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TYPE TESTING PROCEDURE FOR CRANKCASE EXPLOSION RELIEF VALVES

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TYPE TESTING PROCEDURE FOR CRANKCASE EXPLOSION RELIEF VALVES

1. Scope

1.1 To specify type tests and identify standard test conditions using methane gas and air mixture to demonstrate that classification society requirements are satisfied for crankcase explosion relief valves intended to be fitted to engines and gear cases.

1.2 This test procedure is only applicable to explosion relief valves fitted with flame arresters.

Note:
Where internal oil wetting of a flame arrester is a design feature of an explosion relief valve, alternative testing arrangements that demonstrate compliance with this UