include sealings with a melting point < 925 °C are to be tested according to ISO 19921 and ISO 19922.

**B.8.1 Test procedure**

The test procedure is to be performed according to standards ISO 15540 respectively ISO 19921, the test stand shall be adequate to standards ISO 15541 respectively 19922.

To these standards the following clarifications are necessary:

- If the test pressure (at minimum 5 bar) deviates from the nominal pressure, the final test for tightness has to be performed with the test pressure relevant for the product. This is for non-metallic hose lines 2 times, for non-metallic compensators 1.5 times and for connecting joints 1.5 times the maximum allowable working pressure.
The choice of the test specimens is to be performed according to the ISO standards mentioned above (for pipe lines ISO 15540, for connecting elements ISO 19921).

In addition GL reserve the following deviations to these standards:

- Test specimens and their preparation:
  The end fittings for the test specimens are to be defined by GL. In principal the same types of end-fittings are to be used as applied for the impulse test according to ISO 6803 respectively ISO 6802:1991 (E).
- Test specimens of compensators are to be presented for the test fully assembled according to the intended operating conditions equipped with flanges, screw connections, internal guiding pipes - if applicable, vacuum supporting rings, fastening elements, etc.

B.8.2 Test results

The test is deemed to have past if the test specimens meet after the test the requirements of the relevant standards. The results have to be documented by a test Certificate according to the test standards.

B.9 Pressure and tightness tests

Pressure and tightness tests are to be performed at room temperature. The following minimum scope has to be tested:

B.9.1 Pressure test (strength test)

These tests are performed for the proof that the strength of the pressure loaded parts of the test specimen is not impaired under test pressure.

B.9.1.1 Test procedure

- Test pressure \( p_p \) for pipes, valves, fittings:
  \[ 1.5 \times \text{nominal pressure } P_N \]
- Velocity of pressure increase [bar/s]:
  relatively slow resp. acc. to definition of manufacturer
- Test medium:
  water or oil emulsion, vented
  air or other gases up to 6 bar
  other media according to agreement
- Duration of test:
  As far as not defined by GL or relevant technical standards the following minimum test durations are valid:
  Fittings, compensators and other components:
  5 minutes
  Disconnecting couplings with integrated valves according to Table 2.11

B.9.1.2 Other test procedures may be recognized, as far as necessary, after verification by GL.

Table 2.11 Duration of tests for disconnecting couplings

<table>
<thead>
<tr>
<th>Nominal size DN [mm]</th>
<th>Duration of test [minutes]</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN ( \leq 100 )</td>
<td>10</td>
</tr>
<tr>
<td>100 &lt; DN ( \leq 300 )</td>
<td>15</td>
</tr>
<tr>
<td>300 &lt; DN</td>
<td>20</td>
</tr>
</tbody>
</table>
B.9.1.3 Test results

The test is deemed to have past if no pressure decrease occurs and if no permanent deformations or other deficiencies can be visually observed at the pressure loaded parts of the test specimen. Otherwise the test is to be repeated with two test specimen of the type and size which failed. If a test specimen fails, the test is deemed finally not to have past.

B.9.2 Tightness test for houses of fittings and seat sealing

B.9.2.1 Test procedure for test of tightness of the pressure loaded housing

The test has to be performed with gas or liquid, the choice of the test medium being the responsibility of the manufacturer.

- Test pressure:
  \[1.5 \times \text{allowable working pressure (at room temperature), the nominal pressure at minimum. All connections to the housing have to be closed, the valve has to be brought to partly open position and the valve housing has to be filled with test medium.}\]

- Course of test:
  - Liquid as test medium:
    - The valve housing is to be checked visually for external leakages.
  - Gas as test medium:
    - The valve housing is to be immersed in water and the rising of gas bubbles to the water surface has to be checked. No gas shall leak out. The upper side of the valve should be situated at maximum 50 mm below the water surface.

- Duration of test:
  - at minimum 10 minutes respectively according to a technical regulation recognized by GL

B.9.2.2 Test procedure for testing seat tightness

For the test of tightness of the seat the allowable leakage rate has to be agreed before the test between manufacturer and contractor and approved by GL.

The leakage rate is to be checked according to the requirements of GL or another international valve standard recognized by GL.

The test has to be performed with gas or liquid, the choice being the responsibility of the manufacturer. If a valve is not designed for one flow direction only, the test has to be made for both flow directions.

- Test pressure:
  \[1.1 \times \text{maximum allowable working pressure respectively acc. to a standard approved by GL}\]

- Test medium:
  - Liquid or gas. The definition of the test medium is in the responsibility of the manufacturer.

- Course of test:
  1. Closing body, e.g. valve cone, gate valve, piston to be brought in closed position.
  2. Hollow space at the entrance side to be filled with test medium.
  3. Activate test pressure.
  4. Evaluate leakage rate.

- Duration of test:
  - according to definition of manufacturer, at minimum 10 minutes

Note

*Fittings with double seating or two independent seating areas may be tested by establishing the test pressure between the seatings and checking each side of the closed fitting.*
B.9.2.3 Test results

The test is deemed to have passed if the tightness test of the housing shows no leakage and at the tightness test of the seating the leakage rates measured during the test duration, which are defined in the requirements of GL or other relevant international standards recognized by GL, are not exceeded.

B.10 Burst pressure test

This test serves the proof that the specimen has a sufficient safety against failure under influence of internal pressure.

B.10.1 Test procedure

The same specimen may be used as for the tightness tests, if they have passed this first test.

The specimen is to be loaded with stepless increase of pressure (abt. 10 % per minute) up to the test pressure.

- Test pressure: nominal pressure $\times$ safety factor $f$
- Safety factor $f$: test pressure / nominal pressure
  - Below 200 bar nominal pressure: $f = 4.0$
  - Above 200 bar nominal pressure: $f$ to be reduced according to Table 2.12 and as shown for overview in Fig. 2.5
- Test medium: water or water-oil emulsion, vented
  - Other media according to range of application
- Duration of test: 5 minutes at maximum pressure
- Test arrangement: For unrestricted pipe connections both pipe ends are to be fixed, for restrained pipe connections one pipe end has to be free movable.

B.10.2 Test results

The test is deemed to have passed if the test pressure can be kept for the duration of test without observing leakages or cracks at the test specimen which can be visually detected. Light deformations may be accepted.

![Graph showing reduction of safety factor f for nominal pressures above 200 bar](image)

**Fig. 2.5** Reduction of safety factor $f$ for nominal pressures above 200 bar
## Table 2.12 Reduced values of safety factors $f$ for nominal pressures above 200 bar

<table>
<thead>
<tr>
<th>Nominal pressure [bar]</th>
<th>Safety factor $f^1$ [-]</th>
<th>Nominal pressure [bar]</th>
<th>Safety factor $f^1$ [-]</th>
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</table>

1 Intermediate values may be interpolated linearly.
A General

A.1 Components and Systems in this Section

In this Section the necessary test requirements in the framework of a type approval are defined for a certain component respectively a certain overall system of mechanical engineering.

A.2 Further components and systems

Besides of the components and systems for which the test requirements are defined in this Section, there are further components and systems of mechanical engineering where the requirements for a type approval are not defined in these Guidelines, but directly in the Rules for Construction and Classification.

A summary of such essential components is contained in Table 3.1.

A.3 Special requirements

For special requirements on components and systems, which are not covered by these test guidelines, the test requirements are to be defined case by case by GL in accordance with the service and application conditions.

Table 3.1 References to further components and systems with type approval

<table>
<thead>
<tr>
<th>GL Rules</th>
<th>Publication</th>
<th>Title</th>
<th>Component or system</th>
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<tr>
<td>I-1-2, Section 2</td>
<td>Machinery Installations – Internal Combustion Engines and Air Compressors</td>
<td>Internal Combustion Engines</td>
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<tr>
<td>I-1-2, Section 3b</td>
<td>Turbomachinery / Gas Turbines, Exhaust Gas Turbochargers</td>
<td>Exhaust Gas Turbochargers</td>
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<td>I-1-2, Section 12, G</td>
<td>Fire Protection and Fire Extinguishing Equipment</td>
<td>High-pressure CO₂-Fire extinguishing systems (FSS Code, Chapter 5)</td>
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<tr>
<td>I-1-2, Section 12, G.2</td>
<td>Fire Protection and Fire Extinguishing Equipment</td>
<td>Cylinder valves of CO₂ cylinders (BAM approval or equivalent)</td>
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<td>I-1-2, Section 12, I</td>
<td>Fire Protection and Fire Extinguishing Equipment</td>
<td>Gas fire extinguishing systems using gases other than CO₂ (MSC/Circ. 848)</td>
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<tr>
<td>I-1-2, Section 12, J.2</td>
<td>Fire Protection and Fire Extinguishing Equipment</td>
<td>Aerosol fire extinguishing systems (MSC/Circ. 1007)</td>
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<tr>
<td>I-1-2, Section 12, L.1.1</td>
<td>Fire Protection and Fire Extinguishing Equipment</td>
<td>Automatic pressure water spraying systems (sprinkler systems) (IMO Resolution A.800(19))</td>
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</tr>
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</table>
### B Definition of Test Requirements

In the following type approval tests are defined for the named components and systems:

1. Valves and fittings
2. Valves for liquified gases/LNG
3. Fuel oil and oil filters
4. Non-metallic hoses
5. Hoses of metallic materials
6. \( \text{CO}_2 \) hoses
7. Bunker hoses and cargo hoses of non-metallic materials
8. Hose fittings
9. Flame protection covers for non-metallic hoses
10. Compensators of non-metallic materials
11. Compensators of metallic materials
12. Mechanical connecting elements for pipes
13. Plastic pipe systems
14. Air pipe heads
15. Mechanical pressure measuring instruments
16. Mechanical temperature measuring instruments
17. Magnetic level indicators/membrane level indicators
18. Pneumatic tank level indicators
19. Resilient mounting elements
20. Flexible couplings
21. Explosion relief valves for the crankcase of internal combustion engines
22. Equipment for the detection and alarming of oil mist in the crankcase of internal combustion engines (Oil mist detectors)
23. Pressure/vacuum safety valves for cargo tanks
24. Safety valves (spring loaded and pilot controlled), see Section 4
B.1 Valves and fittings

Safety valves are tested according to Section 4.

B.1.1 Tests

B.1.1.1 Tests according to Section 2

- visual inspection
- function test
- vibration test
- low temperature test
- dry heat test
- damp heat test
- salt mist test
- fire resistance test
- pressure test
- tightness test for houses and seats

The tests to be performed will be defined case by case in accordance with the type and range of application.

B.1.1.2 Additional tests according to B.1.3

- endurance test at room temperature for remote controlled butterfly valves

B.1.2 Number of test specimens

The tests have to be performed on at least three test specimens of different nominal diameter of each series and type, as far as not otherwise specified by the relevant test requirements or by GL.

B.1.3 Additional tests

B.1.3.1 Endurance test at room temperature for remote controlled butterfly valves

This test serves to proof that during operation no permanent or short time malfunctions occur if the valves are actuated.

B.1.3.1.1 Test procedure

As far as not specified by other instructions of GL or by an international standard recognized by GL, the test procedure is to be performed as follows.

Opening and closing of the valve to the end positions while the valve is to be exposed in closed condition to the nominal pressure in flow direction.

As far as the valve is not assigned for one flow direction only, the test is to be performed in all flow directions.

The test has to be performed as follows:

- Up to DN 200: 2000 cycles
- > DN 2000: 500 cycles
- Test Pressure: nominal pressure

B.1.3.1.2 Test results

The endurance test is deemed to have been passed if the requirements for the pressure and tightness tests defined in Section 2, B.9.1 and B.9.2 can be met after the endurance test.

B.1.4 Test result overall

The type approval test is deemed to have been passed if all single tests have been performed und the required results could be achieved.
B.2 Valves for liquefied gases/LNG with working temperature below –55 °C

The following paragraphs specify the product tests for type approval of cryogenic valves, excluding safety valves.

The term valves includes the following valve designs:
- Ball valves
- Plug valves
- Butterfly valves
- Gate valves
- Globe valves

B.2.1 Tests

B.2.1.1 Mandatory tests

- Visual inspection

Tests at room temperature:
- Valve body pressure test
- Tightness test of seat and stem with 1.1 times the design pressure
- Function test

Tests at minimum design temperature:
- Tightness test of seat and stem with 1.1 times the design pressure
- Cold shock test
- Fatigue strength and tightness test at low temperature

B.2.1.2 Optional tests

Depending on the design of the valve, application and installation area, e.g. open deck or at internal combustion engines, the following tests may be carried out:
- Salt mist test
- Vibration test
- Fire resistance test

B.2.2 Number of test specimens

Valve body and tightness tests are to be performed on each size and type.

The number of test specimens for cold shock test, fatigue strength test and optional tests is to be determined individually taken into account the valve design.

If the test results of one of the test specimens do not meet the requirements, the tests have to be repeated with two specimens of the failing nominal diameter.

B.2.3 Test procedure

As far as not specified in Section 2, the tests are to be performed according to EN 12567 or as described in the following.

B.2.3.1 Cold shock test

A cold shock test has to be performed to check the influence of quick temperature changes on the functioning.

B.2.3.1.1 Test procedure

The test has to be performed with liquid gas or liquid nitrogen with a test temperature equal to or less than -160 °C at ambient pressure.

The valve has to be brought in a partially open position and is to be filled within 5 minutes.

The valve shall remain filled with the test liquid for at least one hour.

B.2.3.1.2 Test results

After the cold shock test the test specimens have to completely dismantled and checked for damages. All parts not exposed to pressure have to undergo visual inspection, all parts exposed to pressure have to undergo a crack test according to an international standard recognized by GL.
With positive result (free of cracks) of these tests the test is deemed to have passed.

B.2.3.2  Fatigue strength and tightness test at low temperature

The valves to be tested have to undergo a fatigue strength test including an affiliated internal and external tightness test. The fatigue strength test is to be performed with LNG or with liquid oxygen.

As far as not specified by other instructions of GL or by an international standard recognized by GL, the test procedure is to be performed according to EN 12567.

The test procedure should at least include the following scope of tests:

- test for internal tightness at low temperature
- test for external tightness at low temperature
- function test under working pressure at low temperature
- test of fatigue strength at low temperature
- final check of the house and the seat at room temperature after the fatigue strength test
- check of single parts by disassembly of the valve after the fatigue strength test

B.2.3.2.1  Test procedure

The valve is to be internally cooled down on the test stand with LNG or liquid oxygen to a temperature below or equal to \(-160 \, ^\circ C\).

B.2.3.2.1.1  Test for internal tightness at low temperature

The valve has to be closed and is to be relieved at exit side. As far as not defined differently by GL the following leakage rates according to EN 12567 are to be measured under the pressures defined in the following.

\[
0.5 \text{ bar}, \ 0.25 \times p_{e, zul}, \ 0.5 \times p_{e, zul}, \ 0.75 \times p_{e, zul}, \ 1 \times p_{e, zul}
\]

with \(p_{e, zul}\) as maximum allowable working pressure

As far as the valve is not assigned for one flow direction only, the test is to be performed for all directions.

B.2.3.2.1.2  Test for external tightness at low temperature

The external tightness is to be measured under the maximum allowable working pressure of the valve in closed and open position. No gas shall escape. For the measurement a gas detection device with a measurement accuracy of at least \(10\%\) of the lower ignition limit of methane in air is to be used.

B.2.3.2.1.3  Function test under working pressure at low temperature

The test procedure follows the definitions of the manufacturer to be recognized by GL.

The forces and moments for opening and closing have to be measured.

B.2.3.2.1.4  Test of fatigue strength at low temperature

This test shall deliver the proof that under operating conditions no permanent or short time malfunctions are occurring by actuating the valve. As far as not specified otherwise and recognized by GL is the test pressure the nominal pressure. The following cycles have to be endured, a cycle is including the complete opening and closure of the valve:

- Up to nominal size DN 200  :  2000 cycles
- For nominal size >DN 200  :  500 cycles

If the valve is not assigned for one flow direction only, the test is to be performed for all directions.

As far as the test is not performed according to EN 12567, the fatigue strength tests for external and internal tightness have to be repeated in six previously defined intervals according to B.2.3.2.1.1 and B.2.3.2.1.2.

B.2.3.2.1.5  Final check of the house and the seat at room temperature after the fatigue strength test

After finish of the fatigue strength test the following tests have to be repeated for the valve:

Tightness test for house and seat at room temperature according to Section 2.
B.2.3.2.1.6 Check of single parts by disassembly of the valve after the fatigue strength test

After the finish of all tests within the framework of the fatigue strength test the valve has to be disassembled completely. All single parts are to be checked for eventual damages. For the check of the single parts a test report is to be established.

B.2.3.2.2 Test results

The fatigue strength test is deemed to have passed if all test results are according to the specifications of GL or to the specifications of an international valve standard recognized by GL. For the fatigue strength test a test report has to be established which includes all test and measurement results.

B.2.3.3 Fire resistance test

Valves and fittings for liquid gases for the use on ships, as well as offshore and onshore terminals are to be tested on fire resistance.

B.2.3.3.1 Test procedure

The tests for fire resistance are to be performed according to the instructions of ISO 10497 respectively API 607 by a test laboratory recognized and authorized by GL.

B.2.3.3.2 Test results

The tests are deemed to have passed if the test specimens are meeting fully the requirements of ISO 10497 respectively API 607. The test documentation with the test results as well as the original Certificates issued by the test laboratory have to be presented to GL for approval.

B.2.4 Test report

All measurements and conclusions shall be recorded in a test report. Valves shall be approved only if they satisfy the requirements of the different tests.

The report shall include the following:

- the measured leakage rates and stresses/torques during the initial, endurance and final tests at ambient temperature and low temperature
- the leakage rate during the seat leak tightness test during the initial and final tests at ambient temperature
- the endurance class (ref. to EN 12567, B.6)
- the leak tightness class (ref. to EN 12567, B.8)

B.2.5 Unit production testing

Each valve of the batch is to be tested at the manufacturer’s plant in the presence of a GL surveyor.

Testing is to include hydrostatic test of the valve body at a pressure equal to \(1.5\) times and seat and stem leakage test at a pressure equal to \(1.1\) times the design pressure.

In addition, cryogenic testing consisting of valve operation and leakage verification is required for a minimum of \(10\%\) of each type and size of valve of the batch.

B.3 Fuel oil and oil filters

B.3.0 General

The test requirements are only valid for filters with housings made of metals with a melting point < 925 °C as well as for filters with screwed filter elements respectively filter housings.

B.3.1 Tests

B.3.1.1 Tests according to Section 2

- visual inspection
- vibration test
- flame resistance test
- burst pressure test
The tests to be performed case by case will be defined according to filter type and filter housing.

**B.3.1.2 Additional tests according to B.3.3**
- function test

**B.3.2 Number of test specimens**
Two specimens of different size for each type and series are to be tested.

**B.3.3 Additional tests**

**B.3.3.1 Function test**
The function is to be tested according to the GL Rules *Machinery Installations (I-1-2), Section 2, G*

**B.3.4 Test result**
After performing the tests mentioned above, the tightness shall be established in a way that no test medium can escape outside.

**B.4 Non-metallic hoses**
The tests defined in the following are valid mainly for hoses made of elastomers. For approval of hoses made of other non-metallic materials special tests will be defined.

**B.4.1 Tests**

**B.4.1.1 Tests according to Section 2**
- visual inspection
- fire resistance test

**B.4.1.2 Additional tests according to B.4.3**
- diameter and concentricity:
  EN 24671:1993
- Hydrostatic requirements:
  EN ISO 1402:1994
- minimum bending radius:
  hose standard
- impulse test:
  ISO 6803 / 100 °C: 1994
- cold flexibility:
- bonding between the layers:
- vacuum constancy:
  EN ISO 7233:1995
- abrasion resistance:
  EN ISO 6945:1991
- resistance against liquids (oil, water dissolutions, sea water):
  ISO 1817:1996
- ozon resistancy:
  EN 27326:1993

**1 Test procedure and test stand according to ISO 15540 and 15541 required for compensators in fuel oil, hydraulic oil, bilge and sea water systems.**
B.4.2 Number of test specimens

The number of test specimens for additional tests is to be defined according to the test standard, otherwise at minimum three specimens of different size are to be tested for each series and type.

B.4.3 Additional tests

The tests defined in B.4.1.2 are primarily defined for rubber hoses. Other recognized standards for plastic hoses or works standards of the hose manufacturers may be recognized after verification of the test reports.

B.4.4 Test results

The test is deemed to be passed, if the test results according to Section 2 and the additional single tests according to B.4.1.2 are in compliance with the specifications of the manufacturer recognized by GL.

B.4.5 Approval of manufacturing works

If the hoses are manufactured at different manufacturing locations, the proofs for the tests mentioned above are to be submitted for each manufacturing location.

For the fire tests hoses of respective manufacturing locations have to be included, that means the defined specimens are to be made of hoses from the respective manufacturing locations.

B.5 Hoses of metallic materials

B.5.1 Tests

B.5.1.1 Tests according to Section 2

- visual inspection
- pressure and tightness test ²
- burst pressure test ²

B.5.1.2 Additional test according to B.5.3

- endurance test

B.5.2 Number of test parameters

The tests are to be performed with at minimum three test specimens of different size for each series and type if there are no differing regulations defined by GL according to the operating conditions.

B.5.3 Additional test

B.5.3.1 Endurance test

This test serves to proof that flexibility and pressure strength of the hoses are conserved under the influence of defined load cycles for bending fatigue strength and full application of pressure at room temperature. The test arrangement is shown in Fig. 3.1.

² For metallic hose assemblies intended to be used in process pipes, cargo pipes and cargo hose assemblies of gas and chemical tankers as well as cryogenic and non-cryogenic gas piping systems of internal combustion engines and boilers the following requirements apply:

- Tightness-, pressure and burst pressure test is to be performed at the lowest design temperature.
  For low temperature steels (GL Rules for Steel and Iron Materials (II-1-2), Section 2, D) the pressure tests may be carried out at room temperature.
- For application in cargo piping systems of chemical tankers the minimum design pressure shall be 10 bar.
- The burst pressure shall be at minimum 5 times the design pressure.
B.5.3.1.1 Test procedure

The test specimen will be bent with a radius which is equivalent to 12 times the outside diameter of the hose for ± 90°. One forward and backwards movement represents one load cycle.

\[ F = 20 \text{ N} \]

\[ r = 12 d_a \]

**Fig. 3.1** Test arrangement for the endurance test

- test pressure: nominal pressure
- test medium: water
- number of load cycles: \( 1 \cdot 10^4 \)

Alternatively the endurance test may be performed according to the standard ISO 10380.

B.5.3.1.2 Test result

The proof of flexibility and pressure resistance is deemed to be met if the test specimen survives the pressure and tightness test after the endurance test without deficiencies.

B.5.4 Test result overall

The test is deemed to be passed, if the test results according to Section 2 and the single additional test according to B.5.1.2 are equivalent to the specifications of the manufacturer approved by GL.

B.6 CO₂ hoses

B.6.0 General

These test requirements are valid for the approval of hoses made of synthetic rubber. For the approval of other hose materials, as e.g. thermoplastic, special test requirements are to be defined.

In the case of hoses made of synthetic rubber an approval as hydraulic hose issued in advance is an assumption for the approval of a CO₂ hose. CO₂ hoses are to be designed for a working pressure of at least 100 bar.

B.6.1 Tests

B.6.1.1 Tests according Section 2

- Visual inspection (as part 4 of the tests a visual inspection of the outside and inner side layer of the hose has to be performed). No cracks, swellings, bubbles and further deficiencies shall exist.
- burst pressure test according to hose standard (part 6)

B.6.1.2 Additional tests according B.6.3

- prick procedure (part 1 of the tests)
- endurance test with liquid carbon dioxide (CO₂) and cold test afterwards (part 2)
- bending fatigue test (part 3)
- pressure test according to hose standard (part 5)
B.6.2 Number of test specimens

From each hose type which shall be tested the smallest and the biggest dimension has to be manufactured according to manufacturer specification, including pricking and using the fittings to be used for operation of the CO₂ hose.

For the case of prick failures for each test specimen two spare specimens shall be available.

B.6.3 Additional tests

B.6.3.1 Prick procedure

B.6.3.1.1 Test procedure

By sufficient pricking it has to be ensured that gas escaping from the internal layer may escape through the external layer without creating bubbles or further deficiencies.

The procedure has to ensure, that the needles of the pricking device do not damage the internal layer, that means the prick procedure has to be made in controlled manner.

For release of the prick procedure to be used the outer layer of the test specimens including the spare parts has to be perforated.

After the pricking and integration of the hoses a visual inspection and pressure test is to be performed according to hose standard.

B.6.3.1.2 Test results

If leakage is detected after the test, an adequate modification of the prick procedure has to be done.

Subsequently for each failed size two further test specimens are to be manufactured and have to be subjected again to a visual check and pressure test. Should leakage occur again, the applied prick procedure is to be modified respectively to be replaced by a new one.

B.6.3.2 Endurance test with liquid carbon dioxide

The test serves to prove that the hoses are not impaired concerning tightness and form stability by CO₂.

B.6.3.2.1 Test procedure

The test specimens are to be connected to one or more CO₂ cylinders, which are arranged standing with a total volume of at least 45 kg in U-form with the minimum permissible bending radius. For at least 24 hours they have to be exposed to liquid carbon dioxide with room temperature. After expiration of the test period the content of the cylinders is to be emptied via the test specimens within 30 minutes into the open.

After warming up of the test specimens to room temperature, a visual inspection concerning eventually occurring damages of the internal and external layer has to take place.

B.6.3.2.2 Test results

The proof of suitability for the test medium is deemed to have passed if the test specimens show no cracks, swellings, bubbles and further deficiencies and if they remain tight over a test period of 2 minutes. The test pressure has to be equivalent to 2 times the maximum allowable working pressure of the hose line.

B.6.3.3 Bending fatigue test

After emptying, the hoses are to be bent immediately alternately by 180° over an adequate pattern keeping the minimum bending radius.

B.6.3.4 Pressure test according to hose standard

After visual inspection a pressure test with 2 times the maximum allowable working pressure is to be performed, in any way the test pressure shall be at least 200 bar.

B.6.4 Test results overall

The proof of suitability for CO₂ is deemed to be reached if the test specimens do not show, cracks, swellings, bubbles and further deficiencies and remain tight over a test period of 2 minutes.
According to Section 2, the following tests are conducted:

- Visual inspection
- Pressure and tightness test
- Burst pressure test

Additional tests under B.7.3 include:

- Electrical conductivity
- Wearing behaviour of the outer layer
- Durability against liquids
- Behaviour in coldness
- Durability of the outer layer against ozone
- Vacuum durability
- Impulse test according IGC Code

Two test specimens of different size for each series and type must be tested.

For cargo hoses on gas and chemical tankers, the pressure and tightness test as well as the burst pressure test are performed with the lowest/highest design temperature. The design pressure is defined with at least 10 bar. The pressure impulse test must be performed with 200 load changes from 0 to 2 times design pressure.

The burst pressure shall be at least adequate to 5 times the design pressure.

Test results:

The test is deemed to have been passed if all single tests are performed and the demanded requirements are fulfilled.
B.8 Hose fittings

B.8.1 Tests

B.8.1.1 Tests according to Section 2
  • visual inspection

B.8.1.2 Additional tests according B.8.3
  • impulse test
  • fire resistance test

B.8.2 Number of test specimens
For the impulse test for each size of a series one test specimen has to be provided. For the flame resistance test three sizes of each series have to be selected as test specimen.

B.8.3 Additional tests

B.8.3.1 Impulse test
The test has to be performed according to the standard ISO 6803-100 °C:1994.

B.8.3.2 Fire resistance test
The test has to be performed with three test specimens of different size and material (carbon steel and high quality steel). A combination of the materials in a test specimen is possible, however both parts of the test specimen have to be exposed to the flame.

The fittings are to be tested in exactly the same condition as provided for production, which means installation of the fitting on the peeled or unpeeled hose.

B.9 Flame protection covers for non-metallic hoses

B.9.1 Tests

B.9.1.1 Tests according to Section 2
  • visual inspection
  • fire resistance test
  • pressure test

B.9.2 Number of test specimens
Three hydraulic hose lines with textile weave, e.g. 1TE, 2TE, 3TE according to DIN EN 854 and installed flame protection cover are to be tested.

B.9.3 Test parameter
Following the flame resistance test a pressure test with two times the maximum allowable working pressure is to be performed. Holding time is 2 minutes.

B.9.4 Test result
The test is deemed to have passed, if the flame resistance test was successful and no leakage occurs during the subsequent pressure test.

B.10 Compensators of non-metallic materials

B.10.1 Tests

B.10.1.1 Tests according to Section 2
  • visual inspection
  • pressure and tightness test
• burst pressure test with 3 times the nominal pressure respectively maximum allowable working pressure
• fire resistance test

B.10.1.2 Additional tests according to B.10.3
• ozone resistance
• behaviour with pressure liquids
• wearing behaviour of the outside layer

B.10.2 Number of test specimens
The tests are to be performed using at least three test specimens of different size for each series and type, as far as no different regulations are defined by GL according to the operation conditions.

B.10.3 Additional tests
The tests defined in B.10.1.2 are to be performed in accordance with the standards to be defined by the manufacturer and recognized by GL.

B.10.4 Test results
The test is deemed to have passed, if the test results according to Section 2 and the single additional tests according to B.10.1.2 correspond to the specifications of the manufacturer recognized by GL.

B.11 Compensators of metallic materials

B.11.1 Scope
The product tests specified in B.11.2 ff are applicable to metallic compensators installed in piping systems covered by GL Rules for Machinery Installations (I-1-2), Section 11.

For application in process pipes and cargo pipes of gas and chemical tankers as well as cryogenic and non-cryogenic gas piping systems of internal combustion engines and boilers, B.11.3 ff applies.

B.11.2 Metallic compensators for application in piping systems covered by GL Rules for Machinery Installations (I-1-2), Section 11

B.11.2.1 Tests according to Section 2
• visual inspection
• pressure and tightness test
• burst pressure test

B.11.2.2 Additional tests according to B.11.2.4
• endurance test

B.11.2.3 Number of test specimens
The tests have to be performed for at least three different test specimens of different size for each series and type as far as GL has not defined different requirements taking into account the intended application and operating conditions.

---

5 Only for compensators in fuel oil, lubrication oil, hydraulic oil, bilge and seawater systems
6 For compensators which are to be used in process and cargo pipes on gas and chemical tankers, the pressure and tightness test as well as the burst pressure test has to be performed at the lowest design pressure. The design pressure of the compensators is to be scheduled for at least 10 bar. The burst pressure has to correspond 5 times the nominal pressure.
B.11.2.4 Additional tests

B.11.2.4.1 Endurance test

This test serves to demonstrate that the design of the bellow according to Expansion Joint Manufacturers Association (EJMA) or comparable standard ensures the compression strength and flexibility of the compensator under the influence of defined operating cycles and full pressure load.

B.11.2.4.1.1 Test procedure

The test specimen is to be tested as follows:

- number of load cycles: 1000
- test medium: water or water/oil emulsion
- test pressure: nominal pressure

B.11.2.5 Test result overall

The proof of sufficient flexibility and compressive stress is deemed to be established if the test specimen has passed the pressure and tightness test after the endurance test without deficiencies.

B.11.3 Metallic compensators intended to be used in process pipes and cargo pipes of gas and chemical tankers as well as cryogenic and non-cryogenic gas piping systems of internal combustion engines and boilers

B.11.3.1 Number of test specimens

The tests have to be performed for at least three different sizes of each type. Additional test specimens may be tested if deemed necessary according to the intended application and operating condition.

B.11.3.2 Tests according to Section 2

- visual inspection
- tightness test

B.11.3.3 Pressure test

The test is to be carried out on a compensator complete with all the accessories (flanges, stays, articulations, etc.) at twice the design pressure at the extreme displacement conditions recommended by the Manufacturer. No permanent deformations are allowed. The minimum design pressure shall be 10 bar.

B.11.3.4 Burst pressure test

The test is to be carried out on a compensator, not pre-compressed.

It is to be pressure tested to a pressure not less than five times the design pressure without bursting. The duration of the test is not to be less than 5 minutes.

The pressure tests are to be performed at the lowest design temperature.

For low temperature steels (GL Rules for Steel and Iron Materials (II-1-2), Section 2, D) the pressure tests may be carried out at room temperature.

B.11.3.5 Cycle test (thermal movements)

The test is to be performed on a complete expansion joint, which is to successfully withstand at least as many cycles, under the conditions of pressure, temperature, axial movement, rotational movement and transverse movement, as it will encounter in actual service. Testing at room temperature, when conservative, is permitted.

B.11.3.6 Fatigue test (ship deformation)

The test is to be performed on a complete expansion joint, without internal pressure, by simulating the bellows movement corresponding to a compensated pipe length for at least $2 \cdot 10^6$ cycles at a frequency not higher than 5 cycles/second. The test is only required when, owing to the piping arrangement, ship deformation loads are actually experienced.
B.12 Mechanical connecting elements for pipes

B.12.0 Scope

The tests defined in the following are to be applied with a certain scope for the following types of mechanical connections for pipes:
- compression couplings
- pipe unions
- slip on joints

B.12.1 Tests

Summary of tests for the different types

A summary which tests have to be performed for the different types shows Table 3.2.

B.12.1.1 Tests according to Section 2

- visual inspection
- tightness test
- burst pressure test
- fire resistance test

Table 3.2 Summary of the tests for the different types of mechanical connecting elements for pipes

<table>
<thead>
<tr>
<th>No.</th>
<th>Designation</th>
<th>Tests</th>
<th>Types</th>
<th>Where defined, remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Compression couplings and pipe unions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Slip on joints</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tension-proof joints</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Flexible joints</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Tightness test</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>Vibration (endurance) test</td>
<td>+</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>3</td>
<td>Pressure impulse test ^1</td>
<td>+</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>Burst pressure test</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>Pull-out test</td>
<td>+</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>6</td>
<td>Fire resistance test</td>
<td>+ ^3</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>7</td>
<td>Vacuum test</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>8</td>
<td>Repeated assembly test</td>
<td>+ ^2</td>
<td>+</td>
<td>–</td>
</tr>
</tbody>
</table>

Remarks:
^1 for the application of systems with impulse loads, e.g. hydraulic systems
^2 compression couplings excluded
^3 excluded connections with metallic sealing face
^4 see GL Rules for Machinery Installations (I-1-2), Section 11, Table 11.14
+ test required
– no test required
B.12.1.2 Additional tests according to B.12.3

- tightness test for compression couplings
- vibration (fatigue strength) test
- pressure impulse test
- pull out test
- vacuum test
- repeated assembly test

B.12.2 Selection and number of test specimens

The test specimens are to be selected at random from the production line or from the storage by the GL Surveyor and are to be marked unmistakable.

If different sizes and materials of each type are to be tested, at least three sizes for each material, which are representative for the series, have to be selected and tested.

In the case of pipe unions the biggest size of each pressure range is to be tested.

Before assembling the components of the test specimens they are to be checked for compliance with the construction documentation. If not defined otherwise, the length of the pipes to be tested shall be at least 5 times the pipe diameter. The assembly of the connection has to conform exactly to the instructions of the manufacturer. During the tests only adaptations of the connections are to be made which are defined by the manufacturer.

B.12.3 Additional tests

B.12.3.1 Tightness test for compression couplings

a) Mechanical connecting elements for the application as tension-proof joints are not to be fixed in longitudinal direction during the tests.

b) For compression couplings and pipe unions a static gas pressure test is to be performed to check the integrity and tightness of the pipe connection under the influence of gaseous media. The test specimen is to be arranged in a water bath. The test pressure is equivalent to the design pressure, but at maximum 70 bar.

c) If the tightness test according to Section 2, B.9.2 has already been performed with gaseous media, the test described above is not more required.

Other alternative procedures for the tightness test, as e.g. a pneumatic test, may be recognized by GL.

B.12.3.2 Vibration (fatigue strength) test

For the proof that the pipe connections withstand the vibrations under practical operating conditions, the following tests have to be performed:

B.12.3.2.1 Test for compression couplings and pipe unions

Compression couplings, pipe unions and similar connecting elements for the application in tension-proof pipe connections are to be tested with the test procedures described in the following. Tension-proof pipe connections are connections without free angle and longitudinal movement.

Two pipes of different length are to be connected with the test specimen. The shorter pipe is to be fixed, the longer pipe is loaded by a vibration device. The arrangement is shown in Fig. 3.2.

The whole arrangement is to be filled with the test liquid, carefully vented and put under pressure with an impulse pressure according to Fig. 3.4. This pressure is to be documented during the complete test duration. If there is a pressure drop or if visible signs of leakage are observed, the test has to be repeated according to the criteria in B.12.4.

The free end of one pipe is now loaded by vibrations with an amplitude to be computed as follows:

\[
A = 2 \cdot S \cdot L^2 / (3 \cdot E \cdot D)
\]

| A  | single amplitude [mm] |
| L  | length of pipe from pipe connection to vibration device |
S : bending stress (25 % of yield strength of pipe material) \([\text{N/mm}^2]\)
E : module of elasticity of the pipe material \([\text{N/mm}^2]\)
D : outside diameter of pipe \([\text{mm}]\)

During the test the amplitude has to be kept with an accuracy of 5%.

After installation of the test specimen the actual bending stress is to be checked via strain gauges or the bending forces.

The test specimen has to withstand at least \(10^7\) vibration cycles with a frequency of 20 – 30 Hz without damage or leakage. An adjustment of the arrangement of the test specimen is only allowed during the first 1000 cycles.

**B.12.3.2.2 Test for tension-proof joints**

Tension-proof joints will be tested as follows:

Two pipes of different length are to be connected with the test specimen. The shorter pipe is to be fixed, the longer pipe is loaded by a vibration device. The rigidly fixed pipe shall be as short as possible and in no case exceed a length of 200 mm. In longitudinal direction the movement of the pipe shall not be restricted. The arrangement is shown in Fig. 3.3.

The whole arrangement is to be filled with the test liquid, carefully vented and put under pressure with nominal pressure. For the application of joints with impulse load the loading has to be done with pressure impulses according to Fig. 3.4.

The test arrangement is to be loaded with vibrations with 1 meter distance from the middle of the pipe connection, where the cycles, amplitudes and frequencies defined in Table 3.3 are to be kept. A test run for each of the given parameter combinations is to be performed.

**Table 3.3 Parameters for tests with tension-proof pipe joints with cutting ring and grooved pipe ends**

<table>
<thead>
<tr>
<th>Number of load cycles</th>
<th>Amplitude A [mm]</th>
<th>Frequency [Hertz]</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3 \cdot 10^6)</td>
<td>(\pm 0.06)</td>
<td>100</td>
</tr>
<tr>
<td>(3 \cdot 10^6)</td>
<td>(\pm 0.5)</td>
<td>45</td>
</tr>
<tr>
<td>(3 \cdot 10^6)</td>
<td>(\pm 1.5)</td>
<td>10</td>
</tr>
</tbody>
</table>

**Fig. 3.2 Test arrangement for compression couplings and pipe unions**
Fig. 3.3 Test arrangement for tension-proof pipe connections with cutting ring and grooved pipe ends

This pressure is to be documented during the complete test duration. If there is a pressure drop or if visible signs of leakage are observed, the test has to be repeated according to the criteria in B.12.4. At the end of the test again a careful visual inspection for eventual signs of damage which might create leakage has to be performed.

B.12.3.2.3 Test result

At the end of the vibration test no leakage or damage shall occur which may lead to a failure in the following.

B.12.3.3 Pressure impulse test

B.12.3.3.1 Test procedure

The test specimens used for the tightness test may also be used for this test if they have passed the tightness test.

For the pipe unions angle sections and T pieces have to be arranged at the end of the longer pipe.

The pressure impulse test for compression couplings and pipe unions has to be performed at the same time as the vibration test according to B.12.3.2. For this the test specimen is to be loaded with a development of the pressure impulse according to Fig. 3.4. To reach a common test period, the frequency of the vibration test shall be 20 times the frequency of pressure impulse test.

The pressure impulse is to be increased from 0 to 1.5 times of the design pressure \( p_c \) with a frequency of 30 – 100 cycles per minute. The total number of cycles shall not be lower than \( 5 \cdot 10^5 \).

B.12.3.3.2 Test result

During the visual inspection at the end of the test no signs of leakage or damages may be observed to pass the test successfully.
B.12.3.4 Pull out test

B.12.3.4.1 Test procedure

To demonstrate if the pipe connection is able to withstand axial tension on the pipe line in addition to the internal pressure, the following test is to be performed. Pipes of suitable length are to be installed at both sides of the pipe connection. The test piece is to be loaded with the nominal pressure PN and additionally with a longitudinal force $L$:

$$L = 0.25 \cdot \pi \cdot D^2 \cdot PN \ [N]$$

$D$ : outside diameter of the pipe [mm]

$PN$ : design pressure [MPa]

The axial load is to be maintained for a period of 5 minutes.

During the test the pressure is to be indicated and eventual relative movements between connecting element and pipes are to be measured.

B.12.3.4.2 Test result

For a successful test no pressure drop shall occur and there shall be no signs of leakage or damages. In addition no relative movement between the pipes and the connecting element shall occur.

B.12.3.5 Vacuum test

This test serves to proof that the pipe connection shows no leakage in case of vacuum in the pipes under conditions similar to practical operation.

B.12.3.5.1 Test procedure

The test specimen is to be connected to a vacuum pump and to be brought to a pressure of 170 mbar absolute. After stabilization of this pressure the vacuum pump is to be disconnected, the under pressure is to be indicated for a period of 5 minutes and to be observed.

B.12.3.5.2 Test result

To pass the test successfully, no pressure increase shall happen inside.
B.12.3.6 Repeated assembly test

According to the specification of the manufacturer the test specimen of the pipe connection has to be disassembled and assembled 10 times and afterwards the test specimen has to undergo a tightness test according to B.12.3.1.

B.12.4 Test results overall

If a pipe connection does not pass all or only a part of the tests defined in Table 3.2, the tests which have not been passed are to be repeated with two further specimens for the same size and type. If one of the pipe connections does not pass the repeated test, the type and size of the specimen will not be approved.

The applied test procedures and results are to be summarized in a test report which is to be signed by the responsible representatives of the test laboratory.

B.13 Plastic pipes

B.13.0 Scope

These requirements are applicable to plastic pipes, fitting and joints. "Plastic" means both thermoplastic and thermosetting plastic materials with or without reinforcement, such as PVC and fibre reinforced plastics.

The requirements are not valid for hoses and mechanical couplings which are used in metallic piping systems.

Plastic pipe systems for the use in not safety relevant systems, as e.g. sanitary systems, may be approved alternatively to the tests defined herein according to other recognized standards. Typical pipe materials for these applications are thermoplastic plastic materials as e.g. polyethylene (PE), polypropylene(PP), polybutylene (PB).

B.13.1 Tests

B.13.1.1 Tests according to Section 2

• visual inspection

B.13.1.2 Additional tests according to B.13.3

• strength test of pipes and fittings
• impact resistance test
• temperature endurance test
• strength test for connecting elements and techniques
• fire endurance test
• low surface flame spread test
• electrical resistance test (for electrically conductive pipes)
• smoke development and toxicity test
• ageing, liquid absorption and material compatibility test

The scope of tests is to be defined in dependence of the application.

B.13.2 Number of test specimens

B.13.2.1 The selection of test specimen is to be performed in coordination with GL. The number of test specimens is dependent from the range of size as well as from the type and number of the types of connection in question, i.e. bonding, welding, laminating, flanging or plug-in systems.

B.13.2.2 The selection of test specimens is to be done as follows:

• if the largest size to be joined is 200 mm nominal outside diameter, the largest size to be joined is to be selected as test specimen;
• if the largest size to be joined is greater than 200 mm nominal outside diameter, the size of the diameter of the test specimen is to be selected as either 200 mm or 25 % of the largest piping size to be joined, whichever is greater.
B.13.2.3 The test specimens are to be prepared according to the joining technique and connections defined by the manufacturer and shall consist at least of a pipe to pipe connection and a connection pipe to fitting.

B.13.3 Additional tests

B.13.3.1 Strength test for pipes and fittings

This test is to be executed under standard conditions like: atmospheric pressure equal to 100 kPa, relative humidity 30 % and carried fluid temperature 298 °K (25 °C).

The strength of the fittings and connecting elements shall not be less than that of the pipes.

B.13.3.1.1 Internal pressure

Short time test:

The pressure in the test specimen is to be increased in three steps, that means up to nominal pressure, to 1.5 times nominal pressure and until a damage appears on the pipe.

\[ p_{\text{nenn (innen)}} \leq \frac{p_{\text{schadenkurzzeitig}}}{4} \]

The safety factor of 4 is principally to be used for fibre glass reinforced plastics. For thermoplastic plastic materials, which are not applied for safety relevant systems a safety factor according to the standard for the plastic pipe may be used.

Long time test:

\[ p_{\text{nenn (innen)}} \leq \frac{p_{\text{schadenlangfristig}}}{2.5} \]

Under damage after long time operation a use over 100 000 h shall be understood.

B.13.3.1.2 External pressure (optional)

\[ p_{\text{nenn (außen)}} \leq \frac{p_{\text{schadenaussen}}}{3} \]

The maximum outside pressure is the sum of the vacuum inside the pipe and the liquid pressure outside of the pipe. The test pressure \( p_{\text{schadenaussen}} \) shall be at least 3 bar.

Longitudinal strength:

The sum of the longitudinal stresses based on pressure, weight and other loads shall not exceed the permissible tension in longitudinal direction.

In the case of fibre glass reinforced plastics the sum of the longitudinal stresses shall not exceed the half of the circumferential stresses caused by the internal nominal pressure.

B.13.3.1.3 Resistance against external loads

Depending on the installation location, the pipes are loaded in addition to the loads of internal pressure, as well deadweight and filling weight also by outside loads, like e.g. persons, valves, etc. The distances between the pipe supports defined by the manufacturers have to consider this fact.

The defined distances of the pipe supports are to be checked by a load test. A pipe of at least 100 mm diameter which is filled with water and is pressurized with the maximum working pressure is loaded with a load of 100 kg in the middle of two supports for the period of at least 1 hour. During the loading time no leakage or damages of the pipe shall occur.

Alternatively to this test a deformation test according to ASTM D2412 or equivalent may be performed.

B.13.3.2 Impact resistance test

Plastic pipes, fittings and connecting elements are to have a minimum ductility according to recognized national or international standards, e.g. ISO 9854, ISO 9653, IDO 15493 or ASTM D 2444 or equivalent.

Plastic pipes and joints are firstly loaded with an impact in accordance with recognized national or international standards.

Afterwards the specimen is to be subjected to hydrostatic pressure equal to 2.5 times the nominal pressure for at least one hour.
B.13.3.3 Temperature endurance test

The allowable working temperature at the allowable working pressure shall be adequate to the recommendations of the manufacturer, but is to be at least 20 °C lower than the heat distortion temperature.

For thermoplastic materials the heat distortion temperature HDT is to be evaluated according to the standard ISO 75, Method A or the VICAT mollification temperature is to be evaluated according to ISO 306 or ISO 2507.

In case of glass fibre reinforced plastics (GRP) the HDT temperature is to be evaluated according to ISO 75, method A for the actually used resins. Resins with a HDT temperature below 80 °C are not to be used.

B.13.3.4 Strength test for connecting elements and techniques

If the test specimens are cured they have to be exposed to a hydrostatic pressure test with a pressure of design pressure times safety factor \(2.5\) for the duration of an hour. The test is to be performed in a way that the test specimen is loaded in longitudinal and circumferential direction. No leakage and no separation of the elements of the test specimen shall occur.

B.13.3.5 Fire endurance test

Pipes and relevant form and connecting elements with importance for the safety of the ship, have to meet the requirements for fire endurance according to IMO Resolution A.753(18), Appendix 1 and 2 depending on medium and installation location.

Three levels for the fire endurance of plastic pipe systems are to be distinguished:

Fire endurance level 1 (L1):

The pipe system passes the fire endurance test for the duration of one hour in dry condition without losing its integrity.

Fire endurance level 2 (L2):

The pipe system passes the fire endurance test for the duration of 30 minutes in dry condition without losing its integrity.

Fire endurance level 3 (L3):

The pipe system passes the fire endurance test for the duration of 30 minutes in wet condition without losing its integrity.

The relevant level for an actual pipe system and installation location is defined in the GL Rules Machinery Installations (I-1-2), Section 11, B.2.6.

B.13.3.6 Low surface flame spread test

All plastic pipes, except those fitted on open decks and within tanks, cofferdams, pipe tunnels and ducts as well as pipe systems which are situated behind wall and ceiling panels with fire class B, shall have low flame spread characteristics fulfilling the average values listed in IMO resolution A.653(16).

The surface flame spread characteristics are to be determined according to the procedure given in IMO Resolution A.653(16) with regard to the modifications due to the curvilinear pipe surfaces as listed in Appendix 3 of IMO Resolution A.753(18).

Alternatively the speed for spreading flames may be determined according to ASTM D635. The evaluated flame speed shall be adequate to values defined in the standards for the plastic material concerned.

Flame protection coating or insulation:

If a plastic pipe system needs flame protection coating or insulations to reduce the flame spread speed, the following requirements are to be observed:

- the pipes are to be delivered from the manufacturer complete with protection coating
- the fire protection characteristics of the protection coating shall not be diminished by salt water, oil or other liquids which are present in the relevant room
- for assessment of the protection coating heat extension, vibration resistance and elasticity are to be considered
- the fire protection coating shall have enough impact resistance to keep its integrity
B.13.3.7 Electrical resistance test

If electrical conductivity is required for the application, the electrical resistance shall not exceed $1 \cdot 10^6$ Ohm/m. The test is to be performed according to ASTM F 1173-95 or ASTM D257, NS 6126 or equivalent.

B.13.3.8 Smoke development and toxicity test

These tests are to be performed according to the IMO Fire Test Procedure Code (FTP Code).

B.13.3.9 Ageing, liquid absorption and material compatibility test

Ageing:

Depending on the range of application, e.g. open deck, the ageing of the plastic material is to be proven according to recognized standards or manufacturer standards. For bonded connections ISO 9142 is to be applied.

Absorption of liquids:

The absorption of water is to be proven according to recognized standards, e.g. to be evaluated for thermoplastic according to ISO 8361.

Material compatibility:

The manufacturer has to establish durability tables for the plastic pipe system concerned. If the plastic material shall be applied to media for which the manufacturer has not yet declared a release or if the compatibility is restricted, the durability has to be demonstrated according to recognized standards.

B.13.4 Test result overall

The overall test is deemed to have been passed, if the test results according to Section 2 and the single additional tests according to B.13.1.2 meet the requirements defined above.

B.14 Air pipe heads

B.14.1 Tests

B.14.1.1 Test according to Section 2

• visual inspection

B.14.1.2 Additional tests according to B.14.3

• wear resistance and form constancy test of the closure device
• measuring of hydraulic resistance
• tightness of the closure device
• impact test of balls/floats
• compression load of balls/floats
• determination of maximum air velocity

B.14.2 Number of test specimens

The tests are to be performed on at least three test specimens of smallest, medium and maximum size for each series and type.

For the tests of the hydraulic resistance and the tightness of the closure device all nominal diameters of each type are to be tested.

B.14.3 Additional tests

B.14.3.1 Wear resistance and form constancy of the closure device.

This test is to demonstrate that due to water flow through the closing device damages, like e.g. scaling of the seal from the seat, deformation of the ball/float, etc. not are happening.
B.14.3.1 Test procedure

The test specimen is to be subjected to water flow for a period of 30 minutes, whereby the pressure drop measured at the inlet shall be at least 0.5 bar. Subsequently, a tightness test according to B.14.3.3 is to be carried out.

B.14.3.1.2 Test result

The test is deemed to have been passed if no damage to the seal as well as to the ball /float can be detected and the leakage volume does not exceed the quantity specified in B.14.3.3.3.

B.14.3.2 Measurement of hydraulic resistance

By this test the flow characteristic of the air pipe closing devices is to be determined, see Fig. 3.5.

![Arrangement for measurement of hydraulic resistance](image)

B.14.3.2.1 Test procedure

The pressure loss on the inlet of the air pipe closing device is to be determined dependent from the volume flow. The measurement of the volume flow is to be in accordance with a recognized measurement procedure.

Water is to be used as test medium. The flame protection and insect protection grids are to be installed at the test.

Resistance curves up to a pressure loss of 0.5 bar at the inlet of the air pipe closing device are to be determined.

For determination of the resistance curves 10 measurement points are to be equally distributed in the range between 0 and 0.25 bar up and down, another 2 measurement points are to be equally distributed in the range between 0.25 and 0.5 bar up and down.

B.14.3.2.2 Test results

The evaluated measurement data is to be laid down in the form of resistance curves in a diagram.

B.14.3.3 Tightness test of the closure device

This test is to demonstrate that the tightness of the closing device in normal mounting position and up to 40° inclination is ensured, see Fig. 3.6. This test is to be carried out after the tests according to B.14.3.1 and B.14.3.2.

B.14.3.3.1 Test procedure

Test conditions

The tightness of the closure device is to be tested below the water level in the following positions:
**Position I:**  vertical immersion position

**Position II:**  outlet opening 40° inclination to the left

**Position III:**  Outlet opening 40° inclination to right

All parts of the closure device are to be wetted before starting the test.

**B.14.3.3.2 Test course**

The air pipe closure device has to be exposed to at least two immersion cycles under the following conditions:

- The air pipe closure device is to be immersed in each position at a velocity of 4 m/min below the water surface and immediately returned to the starting position. The resulting volume of leaking water is to be determined.

- The air pipe closure device is to be immersed in each position at a velocity of 8 m/min below the water surface and shall stay immersed for at least 5 minutes. The resulting volume of leaking water is to be determined.

**B.14.3.3.3 Test result**

The test is deemed to have been passed if a leakage volume of 2 ml per mm length of the nominal diameter of the inlet pipe is not exceeded.

**B.14.3.4 Testing of balls and floats of non-metallic materials**

This test is to demonstrate that under test conditions as specified in the following no deformation or damage will occur to balls and floats which are part of the closure device.

---

![Diagram of test positions](image-url)  
**Fig. 3.6**  Arrangement of the test positions

The balls and floats are to be subjected to an impact test and a compression loading test in the dry condition and after pre-conditioning by immersion in water respectively fuel oil according to **Table 3.4**.
Table 3.4 Test conditions and test temperatures for balls resp. floats

<table>
<thead>
<tr>
<th>Test condition</th>
<th>-25</th>
<th>20</th>
<th>85</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>After immersing in water</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>After immersing in fuel oil</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

The immersing period in water and fuel oil is to be at least 48 hours.

1 Depending on the material parameters the test temperature may be reduced in agreement with GL.

B.14.3.4.1 Test procedure

B.14.3.4.1.1 Impact test

The balls and floats are to be tested on a pendulum type testing machine under following loads, compare Fig. 3.7

- **impact load** = 2.5 Nm
  number of impacts = 5

  No deformations, cracks or impairment of the surface shall occur

- **impact load** = 25 Nm
  number of impacts = 5

  Some local damages at the impact point may occur, but no permanent deformations or formations of cracks shall occur at balls resp. floats

![Fig. 3.7 Arrangement of the balls/floats in the pendulum testing machine](image-url)
B.14.3.4.1.2 Compression loading test

The compression loading test shall be performed in a way that the balls resp. floats are mounted on a supporting ring with a diameter and mounting surface corresponding to that of the seating of the ball resp. float planned for application. For floats with ball form the loads are to be transmitted via a dished cap with the same internal radius as the float and the mounting is to be on a surface with the same diameter as the seat. For floats with disc form the loads are to be transmitted via a disc with the same diameter as the float.

A load of 3500 N is to be subjected to the balls resp. floats within one minute in a testing machine with a ball or float seat equivalent to the seat of the air pipe closure device and then to be kept for a period of 60 minutes, see Fig. 3.8. The occurring deformations are to be measured at intervals of 10 minutes after application of full load and are to be documented. The course of the deformation over the time shall not show a continuous increase of deformation and after relieving of the load no permanent deformation shall be present.

![Support for Ball and Float](image)

**Fig. 3.8  Arrangement of ball and float**

B.14.3.4.2 Test results

The tests are deemed to have been passed if no permanent deformations to the ball/float or other damages which may impair the tightness of the closure device have been detected.

B.14.3.4.3 Testing of balls and floats made of metallic materials

Balls and floats of metallic materials are to be subjected to an impact test according to B.14.3.4.1.1 in dry condition at room temperature.

B.14.3.5 Determination of maximum air velocity

This is the test of the maximum permissible air velocity from outside and inside. To avoid suction of the ball in the closure device during the bilge operation of water tanks it has to be ensured, that the ball remains in the resting position for air velocities up to 4 m/s. Higher air velocities may be approved by GL after special examination.

B.14.4 Overall test result

The test is deemed to have passed, if the test results according to Section 2 and of the single additional tests according to B.14.1.2 correspond to the specifications of the manufacturer approved by GL.
• function test (with 1.2 times of the scale end value, 10 seconds holding time, accuracy to be checked afterwards with 3 set values)
• dry heat test (test specimen stays operationally connected, test without overload to be performed with increased heat load of 70 °C with functional tests at 70 °C and after cooling down to 20 °C)
• damp heat test (test specimen stay operationally connected, after finishing the second 24 hours test cycle a function test at room temperature is to be performed)
• low temperature test (test at −25 °C, after temperature increase up to 0 °C a function test without overload is to be performed)
• salt mist test (finally a function test without overload at 20 °C is to be performed)

B.15.1.2 Additional tests according to B.15.3
• endurance test
• vibration test
• determination of characteristic curves

B.15.2 Number of test specimens
Three test specimens are to be tested for each series and type.

B.15.3 Additional tests
The additional tests may be checked for compliance with the test standards used by the manufacturer.

B.15.3.1 Endurance test
The pressure measuring instrument shall withstand dynamic loads between 30 % to 60 % of the scale end value for the number of load cycles defined in Table 3.5.

Table 3.5 Load cycles for mechanical pressure measuring instruments

<table>
<thead>
<tr>
<th>Scale end value of pressure measuring instrument [bar]</th>
<th>Number of load cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 25</td>
<td>100 000</td>
</tr>
<tr>
<td>above 25 to 600</td>
<td>50 000</td>
</tr>
<tr>
<td>above 600 to 1600</td>
<td>15 000</td>
</tr>
</tbody>
</table>

B.15.3.2 Vibration test
The characteristic curve is to be chosen according to the installation location (compare Section 2). The instrument has to undergo a test without overload in installation location 90° according to DIN 16257. The vibration loading is effected in horizontal and vertical direction in the plane of the scale.

After the vibration test a function test is to be performed.

The test results are to be summarized as defined for the examples in Table 3.6

B.15.3.3 Determination of characteristic curves
The final determination of the characteristic curves is to be performed after the respective last single test of the instrument.

The making for the set values shall be performed with slight knocking at increasing and dropping pressure. The characteristic curve is to be measured up and down with 10 set values each.

The test results are to be summarized as defined for the examples in Table 3.7.
B.15.4 Test result

B.15.4.1 The total error of the pressure measuring instrument shall be at maximum $\pm 5\%$ of the sum of the two scale end values and is valid for all positions of the scale in the indicating range.

B.15.4.2 The test is deemed to have been passed, if the measurement accuracy required by GL and guaranteed by the manufacturer has been verified.

B.16 Mechanical temperature measurement instruments

B.16.1 Tests

B.16.1.1 Test according to Section 2

- visual inspection
- function test (test with 1.2 times scale end value, then 3 set values are to be tested)
- low temperature test (followed by function test without overload with 3 set values)
- dry heat test (followed by function test without overload with 3 set values)
- damp heat test (followed by function test without overload with 3 set values)
- salt mist test (followed by function test without overload with 3 set values)
- vibration test (characteristic curve acc. to installation location, but not higher than curve 2; installation location during the test nominal location $90^\circ$ according to DIN 16257; vibration loads horizontally and vertically in the plane of the face plate)

The tests to be performed in a single case are to be defined according to the type of the measurement instrument and the range of application.

### Table 3.6 Model for the results of vibration tests

<table>
<thead>
<tr>
<th>Type of device</th>
<th>Measurement range [bar]</th>
<th>Test direction</th>
<th>Resonance frequencies [Hertz]</th>
<th>Resonance step-up [bar]</th>
<th>Endurance test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>vertical</td>
<td>$19 - 20$</td>
<td>$\pm 0.3 - 0.4$</td>
<td>$2$ $\pm 1 \text{ mm}$ $19 - 20$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>horizontal</td>
<td>none</td>
<td>$-\text{---}$</td>
<td>$-\text{---}$</td>
</tr>
<tr>
<td>$0 - 1$</td>
<td></td>
<td>vertical</td>
<td>$17 - 18$</td>
<td>$\pm 0.16$</td>
<td>$1$ $\pm 1 \text{ mm}$ $17 - 18$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>horizontal</td>
<td>$39$</td>
<td>$\pm 0.1$</td>
<td>$1$ $0.7g$        $39$</td>
</tr>
</tbody>
</table>

### Table 3.7 Model for determination of characteristic curves

<table>
<thead>
<tr>
<th>Set values [bar]</th>
<th>Actual values</th>
<th>Mistake</th>
<th>Reverse span</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forward [bar]</td>
<td>Backward [bar]</td>
<td>Forward [%]</td>
</tr>
<tr>
<td>0.5</td>
<td>0.59</td>
<td>0.57</td>
<td>$-0.35$</td>
</tr>
<tr>
<td>2.5</td>
<td>2.52</td>
<td>2.54</td>
<td>$-0.06$</td>
</tr>
<tr>
<td>7.5</td>
<td>7.40</td>
<td>7.40</td>
<td>$0.42$</td>
</tr>
<tr>
<td>12.5</td>
<td>12.36</td>
<td>12.37</td>
<td>$0.58$</td>
</tr>
<tr>
<td>17.5</td>
<td>17.36</td>
<td>17.35</td>
<td>$0.55$</td>
</tr>
<tr>
<td>20</td>
<td>19.90</td>
<td>19.88</td>
<td>$0.42$</td>
</tr>
<tr>
<td>25</td>
<td>24.87</td>
<td>24.88</td>
<td>$0.52$</td>
</tr>
<tr>
<td>etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B.16.1.2 Additional tests according to B.16.3
- endurance test
- determination of characteristic curves before and after the single tests in B.16.1.1 and B.16.1.2.

B.16.2 Number of test specimens
Three test specimens are to be tested for each series and type.

B.16.3 Additional tests
The tests defined in B.16.1.2 may be equalized with the test standard applied by the manufacturer.

B.16.3.1 Endurance test
500 load cycles with 75 % ± 5 % of the scale end value are to be performed, afterwards the accuracy is to be tested with 3 set values.

B.16.3.2 Determination of characteristic curves
The characteristic curve shall be measured up and down with 10 set points each.

B.16.4 Test result
B.16.4.1 The overall error of a temperature measuring instrument shall be at maximum ± 5 % of the sum of the both end values of the scale and be valid for all scale positions of the indicating range.

B.16.4.2 The test is deemed to be passed, if the measuring accuracy demanded by GL and guaranteed by the manufacturer could be verified.

B.17 Magnetic level indicators/membrane level indicators

B.17.1 Tests
B.17.1.1 Tests according to Section 2
- visual inspection
- function test before and after the vibration test with the inclination of 22.5° (magnetic level indicator only)
- vibration test
- pressure and tightness test
- burst pressure test

B.17.1.2 Additional test according to B.17.3
- proof of the resistance against relevant media

B.17.2 Number of test specimens
The tests have to be performed with one test specimen.

B.17.3 Additional tests
The proof of the durability may be balanced with the instructions of the manufacturers.

B.17.4 Test results
The test is deemed to have been passed, if at the pressure and tightness test, at the burst pressure test and at the function test no deficiencies have been detected.
B.18 Pneumatic tank level indicators

B.18.1 Tests

B.18.1.1 Test according to Section 2

- visual inspection
- function test of the indicating instruments before and after the vibration test
- vibration test of the indicating instruments
- pressure and tightness test of the compressed air treatment system including pressure measurement converter as well as non-return valve of the pearl-out line
- burst pressure test of the pressure measurement converter

B.18.1.2 Additional tests

B.18.1.2.1 Tests of the indicating instruments acc. to B.18.3

- tightness test
- determination of accuracy and hysteresis
- temperature influence
- load test
- blow out test

B.18.1.2.2 Test of the complete plant

- determination of the accuracy of the complete plant by means of three measuring points with water columns of 0 – 1 m, 0 – 2 m and 0 – 4 m.

B.18.2 Number of test specimens

The tests have to be performed with one indicating instrument and one tank level indicator with at least three measuring points.

B.18.3 Additional tests

The tests have to be performed according to EN 837-1 or equivalent standards.

If the indicating instruments owe already a type approval Certificate by GL, they have to be tested only within the frame work of the complete plant according to B.18.1.2.2.

B.18.4 Test results

The test is deemed to have been passed, if for the vibration and pressure tests of the indicating instruments as well as of the compressed air treatment system no deficiencies have been detected. Further on a total measuring error of $\pm 5\%$ related to the end value of the indicating instruments shall not be exceeded.

B.19 Resilient mounting elements

B.19.0 General

The test requirements defined in the following are valid for the mounting elements which are serving for the isolation of vibrations at the mounting of machinery plants.

B.19.1 Tests

B.19.1.1 Test according to Section 2

- visual inspection

B.19.1.2 Additional tests according to B.19.3

- resistance against possible aggressive media (between others: fuel oil, lubrication oil, cleaner, water, etc.)
• degree of damping of vibrations
• load tests for determination of spring characteristic (power-way-diagram) in vertical, longitudinal and transverse direction
• load tests for determination of the maximum permissible loading, the maximum permissible permanent loading and the maximum permissible spring displacement (at least in main load direction)
• determination of permissible shock loads (if applicable)
• vibration tests for determination of fatigue strength
• timely setting behavior under load (at least in main load direction)
• temperature resistance as well as influence of the temperature on the spring characteristic and the fatigue strength (temperature range according to range of application, usually 10 – 70 °C)
• determination of the hardness of the rubber

B.19.2 Number of test specimens
The tests have to be performed at least with 3 test specimens of different size for each series and type.
If one test specimen does not meet the requirement of a test, then the test may be repeated once more with two test specimens of the same size. If one of the test specimens does not pass the repeat test, then the test for the elements in the presented arrangement is to be considered as unsuccessful.

B.19.3 Additional tests
The tests defined in B.19.1.2 are generally to be performed according to recognized standards to be agreed between manufacturer and GL. Each test procedure is to be presented before performing the test.

B.19.4 Further information
In addition to the tests defined in B.19.1.1 and B.19.1.2 as well as to the documentation to be submitted according to Section 1, A.4 the following information shall be given for resilient mounting elements:
• unloaded height
• expected life time
• instructions for maintenance and care
• identification respectively marking during manufacturing concerning series and type

B.19.5 Test result
The tests are deemed to have been passed, if the defined specifications are verified, a continuous operation is secured and no other deficiencies can be found.

B.20 Flexible couplings

B.20.0 General
B.20.0.1 The test requirements defined in the following are valid for flexible couplings to be applied for torque transmission of propulsion plants and propulsion motors.

The scope of the test may be reduced in agreement with GL for couplings in Diesel generator units.
The couplings of units, where it is not required to submit a calculation of torque vibrations according to the valid GL Rules for Machinery Installations (I-1-2), Section 16, a proof of the dynamic values for torsional stiffness \( c_{TDYN} \), damping \( \psi \), permissible vibratory torque \( T_{KW} \) and power loss \( P_{KV} \) may be dispensed.

B.12.0.2 Definitions
\[ T_{KN} \] : nominal torque: torque which can be permanently transmitted within the complete permissible range [Nm]
\[ T_{Kmax1} \] : permissible torque: maximum torque, to be reached during a normal transient condition of the plant [Nm]
TKmax2: permissible torque: maximum torque, to be reached during an abnormal instationary condition of the plant [Nm]

TKW: vibratory torque: amplitude of the permanently permissible periodic torque vibration [Nm]

PKV: permissible power loss with which the maximum permissible core temperature of the elastomer (usual values for natural rubber abt. 100 °C resp. for silicon abt. 140 °C) at continuous operating condition is reached [kW]

cTdyn: dynamic torsional stiffness as relation of the elastic torque to the amplitude of the torsion angle during an oscillation about the average position [Nm/rad]

ψ: dynamic damping characteristic as relation of the damping work which is transferred to heat during one oscillation period, to the elastic work of deformation [-]

B.20.1 Tests

B.20.1.1 Tests according to Section 2

- visual inspection

B.20.1.2 Additional tests according to B.20.3

- Determination of the rubber hardness

- Load test with determination of the distortion angle Δ for loads of 25 %, 50 %, 75 %, 100 %, 125 % and 150 % of the nominal torque TKN for definition of the spring characteristics.

- Dynamic load test with an average torque of 25 %, 50 %, 75 % and 100 % of the nominal torque TKN superimposed with changing amplitudes of 25 %, 50 % and 100 % of the permissible TKW with a frequency between 2 and 20 Hz for determining the dynamic torsional stiffness cTdyn and damping ψ.

- Dynamic load test for verification of the permissible power loss PKV. For this the vibratory torque TKW and the frequency have to be adjusted in a way that the coupling is exposed to the permissible power loss PKV. The core temperature of the elements is to be recorded until 110 °C are reached without deviation for a period of 30 minutes.

- Dynamic load test at 100 % nominal torque TKN superimposed with 110 % of the permissible vibratory torque TKN with a frequency between 2 and 20 Hz for a period of at least 1 hour for confirmation of the permissible vibratory torque TKW.

- Load test with a pulsating load of 0 – 150 % of the nominal torque TKN without heat influence (that means: low frequency) for a duration of 5 \cdot 10^4 load cycles for confirmation of the permissible torque TKmax1 for normal transient conditions of the plant.

- Load test with a load of 400 % of the nominal torque TKN for confirmation of the maximum torque TKmax2 for abnormal instationary conditions of the plant.

B.20.2 Number of test specimens

The tests have to be performed with at least three test specimens of different size for each series and type.

If a test specimen does not meet the requirements of a test, the test may be repeated once more with two test specimens of the same size. The causes for the deviation have to be clarified.

If one of the test specimens does not pass the repeat test, then the test for the components in the presented arrangement is to be considered as unsuccessful.

B.20.3 Additional tests

The tests summarized in B.20.1.2 are generally to be performed in agreement between manufacturer and GL according to recognized standards and regulations. Each test procedure is to be presented to GL before performing the test.
B.20.4 Further information

In addition to the tests defined in B.20.1.1 and B.20.1.2 as well as to the documentation to be submitted according to Section 1, A.4 the following information shall be given for flexible couplings:

- instructions to installation, maintenance and care
- resistance against possibly aggressive media, as e.g. fuel oil, lubrication oil, water, cleaner, etc.
- identification resp. marking during manufacturing for series and type
- marking of the limit value for permanent deformation

B.20.5 Test result

The tests are deemed to have been passed, if the defined specifications are confirmed within a tolerance from -20 % to +10 %, a permanent operation is secured and no further deficiencies are experienced.

B.21 Explosion relief valves for the crankcase of internal combustion engines

B.21.0 General

B.21.0.1 Scope

The following requirements for relief valves are valid for internal combustion engines and also gear cases. The test procedure is only applicable to explosion relief valves with flame arrestors.

Where the flame arrester of the valve is designed in such a way that it is oil wetted during operation, alternative testing arrangements that demonstrate compliance with these Rules may be proposed by the manufacturer. They have to be agreed by GL.

Where valves are to be installed with shielding arrangements to deflect the emission of explosion combustion products, the valves are to be tested with the shielding arrangements fitted.

B.21.0.2 Purpose

The drawings and documentation have to be approved before the start of the tests by the Head Office of GL.

The purpose of type testing is:

- verification of the effectiveness of flame arresters
- verification that the valve closes after an explosion
- verification that the valve is gas/air tight after an explosion
- evaluation of the valve-specific maximum overpressure during an explosion

B.21.0.3 Standards to be recognized

The following standards have to be considered as far as applicable:

- EN 12874: Flame arresters - Performance requirements, test methods and limits for use
- ISO/IEC EN 17025: General requirements for the competence of testing and calibration laboratories
- IMO MSC/Circular 677: Revised Standards for the Design, Testing and Locating of Devices to Prevent the Passage of Flame into Cargo Tanks in Tankers

B.21.1 Tests

B.21.1.1 Tests according to Section 2

- visual inspection

B.21.1.2 Additional tests according to B.21.3

- demonstration of opening pressure and air tightness
- explosion tests stage 1
- explosion tests stage 2
- explosion tests stage 3
B.21.2 Test specimens

B.21.2.1 The valves are to be selected from the manufacturer’s normal production line by a representative of GL.

B.21.2.2 The selected valves have to be clearly marked to avoid any possible confusion.

B.21.2.3 For approval of a certain valve size, three valves of this size have to be tested in each intended orientation according to B.21.3.

B.21.2.4 For a series of valves according to B.21.2.6 three valves of one size of the middle range, one valve of the smallest and one of the largest size have to be tested.

B.21.2.5 The valves selected according to B.21.2.1 have to be at first satisfactorily tested according to B.21.3.1 before to be used for the other tests.

B.21.2.6 Prerequisites for series qualification of valves with the same design of the flame arrester

B.21.2.6.1 The qualification of the flame arrestors of a series of valves can be evaluated if one of these devices has been tested and found satisfactory.

B.21.2.6.2 The quenching ability of a flame arrester depends on the total mass of quenching lamellas/mesh. Provided the materials, thickness of materials, depth of lamellas, thickness of mesh layer and the quenching gaps are the same, then the same quenching ability can be qualified for different sizes of flame arresters subject to (1) and (2) being satisfied.

\[
\frac{n_1}{n_2} = \left(\frac{S_1}{S_2}\right)^{0.5} \quad (1)
\]

\[
\frac{A_1}{A_2} = \frac{S_1}{S_2} \quad (2)
\]

- \(n_1\): number of lamellas of size 1 flame arrester for a valve with a relief area equal to \(S_1\)
- \(n_2\): number of lamellas of size 2 flame arrester for a valve with a relief area equal to \(S_2\)
- \(A_1\): free area of quenching device for a valve with a relief area equal to \(S_1\)
- \(A_2\): free area of quenching device for a valve with a relief area equal to \(S_2\)

B.21.2.6.3 The qualification of explosion relief valves of larger sizes than that which have been selected according to B.21.2 and have been satisfactorily tested in accordance with B.21.3 can be proven where valves are of identical features of construction subject to the following:

B.21.2.6.3.1 The free area of the largest valve of a series shall not exceed three times \(+5\%\) that of the valve that has been satisfactorily tested.

B.21.2.6.3.2 One valve of the largest size, subject to B.20.2.6.3.1, requiring qualification is subject to satisfactory testing required by B.21.3.1 and B.21.3.4, except that a single valve will be accepted in B.21.3.4.1 and the volume of the test vessel is not be less than one third of the volume required by B.21.3.2.1, last paragraph.

B.21.2.6.3.3 The assessment and records are to be in accordance with B.21.5 noting that B.21.5.2 will only be applicable for stage 2 for a single valve.

B.21.2.6.4 The qualification of explosion relief valves of smaller sizes than that which have been selected according to B.20.2 and have been previously satisfactorily tested in accordance with B.21.3 can be evaluated where valves are of identical features of construction subject to the following:

B.21.2.6.4.1 The free area of the smallest valve of a series is not to be less than one third of the valve that has been satisfactorily tested.

B.21.2.6.4.2 One valve of the smallest size, subject to B.21.2.6.4.1, requiring qualification is subject to satisfactory testing required by B.21.3.1 and B.21.3.4, except that a single valve will be accepted in B.21.3.4.1 and the volume of the test vessel is not to be greater than the volume required by B.21.3.2.1, last paragraph, but not less than one third of this volume.

B.21.2.6.4.3 The assessment and records are to be in accordance with B.21.5 noting that B.21.5.2 will only be applicable for stage 2 for a single valve.
B.21.3 Additional tests

B.21.3.1 Demonstration of opening pressure and air tightness

Tests of the valves which have been selected according to B.21.2 are subjected to a pressure test at the manufacturer's works to prove that the specification is kept within a tolerance of ± 20% and that the valve is air tight at a pressure below the opening pressure for at least 30 seconds.

This is to evaluate the free area of the valve and of the flame arrester as well as the prove of the amount of maximum valve lift at 0.2 bar. A calculation of the spring force may be accepted by GL instead of this test.

B.21.3.2 General requirements for the explosion tests

B.21.3.2.1 Test facilities

The testing institution has to be accredited to a national or international standard and accepted by GL.

The test facilities for all three stages have to be arranged and equipped in the following way:

- The test facilities are to be equipped so that they can perform and record explosion testing in accordance with this procedure.
- The test facilities are to have equipment for controlling and measuring a methane gas concentration within a test vessel to an accuracy of ± 0.1%; The test vessel is to have connections for measuring the methane concentration in air at the top and bottom.
- The test facilities are to be capable of effective point loaded ignition of a methane/air mixture; The ignition is to be made at the centreline of the test vessel at a position approximately one third of the height or length of the test vessel opposite to where the valve is mounted.
- The pressure measuring equipment is to be capable of measuring the pressure in the test vessel in at least two positions, one at the valve and the other at the test vessel centre. The measuring arrangements are to be capable of measuring and recording the pressure changes throughout an explosion test at a frequency recognising the speed of the events during an explosion. The result of each test is to be documented by video recording and by recording with a heat sensitive camera;
- The test vessel for explosion testing is to be documented. It shall not be designed like a "pipe" which means that the distance between dished ends is not more than 2.5 times the diameter. Any stand-pipe arrangements of the test vessel shall be considered for the calculation of the volume.
- The test vessel is to be provided with a flange, located at the end of the vessel along its centreline, for mounting the explosion relief valve in the intended orientation, i.e. vertical or horizontal.
- A circular plate is to be provided for fitting between the pressure vessel flange and valve to be tested. The outside diameter shall be of 2 times the outer diameter of the valve and an internal bore shall have the same internal diameter as the valve to be tested.
- The test vessel volume is to be as far as practicable, related to the size and capability of the relief valve to be tested. In general, the volume is to correspond to the requirement that the free area of an explosion relief valve is not to be less than 115 cm²/m³ of the crankcase volume; this means:
  1. The testing of a valve having 1150 cm² of free area would require a test vessel with a volume of 10 m³.
  2. Where the relation of the free area of relief valve is greater than 115 cm²/m³ of the crankcase gross volume, the volume of the test vessel is to be consistent with the design ratio.
  3. In no case is the volume of the test vessel to vary by more than +15 % to –15 % from the design cm²/m³ volume ratio.

B.21.3.2.2 Explosion test process

For the explosion test process the following requirements have to be considered:

- All explosion tests are to be carried out using an air and methane mixture with a volumetric methane concentration of 9.5 % ± 0.5 %. This concentration shall be measured at the top and bottom of the vessel and shall not differ by more than 0.5 %.
- The pressure in the vessel is not to be less than atmospheric and is not to exceed the opening pressure of the relief valve.
- The ignition is to be made using a maximum 100 Joule explosive charge.
B.21.3.2.3 Test method

The following requirements are to be satisfied at explosion testing:

- The explosion testing is to be witnessed by a GL Surveyor.
- Where valves are to be installed on engines or gear cases with shielding arrangements to deflect the combustion products of an explosion, the valve is to be tested with the shielding arrangements fitted.
- Successive explosion testing to establish a valve’s functionality is to be carried out as quickly as possible during stable weather conditions.
- The pressure rise and decay during all explosion testing is to be recorded.
- The external condition of the valve is to be monitored during each test for indication of any flame release by video and heat sensitive camera.
- The explosion testing is to be performed in the following three stages for each valve that is required to be approved as type tested.

B.21.3.3 Explosion tests stage 1

Two explosion tests are to be carried out in the test vessel with the circular plate defined in B.21.3.2.1 fitted and the opening in the plate covered by a 0.05 mm thick plastic film. The aim of this test is to establish a reference pressure level in the test vessel which can be used for determination of the capability of a relief valve in terms of pressure rise.

B.21.3.4 Explosion tests stage 2

B.21.3.4.1 Two explosion tests are to be carried out on three different valves of the same size, compare B.20.2. Each valve is to be mounted in the orientation for which approval is sought, i.e. in the vertical or horizontal position with the circular plate described in B.21.3.2.1 located between the valve and pressure vessel mounting flange.

B.21.3.4.2 The first of the two tests is to be carried out with a 0.05 mm thick polythene bag, having a minimum diameter of three times diameter of the circular plate and a volume not less than 30 % of the test vessel, enclosing the valve and circular plate. Before carrying out the explosion test the polythene bag is to be empty of air. The polythene bag is required to provide a readily visible means of assessing whether there is flame transmission through the relief valve following an explosion consistent with the requirements of the standards identified in B.21.0.3.

During the test the explosion pressure will open the valve and some unburned methane/air mixture will be collected in the polythene bag. When the flame reaches the flame arrester and if there is flame transmission through the flame arrester, the methane/air mixture in the bag will be ignited and this will be visible.

B.21.3.4.3 Provided that the first explosion test successfully demonstrated that there was no indication of combustion outside the flame arrester and there are no visible signs of damage to the flame arrester or valve, a second explosion test without the polythene bag arrangement is to be carried out as quickly as possible after the first test.

During this second test the valve is to be visually monitored for any indication of combustion outside the flame arrester. This test is required to demonstrate that the valve can still function in the event of a secondary crankcase explosion.

B.21.3.4.4 After each explosion, the test vessel is to be maintained in the closed condition for at least 10 seconds to enable the tightness of the valve to be ascertained. The tightness of the valve can be verified during the test from the pressure/time records or by a separate test after completing the second explosion test.

B.21.3.5 Explosion tests stage 3

B.21.3.5.1 Two further explosion tests according to stage 1 have to be carried out.

B.21.3.5.2 These further tests are required to provide an average baseline value for assessment of pressure rise, recognizing that the test vessel ambient conditions may have changed during the testing of the valves in stage 2.
B.21.3.6 Check of components

After completing the explosion tests, the valves are to be dismantled and the condition of all components is to be ascertained and documented.

B.21.4 Test report

A full test report has to be submitted to GL that includes the following information and documents:

B.21.4.1 Opening pressure and air tightness test
- test specification
- designation, dimensions and characteristics of the tested valves
- a test report summarizing the results of the tests according to B.21.3.1 including the free area of the valve and of the flame arrester and of valve lift at 0.2 bar overpressure

B.21.4.2 Explosion tests
- test specification
- designation, dimensions and characteristics of the tested valves
- volume of test pressure vessel including details
- orientation in which the valve was tested (vertical or horizontal position)
- methane in air concentration for each test
- ignition source
- pressure curves for each test showing rise and decay during an explosion with indication of the pressure variation showing the maximum overpressure and steady underpressure at two points in the test vessel during testing
- video recording of each valve test and evaluation of the results of measurements of the heat sensitive camera
- condition of all valve components after each test is to be noted, photographic records are to be included

B.21.5 Test results

To verifying compliance with this Rule the assessment has to address the following:

B.21.5.1 The functioning of the flame arresters is proven if there is no indication of flame or combustion outside the valve during the explosion tests. This should be confirmed by measurements by a heat sensitive camera.

B.21.5.2 The pressure rise within the test vessel due to the installation of a relief valve is the difference between the average pressure of the four explosions from stages 1 and 3 and the average of the first tests on the three valves in stage 2. The valve has passed the type approval test if the pressure rise is not to exceed the limit specified by the manufacturer.

B.21.5.3 To verify that the valve has effectively closed and is reasonably gas-tight following dynamic operation during an explosion an under pressure of at least 0.3 bar is held by the test vessel for at least 10 seconds following an explosion.

B.21.5.4 After dismantling of the valve the flame arrester shall not show signs of serious damage or any deformation that may affect the operation of the valve. Any indication of valve sticking or uneven opening during the explosion that may affect operation of the valve has to be considered.
B.22 Equipment for the detection and alarming of oil mist in the crankcase of internal combustion engines (Oil mist detectors)

B.22.0 General

B.22.0.1 Scope
Oil mist detectors are to be used for crankcases of internal combustion engines, but may also be applicable for gear cases.

B.22.0.2 Purpose
The oil mist detector to be tested has to have approval of its drawings and documentation by GL Head Office before the start of the tests.

The purpose of type approval testing is sevenfold:
- verify the functionality of the oil mist detector
- verify the effectiveness of the oil mist detectors
- verify the accuracy of oil mist detectors
- verify the alarm set points
- verify time delays between oil mist leaving the source and alarm activation
- verify functional failure detection
- verify the function to detect optical disturbances

B.22.1 Tests
For the detectors including the indication panel the following tests have to be executed:

B.22.1.1 Tests according to Section 2
- vibration test
- dry heat test
- damp heat test

B.22.1.2 Tests for electric/electronic equipment
The following tests have to be executed according to GL Guidelines for Test Requirements for Electrical / Electronic Equipment and Systems (VI-7-2):
- electrical power supply failure test
- electrical power supply variation test
- electromagnetic compatibility (EMC) test, where susceptible
- insulation resistance test
- high voltage test
- static and dynamic inclination test, if moving parts are contained
- further tests may become necessary depending on the type of design

B.22.1.3 Additional tests according to B.22.3
- functional test

B.22.2 Number of test specimens

B.22.2.1 The oil mist detectors selected for type testing are to be selected from the manufacturer's normal production line by the GL Surveyor.

B.22.2.2 Two detectors of each type are to be tested. One is to be tested in clean condition and the other in a condition representing the maximum level of lens obscuration specified by the manufacturer.
B.22.2.3 The approval of one type of a design series may be used to qualify other devices having identical construction details. Proposals by the manufacturer of the oil mist detectors for approval of a series are to be agreed by GL.

B.22.3 Additional functional test

B.22.3.1 Test facility

The testing institution has to be accepted by GL and the test facility shall have the following equipment:

- a test chamber with a volume of not less than 1 m³
- the concentration of oil mist in the test chamber is to be measured in the top and bottom of the chamber and these concentrations are not to differ more than 10 %
- the oil mist detectors are to be capable of detecting oil mist in air concentrations between 0 and 10 % of the lower explosive limit (LEL) or between 0 and a percentage corresponding to a level not less than twice the maximum oil mist concentration alarm set point.

B.22.3.2 Generation and control of oil mist

The oil mist generation is to satisfy the following:

B.22.3.2.1 Oil mist is to be generated with suitable equipment using an SAE 80 monograde mineral oil or equivalent and is to have a maximum droplet size of 5 μm. The oil droplet size is to be checked using the sedimentation method.

B.22.3.2.2 The oil mist concentrations used are to be ascertained by the gravimetric deterministic method or equivalent.

B.22.3.2.3 Samples of oil mist are to be taken at regular intervals and the results plotted against the oil mist detector output. The oil mist detector is to be located adjacent to where the oil mist samples are drawn off.

B.22.3.2.4 The results of a gravimetric analysis are considered invalid and are to be rejected if the resultant calibration curve has an increasing gradient with respect to oil mist detection reading. This situation occurs when insufficient time has been allowed for the oil mist to become homogeneous. Single results that are more than 10 % below the calibration curve are to be rejected. This situation occurs when the integrity of the filter unit has been compromised and not all of the oil is collected on the filter paper.

B.22.3.2.5 The filters require to be weighed to a precision of 0.1 mg and the volume of air/oil mist sampled by 10 ml.

B.22.3.3 Test method

B.22.3.3.1 The oil mist detector is to be tested in the orientation (vertical, horizontal or inclined) in which it is intended to be installed on an engine or gear case as specified by the equipment manufacturer.

B.22.3.3.2 Where sensitivity levels can be adjusted, testing is to be carried out at the extreme and mid-point level settings.

B.22.3.3.3 The alarm set point for oil mist concentration is to provide an alarm at a maximum level corresponding to not more than 5 % of the LEL.

B.22.3.3.4 Where alarm set points can be altered, the means of adjustment and indication of set points are to be verified against the equipment manufacturer's instructions.

B.22.3.3.5 Where oil mist is drawn into a detector via piping arrangements, the time delay between the sample leaving the crankcase and operation of the alarm is to be determined for the longest and shortest lengths of pipes recommended by the manufacturer. The pipe arrangements are to be in accordance with the manufacturer's instructions/recommendations.

B.22.3.3.6 The elements of the oil mist detector which are in contact with the crankcase atmosphere and may be exposed to oil splash and spray from engine lubricating oil are to be demonstrated as being such, that openings do not occlude or become blocked under continuous oil splash and spray conditions. Testing is to be in accordance with arrangements proposed by the manufacturer and agreed by GL.
B.22.3.3.7 The elements of the detector may be exposed to water vapour from the crankcase atmosphere which may affect the sensitivity of the equipment and it is to be demonstrated that exposure to such conditions will not affect the functional operation of the detector. Where exposure to water vapour and/or water condensation has been identified as a possible source of detector malfunctioning, testing is to demonstrate that any mitigating arrangements such as heating are effective. Testing is to be in accordance with arrangements proposed by the manufacturer and agreed by GL.

B.22.3.4 Equipment examination

After completing the tests, the oil mist detector is to be examined and the condition of all components is to be ascertained and documented.

B.22.4 Further information

B.22.4.1 A full test report has to be submitted to GL which includes the following information and documents:

- test specification
- details of oil mist detector tested such as name of manufacturer, type designation, oil mist concentration assessment capability and alarm settings, etc.
- description and schematic layout of oil mist detectors showing location of sensors and piping arrangements and dimensions including alarm limits
- test results including photographic records of the monitoring equipment condition

B.22.4.2 In addition a maintenance and test manual has to be delivered by the manufacturer to GL.

B.22.5 Test results

The complete test is deemed to have been passed if:

- the detailed tests according B.22.1.1 and B.22.1.2 have fulfilled the acceptance criteria defined in Section 2 respectively in the relevant GL Rules
- the additional functional test according to B.22.3 has proven that the oil mist detector is suitable to detect and measure oil mist concentrations with the required accuracy and that the performance is kept under the defined environmental conditions

The type approval Certificate has to include the mechanical as well as the electric/electronic part of the system.

B.23 Pressure/vacuum safety valves for cargo tanks

B.23.1 General

B.23.1.1 Scope

The following requirements for pressure/vacuum safety valves are valid for:

- cargo tanks on oil and chemical tankers

B.23.1.2 Purpose

The purpose of pressure/vacuum safety valves is:

- prevention of entrance of flames into the cargo tanks
- protection of the structure of cargo tanks against overpressure and vacuum

B.23.1.3 Documents for approval

The following documents have to be submitted for approval:

- drawings and part lists with material data
- design calculations
- installation instructions
- operating and maintenance instructions
- documentation for the test facilities
B.23.1.4 Marking of the device
The safety valves are to be marked durably and lasting with the following data:

- manufacturer's name or trademark
- designation of type, suitable for clear identification
- size of inlet and outlet of the approved valve
- approved location for installation including maximum and minimum length of pipe, if any
- direction of flow through
- serial number
- designation of test laboratory and number of test report
- reference number for compliance with applied standards
- hydrostatic test pressure
- pressure and vacuum setting used during testing
- other markings if required by national regulations

B.23.2 Tests

B.23.2.1 Tests according Section 2
- visual check

B.23.2.2 Additional tests according to B.23.3
- corrosion test
- hydrostatic pressure test
- flow and velocity test
- functional test with external layer of ice
- test for undamped oscillations
- fire resistance test

These tests are in principal equivalent to the standard ISO 15364 and the IMO Regulation MSC/Circ. 677.

B.23.3 Selection and number of test specimens
One valve of each type and each size is to be tested.

Changes of design, materials or construction that effect the corrosion resistance or the flow characteristics are to be considered as change of type and require therefore new test specimens and tests.

B.23.4 Additional tests

B.23.4.1 Corrosion test
A complete valve including a section of pipe to which the valve will be fitted, shall be exposed to a 5% sodium chloride spray at a temperature of 25 °C for the period of 240 hours. Subsequently drying for 48 hours has to be performed. Afterwards all movable parts shall operate properly and there shall be no corrosion deposits that cannot be washed off.

B.23.4.2 Hydrostatic pressure test
The pressure retaining part of the valve shall be subjected to a hydrostatic pressure test with at least 1.5 times the maximum allowable working pressure, at a minimum pressure of 3450 hPa. For the test period of 10 minutes no rupture, leaking or permanent distortion shall be observed. For this purpose the valve disc may be gagged or blocked.
B.23.4.3 Flow and velocity test

B.23.4.3.1 Determination of capacity

The capacity of the pressure/vacuum safety valve shall be established by flow testing at least at one test specimen of every type and size under the conditions listed in B.23.3.3.2 to 23.3.3.4.

B.23.4.3.2

B.23.4.3.3 Capacity data

The following requirements shall be met when establishing capacity data:
- The pipes, as well as the connections between the pipes and the device, shall be without obstructions causing additional turbulence.
- The nominal diameter of the test pipe shall be of the same or larger size as the valve being tested.
- All pressure measuring points shall be arranged normal to the pipe axis and shall not influence the flow.
- The test medium shall be air at ambient conditions; ambient pressure and temperature shall be recorded to convert flow rate to normal conditions.
- All measuring instruments shall be calibrated.

B.23.4.3.4 Test plant

The arrangement of the test plant is shown in Fig. 3.9.

The dimensions of the tank (key 3) shall be sufficient to allow a mean flow velocity of less than $\frac{0.5}{m}$ in the tank. The pressure course in the tank is to be recorded under these conditions.

The test pipe length $L_1$ shall have a length of not more than $10 \cdot D$ and not less than $1.5 \cdot D$ of the test specimen. The tank penetration shall be at a location of the tank where it is essentially flat and the rounding of the penetration shall be in accordance with recognized national or international standards to provide uniform pressure drop influence.

For testing the vacuum part the flow direction is to be reversed.

It is to be observed that the fan may cause oscillation in the system if the fan wings are not aligned or damaged.

B.23.4.3.5 Flow measurements

- The flow measurements are to be made for the lowest and highest setting of the specific test specimen. Flow values for in-between settings can be interpolated.
- The pressure at which the valve opens is to be established using a flow rate resulting in a pressure rise not greater than $0.01 \frac{N}{mm^2/min}$ ($10 \frac{kPa}{min}$). The set pressure shall be within $\pm 3\%$ of the calculated pressure expressed as the correlation between the closing force and the area of the disc against which tank pressure is projected.
- Depending on valve type, the flow measurements shall be performed in several steps according to ISO 15364, Annex B. This standard shows in Annex F also examples for flow diagrams. During the steps according to Annex B the average velocity of the air through a cross section of the valve's outlet to atmosphere is to be recorded.
- Valves based upon maintaining a minimum velocity shall be suitable of opening in such a way that a velocity of $30 m/s$ is immediately initiated and will be maintained for all flow conditions. When the gas flow is interrupted the minimum velocity shall be maintained during the closing procedure until the valve is fully closed.
- The tests are to be performed with the test plant according to B.23.3.3.3, all measuring instruments are to be calibrated where the inaccuracy shall not exceed $\pm 5\%$.

B.23.4.4 Functional test with external layer of ice

With this test shall be verified up to which thickness of external ice layer the ability of the valve to function is maintained.
The valve including a section of the pipe to which the valve will be fitted shall be exposed to a temperature of \(-10 \, ^\circ\text{C}\) for a period of 24 hours. Afterwards 1 l water with a temperature not higher than \(+2 \, ^\circ\text{C}\) shall be sprayed every 10 minutes on the outer parts of the valve until the required thickness of the ice layer is reached. It is to be checked if a proper function of the valve is given.

**B.23.4.5 Test for undamped oscillations**

**B.23.4.5.1 Test arrangement**

The arrangement of the test plant is shown in Fig. 3.10.

**B.23.4.5.2 Test procedure**

- The tests are to be carried out with the lowest and highest setting of the particular test specimen.
- The length \(L_2\) and the diameter of the pipe as well as the content of the tank are to be determined by the manufacturer.
- The tests are to be carried out for 3 minutes each at ten equally spaced flow rates which include the range of \((0.2 \text{ to } 2.0) \times Q_{\text{close}}\); \(Q_{\text{close}}\) represents the minimum through flow to keep the valve open without contact between valve disc and valve seating.
- Detrimental hammering of the valve disc to seating and upper stops is to be avoided, to avoid resulting damages. If the disc location sensor indicates contact with either seating or upper stops with a frequency of more than 0.5 Hz, the pipe length \(L_2\) shall be shortened until this value is not exceeded. That pipe length is to be recorded as \(L_{\text{max}}\), the used pipe diameter as \(D_{\text{min}}\) and the content of the tank as \(V_{\text{min}}\). These values are to be adequately observed for the practical application.
- For valves, where there is no flow volume at the closing pressure, the tests shall already start at \(0.1 \times Q_{\text{close}}\).

**B.23.4.6 Fire resistance test**

The fire resistance test for the valve and the flame arrestor of the vacuum part is to be performed according to IMO MSC/Circ. 677.
B.23.5 Test results

B.23.5.1 Test report

The test report shall contain:

- detailed drawings of the valve and its components
- details about performed tests and the results obtained, with all recorded test data
- specific advice on approved attachments
- drawings of the test plant including a description of the inlet and outlet piping attached
- markings of the test specimens
- operation and installation manual (to be established by the manufacturer)
- number of test report

B.23.5.2 Test criteria

The test is deemed to have passed, if the test specimens show no mechanical damages, which influence the original performance in an unfavourable way.

B.24 Safety valves

The spring loaded and pilot controlled safety valves are treated in Section 4.

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Fig. 3.10  Test plant for vibration measurements
Section 4 Test Requirements for Special Components of Offshore Technology

A General
In this Section the necessary test requirements in the scope of type approval testing of special components of offshore technology are defined.

For components, plant elements or devices not mentioned herein, the test requirements are to be defined case by case according to operating conditions.

B Definition of the Test Requirements
In the following for the mentioned components type approval tests will be defined:

1. Quick connect/disconnect coupling as emergency separating device
2. LNG control and shut-off valve for use in terminals
3. Safety valves

B.1 Quick connect/disconnect (QC/DC) coupling as emergency separating device in LNG operation

Quick connect/disconnect couplings (QC/DC) with integrated valve for the application in hose connections between loading terminals and ships as well as between ships (Ship to shore/Ship to Ship).

B.1.1 Tests

B.1.1.1 General
For these tests the data defined in the GL Rules for Machinery Installations (IV-6-5), Section 13c are to be considered additionally.

B.1.1.2 Tests according to Section 2
- visual inspection
- salt mist test
- pressure test

B.1.1.3 Additional tests according to B.1.3
- cold shock test
- combined strength and leakage volume test
- operational and emergency separating test including leakage volume measurement under ice conditions
- fire safe test

B.1.2 Number of test specimen
The number of test specimens is defined as follows:
DN 25 – DN 100: one test specimen of arbitrary nominal size
Nominal size > DN 100: one test specimen for each nominal size
B.1.3 Additional tests

B.1.3.1 Cold shock test

B.1.3.1.1 Test procedure

The test of the operationally connected QC/DC is to be performed with liquid nitrogen at a low temperature less than $\text{\textminus}160\,\text{°C}$ and ambient pressure:

- The QC/DC is to be filled with liquid nitrogen within 5 minutes.
- The external surface of the QC/DC shall be exposed to atmosphere during the whole test duration.
- All internal areas which are in contact with the medium have to come into contact with the medium and shall be exposed to the cold shock test.
- The QC/DC has to stay filled with liquid nitrogen under test conditions for at least 1 hour.

B.1.3.1.2 Test results

After finish of the cold shock test and after reaching room temperature, the QC/DC has to be dismantled completely. All parts which are not exposed to pressure have to undergo a visual inspection. All parts which are exposed to pressure have to undergo a crack test according to recognized international technical regulations.

With a positive result (free of cracks) of these tests the cold shock test is deemed to have been passed.

B.1.3.2 Combined strength and leakage volume test

The combined strength and leakage volume test shall ensure the perfect operation of the QC/DC under a simulated test load.

B.1.3.2.1 Procedure for relevant leakage and tightness tests

For the following applied leakage and tightness test the following test procedures are valid:

B.1.3.2.1.1 Test of internal tightness

The QC/DC is internally to be cooled down by LNG or liquid nitrogen to a temperature of less than $\text{\textminus}160\,\text{°C}$.

The valves of the QC/DC are to be closed and are to be freed at the outlet side from pressure and medium. The leakage rates are to be measured under the following pressures:

$0.5\,\text{bar};\ 0.25 \times p_c;\ 0.5 \times p_c;\ 0.75 \times p_c;\ 1 \times p_c$ with $p_c = 19\,\text{bar}$ or the specified design pressure, if that is bigger.

The valves have to close tight, no medium shall escape.

B.1.3.2.1.2 Test of external tightness

The external tightness of the QC/DC is to be measured under the allowable pressure in open and closed position. For external tightness measurement a gas detector is to be used.

B.1.3.2.1.3 Test results

The tests are deemed to have been passed, if the test results of the internal and external tightness tests meet the conditions defined by the manufacturer and approved by GL.

B.1.3.2.2 Strength test - Test procedure Part 1

- Operationally connected QC/DC with liquid nitrogen; working pressure 19 bar or specified design pressure if bigger; temperature less than $\text{\textminus}160\,\text{°C}$.
- Loading of the QC/DC with a bending moment $MT = 2 \times MA$, with $MA$ as maximum bending moment to be calculated, to be chosen from the most unfavourable load combination according to the loads occurring during operation.
- Loads are e.g. deadweight (DL), pressure (PL), wind (WL), thermal load (TL).
- The loads have to be applied stepwise and to be kept for 5 minutes.
- Measurement of external leakage according to B.1.3.2.1.2.
B.1.3.2.3 Strength test - Test procedure Part 2

Operationally connected QC/DC with liquid nitrogen; working pressure 19 bar or specified design pressure, if bigger; temperature less than −160 °C.

The QC/DC is to be released under maximum test load:
- Both integrated valves have to close tight. (no jamming!)
- Both parts of the QC/DC shall separate.
- Measurement of the internal leakage of both integrated valves according to B.1.3.2.1.1.

B.1.3.2.4 Test results

The test is deemed to have been passed, if under external load no leakage and permanent deformation is occurring at any part. After separation of the both housing halves no internal leakage shall occur.

B.1.3.3 Operational and emergency separating test including leakage volume measurement under ice conditions

During the operation of the QC/DC and the LNG flow the possibility of icing exists. In case of an emergency release the QC/DC has to separate also under icing conditions without problems and the both integrated valves have to close tight.

The emergency separating test is to be performed under normal and icing conditions. The separation and the tight closing including leakage are to be checked.

B.1.3.3.1 Test procedure

The operationally connected QC/DC is to be tested with liquid nitrogen at a temperature less than −160 °C under a working pressure of 19 bar or the specified design pressure, if this is bigger.
- For the test under icing the QC/DC is to be provided with a continuous external ice layer of 10 mm (at all components). The ice layer is e.g. to be created by spraying with water.
- Loading of the QC/DC with a bending moment \( MT = 2 \times MA \), with MA as maximum bending moment to be calculated, to be chosen from the most unfavourable load combination according to the loads occurring during operation.
  
  Loads are e.g. deadweight (DL), pressure (PL), wind (WL), thermal load (TL).
- The loads have to be applied stepwise and to be kept for 5 minutes.

B.1.3.3.2 Scope of measurements and tests

The following measurements and tests have to be performed:
4. Measurement of the external leakage according to B.1.3.2.1.2. No gas shall escape!
5. Release of the QC/DC.
6. Measurement of the closing time respectively of the time for complete opening (maximum 30 seconds)
7. Measurement of the internal leakage of the both integrated valves according to B.1.3.2.1.1.

B.1.3.3.3 Number and type of tests to be performed

The test is to be performed for 10 times under the following criteria:
- 3 test procedures under icing, without external load
- 2 test procedures under icing, with external load according to B.1.3.3.1
- 3 test procedures without icing, without external load
- 2 test procedures without icing, with external load according to B.1.3.3.1

B.1.3.3.4 Test results

The test is deemed to have been passed if the following criteria are met:
- No external leakage shall occur.
- The both halves of the QC/DC have to separate. No leakage shall occur at the valves.
- Both integrated valves have to close tight (no jamming !)
B.1.3.4 Fire safe test
The QC/DC is subjected to a Fire Safe Test according to API 607/6FA or according to ISO 10497. The test is to be performed by an authorized API Test Institute or a governmentally approved Test Authority. The fire safe test is to be performed for the QC/DC in closed as well as in separated condition with both closed valves on each side.
All details and the scope of test are to be agreed with GL before start of the test. The successfully performed fire safe test is to be documented with all test and measurement results and Certificates. The documentation is to be submitted to GL as original for approval and will become part of the GL type approval Certificate.

B.1.4 Test result overall
The results of all single tests have to be positive to reach an overall approval. The results of all tests have to be documented.

B.2 LNG control and shut-off valve for use in terminals
Scope of tests for control of shut-off valves of different types for the use in LNG terminals.

B.2.1 Tests
B.2.1.1 General
For these tests the definitions in the GL Rules for Machinery Installations (IV-6-5), Section 13c are to be considered.

B.2.1.2 Test according to Section 2
- visual inspection
- pressure test
- tightness test

B.2.1.3 Additional tests according to B.2.3
- cold shock test
- tightness test for housing and seating at low temperature
- function test at room temperature and at low temperature
- fatigue strength test and tightness test at low temperature
- fire resistance test

B.2.2 Number of test specimens
The type approval test is to be performed with three test specimens of different nominal size for each type and series. If the test results of one of three specimens do not meet the requirements, the test is to be repeated with two test specimens of the nominal size which failed.

B.2.3 Additional tests
As far as not otherwise defined by GL or if specified by an international standard recognized by GL, the test procedure for the additional tests is to be performed according to EN 12567 or as defined in the following.

B.2.3.1 Cold shock test
A cold shock test has to be performed to check the influence of temperature expansions on the function.

B.2.3.1.1 Test procedure
The test has to be performed with liquid gas or liquid nitrogen at a test temperature equal or less than -160 °C at ambient pressure.
The valve is to be brought in a partially open position and is to be filled within 5 minutes. The valve has to stay filled with the medium for at least 1 hour under test conditions.
B.2.3.1.2 Test results
After the performed cold shock test the test specimens have to be completely dismantled and checked for damages. All parts which are not exposed to pressure have to undergo a visual inspection. All parts which are exposed to pressure have to undergo a crack test according to an international standard recognized by GL.

With a positive result (free of cracks) of these tests the cold shock test is deemed to have been passed.

B.2.3.2 Function test at room temperature
With the valves a function test at room temperature has to be performed.

B.2.3.2.1 Test procedure
The test procedure has to follow the definitions of the manufacturer which are recognized by GL.

The handling forces and moments for opening and closing of the valves are to be measured and, if necessary, to be compared with the instructions of the manufacturer.

B.2.3.2.2 Test results
The test is deemed to have been passed, if the test results are in accordance with the design data of the manufacturer.

B.2.3.3 Fatigue strength test and tightness test at low temperature
The types of valves to be tested have to be subjected to a fatigue strength test. The fatigue strength test is to be performed with LNG or liquid nitrogen.

As far as not specified by other instructions of GL or by an international standard recognized by GL, the test procedure is to be performed according to EN 12567.

The test sequence shall at least include the following scope of tests:
- test of internal tightness at low temperature
- test of external tightness at low temperature
- function test under working pressure at low temperature
- test of fatigue strength at low temperature
- final test of the housing and the seating at room temperature after the fatigue strength test
- check of single parts by dismantling of the valve after the fatigue strength test

B.2.3.3.1 Test procedure
The valve is internally to be cooled down at the test stand with LNG or liquid nitrogen to a temperature below \(-160\, ^\circ C\).

B.2.3.3.1.1 Test of internal tightness at low temperature
The valve is to be closed and to be relieved at the outlet side of the valve. Unless specified otherwise by GL the leakage rates defined according to EN 12567 are to be measured under the pressures defined as follows:

\[ 0.5 \text{ bar}; 0.25 \times p_{c,zul}; 0.5 \times p_{c,zul}; 0.75 \times p_{c,zul}; 1 \times p_{c,zul} \] with \( p_{c,zul} \) as maximum allowable working pressure.

If the valve is not designed for one flow direction only, the test is to be performed for all flow directions.

B.2.3.3.1.2 Test of external tightness at low temperature
The external tightness is to be measured under the maximum allowable working pressure in closed and open position. No gas shall escape. For the measurement a gas detector with a measurement accuracy of at least 10 % of the lower ignition limit of methane in air is to be used.

B.2.3.3.1.3 Function test under working pressure at low temperature
The test procedure is to be performed according to the instructions of the manufacturer recognized by GL. The forces and moments needed for opening and closing are to be measured.
B.2.3.3.1.4 Test of fatigue strength at low temperature

This test serves as proof that in practical operation no permanent or temporary functional disturbances are occurring by operating the valve. As far as not specified otherwise and recognized by GL, the test pressure is the nominal pressure. The following load cycles have to be performed, one load cycle containing a complete opening and closing of the valve:

- up to nominal diameter \( \text{DN} = 200 \text{ mm} \):
  - 2000 load cycles
- for nominal diameter above \( \text{DN} = 200 \text{ mm} \):
  - 500 load cycles

If the valve is not designed for one flow direction only, the test is to be performed for all through directions.

Unless the test is not performed according to EN 12567, the tests for external and internal tightness are to be repeated during the fatigue strength test in six, defined in advance intervals according to B.2.3.3.1.1 and B.2.3.3.1.2.

B.2.3.3.1.5 Final test of the housing and seating at room temperature after the fatigue strength test

After finishing the fatigue strength test the following tests are to be repeated with the valve:

- tightness test of housing and seating according to B.2.1.2

B.2.3.3.1.6 Check of single parts by dismantling of the valve after the fatigue strength test

After finishing all tests for the fatigue strength test, the valve has to be dismantled completely. All single parts are to be checked for eventual damages. For the check of single parts a test report is to be created.

B.2.3.3.2 Test results

The fatigue strength test is deemed to have been passed, if all test results are in accordance with the instructions of GL or with the instructions of an international valve standard recognized by GL. For the fatigue strength test a test report is to be established which shall contain all test and measurement results.

B.2.3.4 Fire resistance test

Valves and fittings for liquefied gases for the use at offshore and onshore terminals are to be tested for fire resistance.

B.2.3.4.1 Test procedure

The tests for fire resistance are to be performed according to the instructions of ISO 10497 by a test laboratory recognized and authorized by GL. An alternative test according to API standard may be recognized by GL if suitable.

B.2.3.4.2 Test results

The tests are deemed to have been passed if the test specimens meet the full scope of requirements of ISO 10497. The test documentation with the test results as well as the Certificates issued by the test laboratory is to be submitted to GL as original for approval.

B.2.4 Test result overall

All test and measurement results of the following scope of tests are to be documented in a test report to be approved by GL. The test report shall include the following results and data:

Visual inspection, pressure test, cold shock test, tightness test of the closure and the spindle penetrations as well as strength test of the housing relating to enclosures, blowholes, etc. at room and low temperature, fatigue strength test.

Data concerning leakage and tightness classes are to be defined according to the instructions of GL or the relevant international valve standard recognized by GL.
B.3 Safety valves

Safety valves for the application on ships, onshore and offshore terminals, as well as LNG plants.

B.3.1 Tests

B.3.1.1 General

For these tests the definitions in the GL Rules for Machinery Installations (IV-6-5), Section 13c are to be considered additionally.

For safety valves of LNG tankers the definitions in the GL Rules for Liquefied Gas Carriers (I-1-6) are to be considered.

B.3.1.2 Tests according to Section 2

- visual inspection

B.3.1.3 Additional tests according to B.3.4

- pressure test
- test of seating tightness
- test for determination of the function characteristic
- test for determination of the opening characteristic
- test for the determination of the through flow characteristic

For safety valves in LNG plants the tests are to be performed with gases of known features according to data given in B.3.4.3.2.

B.3.1.4 Additional tests for safety valves for low temperature use/LNG as well as on liquefied gas tankers according to B.3.6

- cold shock tests

B.3.1.5 Additional tests only for safety valves on seagoing ships according to B.3.7

- salt mist test (only for safety valves which are installed on the open deck)

B.3.2 Number of test specimens

For the requirements and selection of test specimens the instructions of the ISO EN 4126 are to be considered. Otherwise the following instructions of GL are valid:

For a certain type series of a safety valve, consisting of seven or more nominal sizes, the tests are to be performed with three safety valves of different nominal size for each series. If the series consists of maximum six nominal sizes, the number of test specimens may be reduced to two.

In case of extensions of safety value series, for which the tests of the preceding test specimens and nominal sizes are not more representative, further tests with a relevant number of test specimens are to be agreed.

B.3.3 Test facilities

Test facilities shall be according to the newest technical standard and shall be suitable for the requirements of the relevant technical standard on which the design is based. All measuring instruments are to be calibrated before start of the test.

B.3.4 Additional tests

Unless not specified by other instructions of GL or another international standard recognized by GL, the additional tests are to be performed according to the instructions in ISO EN 4126. Otherwise the additional tests shall include the following test procedures.
B.3.4.1 Pressure test

B.3.4.1.1 Hydrostatic pressure test

B.3.4.1.1.1 Test procedure

The part of the valve from the inlet to the valve seating is to be tested with 1.5 times the maximum allowable working pressure defined by the manufacturer. The valve body at the outlet side is to be tested with 1.5 times the maximum back pressure defined by the manufacturer.

The relevant duration of test shall enable a visual inspection of the valve parts and surfaces. As far as the test duration is not defined according to ISO 4126 or according to another international standard recognized by GL, the minimum duration of the pressure test has to be chosen according to Table 4.1.

Table 4.1 Minimum duration of the pressure test

<table>
<thead>
<tr>
<th>Nominal size DN [mm]</th>
<th>Duration of test [minutes]</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN ≤ 100</td>
<td>10</td>
</tr>
<tr>
<td>100 &lt; DN ≤ 300</td>
<td>15</td>
</tr>
<tr>
<td>300 &lt; DN</td>
<td>20</td>
</tr>
</tbody>
</table>

B.3.4.1.2 Pneumatic pressure test

The pressure test with compressed air or other suitable gases may be possible as an alternative to the hydrostatic pressure test with GL approval and under the following conditions:

a) The design of the valve does not allow filling with water or another liquid.

b) The valve will be tested for operation conditions which do not tolerate even a little amount of water.

For pneumatic pressure trials adequate precautionary and safety measures have to be taken, especially for protection of human life. For designs of safety valves with pneumatic pressure test the material has to be chosen in a way that the danger of brittle fracture under test conditions will be avoided.

B.3.4.1.2.1 Test procedure

The test procedure and the instructions for test duration and test pressure are to be chosen according to B.3.4.1.1.1.

B.3.4.1.2.2 Test results

The test is deemed to have been passed, if no permanent damages or other deficiencies at the parts exposed to pressure and no inadmissible leakages at the housing and at the closures can be stated.

B.3.4.2 Test for seating tightness

B.3.4.2.1 Test procedure

The test for the tightness of the seating and the belonging leakage rates are to be performed according to the design standard of the safety valve as well as to the instructions of the manufacturer, the operator and the approval of GL.

B.3.4.2.2 Test results

The test is deemed to have been passed, if the tightness of the seating and the belonging leakage rates are in accordance with the definitions of GL and the standard of the safety valve.

B.3.4.3 Test of determination of the function characteristic

B.3.4.3.1 Actuation pressure

Unless specified by a safety valve standard recognized by GL, the instructions of ISO 4126 have to be considered for the test of the actuation pressure.

As actuation pressure for which the function characteristic is to be evaluated, the minimum and maximum actuation pressure for the actually installed spring is to be used.
B.3.4.3.1.1 Permissible tolerances
The permissible tolerances respectively limit values for the function characteristics are the following:

a) Actuation pressure: \( \pm 3\% \) of the actuation pressure or \( \pm 0.15 \) bar, the bigger value is valid
b) Lift: not less than the value defined by the manufacturer
c) Difference of opening pressure: the value defined by the manufacturer, but maximum \( 10\% \) of the actuation pressure or \( 0.1 \) bar, the bigger value is valid.
d) Difference of closing pressure: not bigger as the value defined by the manufacturer, but within the following limits:
   - For compressible media: minimum \( 2.0\% \) (not valid for safety valves with proportional opening characteristic);
     maximum \( 15\% \) or \( 0.3 \) bar, the bigger value is valid
   - For incompressible media: minimum \( 2.5\% \) (not valid for safety valves with proportional opening characteristic);
     maximum \( 20\% \) or \( 0.6 \) bar, the bigger value is valid

e) The difference of the opening pressure and the difference of the closing pressure are to have for valves with lift limitation the same tolerances and limit values as for valves with not limited lift.
f) The difference of the opening pressure and the difference of the closing pressure of safety valves with proportional opening characteristics have to be checked and shall be constant within the minimum and maximum value defined by the manufacturer for different lifting heights. A curve has to be established, showing the lift of the valve in relation to the difference of the opening pressure.

Other tolerances may be chosen from an international standard for safety valves recognized by GL respectively are to be approved by GL.

B.3.4.3.1.2 Permissible tolerances for LNG Tanks on board of liquefied gas tankers
For safety valves on board of liquefied gas tankers the following tolerances are valid for the actuation pressure respectively the adjustment pressure to safeguard that the safety valve opens at the prescribed adjustment pressure:

- \( \pm 10\% \) for pressures from \( 0 \) to \( 1.5 \) bar
- \( \pm 6\% \) for pressures from \( 1.5 \) to \( 3.0 \) bar
- \( \pm 3\% \) for pressures from \( 3.0 \) bar and above

See also the information in the GL Rules for Liquefied Gas Carriers (I-1-6), Section 8.

B.3.4.3.2 Test media
The following test media are to be applied:

- a) Valves for air and other gases are to be tested with air or other non-toxic and non-flammable gases with known characteristics.
- b) Valves for toxic and flammable gases are to be tested with air or other non-toxic and non-flammable gases with known characteristics.
- c) Valves for steam are to be tested with superheated steam with minimum \( 10 \) °C superheating.
- d) Valves for any other vapours are to be tested with air or non-toxic and non-flammable gases with known characteristics.
- e) Valves for liquid operation are to be tested with water or another liquid with known characteristics.

B.3.4.3.3 Test results
The test are deemed to have been passed, if the actuation pressures and the belonging springs fulfil the instructions of the valve standard and the design criteria agreed between manufacturer and costumer approved by GL.

B.3.4.4 Test for determination of the opening characteristic
The characteristic for opening and lifting is to be specified by the manufacturer.
B.3.4.4.1 Test procedure

Unless specified and approved by GL, the requirements according to ISO EN 4126 are to be considered. Alternatively instructions of other international standards recognized by GL may be applied.

B.3.4.4.2 Test results

The test is deemed to have passed, if the opening and lifting characteristics are according to the design requirements of the manufacturer and the valve standard approved by GL.

B.3.4.5 Test for the determination of the flow characteristic

For the test of the through flow characteristic the media according to B.3.4.3.2 are to be chosen. The safety valves to be tested have to be the same as were used for determining the function and opening characteristics.

B.3.4.5.1 Test procedure

Unless specified otherwise by GL the definitions for the test procedure according to ISO EN 4126 are to be considered. Alternatively instructions of other international standards recognized by GL may be applied.

B.3.4.5.2 Test results

The test results have to deliver the following characteristic data:

- number of tests for each type and nominal diameter of the safety valve
- actual outlet mass flow evaluated by the test
- outlet figure according to theoretical mass flow

The mechanical characteristics of the valve as satisfactory retaking of the seating, rattling, fluttering, sticking and/or disturbing vibrations are to be checked by visual and/or acoustic observations. All test results are to be documented in a test report.

B.3.5 Test result overall

The test results shall include all reports, measurements and test results of the single performed tests. Reports concerning the adjustment and calibration of the instruments and the test equipment are to be delivered in the same way.

The test results shall include the following information:

- results of the visual inspection
- results of the pressure test
- function and opening characteristics with actuation and closing pressure
- number of the tests for each type and nominal diameter of the safety valve
- actual outlet mass flow evaluated by the test
- calculated outlet figure according to theoretical mass flow
- for safety valves in LNG operation: successfully performed cold shock test, see also data under 3.6
- for safety valves on ships: successfully performed salt mist test

The test is deemed to have been passed, if the test results are in accordance with the approved requirements of GL and the relevant standard for safety valves.

B.3.6 Safety valves for LNG/liquefied gas operation

Safety valves for the utilization in LNG plants as well as on liquefied gas tankers have to meet additionally to the requirements defined in B.3.1.2 and B.3.1.3 the following test requirements.

B.3.6.1 Cold shock test

A cold shock test is to be performed to check the influence of temperature expansion on the function. Unless specified by a standard approved by GL, the cold shock test is to be performed as follows.
B.3.6.1.1 Test procedure
The test is to be performed with liquefied gas or liquid nitrogen at a test temperature equal or less than -160 °C under ambient pressure.

The valve has to be brought in a partially open condition and is to be filled within 5 minutes.

B.3.6.1.2
The valve shall remain filled with the test medium for at least 1 hour under test condition.

B.3.6.1.3 Test results
After the performed cold shock test the test specimens have to be completely dismantled and checked for damages. All parts which are not exposed to pressure have to be subjected to a visual inspection. All parts which are exposed to pressure have to be subjected to a crack test according to a recognized international standard.

With a positive result (free of cracks) of these tests the cold shock test is deemed to have been passed.

B.3.7 Additional tests only for safety valves on seagoing ships
Safety valves for the use on seagoing ships have to undergo a salt mist test. The salt mist test serves as a proof that the safety valves have a sufficient corrosion resistance under salty atmosphere and that the operability is unimpaired.

The salt mist test is to be performed according to Section 2, B.7

B.3.8 Remarks to the type approved safety valves according to ASME and API
The utilization of type approved safety valves according to ASME and API on ships, onshore and offshore plants as well as LNG plants may be approved by GL under following preconditions:

The type approved safety valves are able to fulfil the requirements of technical safety for the purpose of utilization and operation and the location of installation.

The tests relating to function and opening characteristics as well as flow measurement have been successfully performed according to the instructions of ASME and API and are approved by GL for the adequate purpose of utilization and installation location.

The tests have been performed by a test laboratory officially recognized and authorized by the ASME and/or API organisations.

The test results contain at least the data defined in B.3.5.

The test documentation with the test results as well as the issued test Certificates are to be submitted to GL for approval as originals.
Annex A Guidelines for the Performance of Product Audits

A General

A.1 Within the framework of a product audit it is to be checked whether the requirements for materials respectively final surveys as well as markings of the product specified in the Rules for Classification and Construction of GL are part of the quality system implemented by the manufacturer. Furthermore is to be checked if the specified characteristics of the product are maintained by adequate manufacturing procedures and if they are proven and documented by the tests performed by the manufacturer according to the working procedures and test instructions. The results of the performed examination are to be documented by the Auditor in a report.

A.2 The relevant elements of quality management (QM), affecting the design, production and testing of the delivered products are to be checked in accordance with the procedure and working instructions as well as test instructions of the manufacturer. As a rule, these instructions have to comply with the requirements of relevant recognized standards.

A.3 The product audit is to be performed in the manufacturer’s workshop. During the audit the QM documents of at least three completed deliveries are to be checked at random.

A.4 Regarding manufacturing of the product, the elements of the QM system (e.g. ISO 9001 or equivalent) which are defined in detail in the following are to be examined:

B The Elements of the QM System

B.1 Document and data control

For control of documents and data procedures are to be available, whereas documents of external origin, such as construction rules, standards and customer requirements, have to be taken in account as well.

B.2 Testing and release of supplied product components

B.2.1 The specifications for components which are required for manufacturing of the products have to be defined and released by the manufacturer.

B.2.2 The manufacturer has to specify the requirements regarding the required tests and documentation in the purchase documents.

B.3 Identification and traceability of product components

B.3.1 To enable identification and traceability at any time during all phases of production from semifinished to final product as well as during supply and assembly, the product components are clearly marked, as appropriate.

B.3.2 The marking of the final product shall be in accordance with the conditions defined in the Construction Rules and Guidelines.

B.3.3 For these activities the manufacturer has to establish documented procedures.
B.4 Inspection and testing

B.4.1 General

For inspections and tests to be performed, the manufacturer has to establish and maintain working instructions respectively test instructions and process procedures. These have to include the requirements of the Rules for Classification and Construction of GL.

All tests have to be performed by adequately trained personnel.

B.4.2 Receiving inspection and testing

Components which are supplied to the manufacturer are to be subjected to a receiving inspection. The acceptance criteria have to be defined in the relevant working instruction respectively in the test instruction. The supplied components are to be marked upon release. Receiving inspection and marking have to be documented for traceability of the components.

B.4.3 Intermediate inspection and testing

B.4.3.1 The results of the planned intermediate inspections and tests are to be documented.

B.4.3.2 It shall be ensured, that only components, which have successfully completed the required tests and inspections are subsequently processed.

B.4.4 Final inspection and testing

B.4.4.1 The working instruction respectively the test instruction for the final inspection and testing shall contain details confirming that all assigned quality tests, including receiving, intermediate and final inspections and tests have been carried out completely and that the results meet the quality requirements.

B.4.4.2 It has to be ensured that no products are dispatched before all tests and inspections defined in the test instruction and QM instruction have been successfully completed.

B.4.5 Inspection and test records

The manufacturer has to establish records to provide evidence of all performed inspections and tests with the respective products. The records have to clearly prove that the products meet the requirements of the tests and acceptance criteria.

B.5 Control of inspection and test equipment

B.5.1 The inspection and test equipment used by the manufacturer is to be controlled, calibrated and maintained in accordance with the criteria specified in procedures and shall be capable of being identified by appropriate marking.

B.5.2 Records are to be established and maintained on the calibration of inspection and test equipment used by the manufacturer.

B.5.3 The manufacturer has to specify the required accuracy of measurements and testing to be performed. Consequently appropriate inspection and test equipment has to be selected, the accuracy of which complies with international or national standards.

B.6 Inspection and test status

The inspection and test status of products has to be identified by suitable means which indicate the conformance of the products with regard to quality checks performed. The identification of the inspection and test status has to be maintained throughout production, installation and maintenance to ensure, that only products which have passed the required quality checks are dispatched, installed and used.

B.7 Control of non-conforming products

B.7.1 To ensure that no products are released and used, which did not meet the required quality requirements, these products are to be clearly marked and stored in separate areas.

B.7.2 The measures for further treatment are to be specified and documented.
B.8 Control of quality records

B.8.1 The manufacturer has to establish and maintain working procedures for identification, collection, registration, accessibility, filing, storage, maintenance and disposition of quality records.

B.8.2 Quality records have to be stored according to the Guidelines of GL, to demonstrate conformance to the specified quality requirements and effective operation of the quality system.

For inspection and test records in the frame work of a type approval testing there is the obligation to keep them up to 5 years after ending of the validity of the Type Approval Certificate.

Records in the frame work of the accompanying quality control of the manufacturing process have to be kept at minimum for 10 years after delivery of the product.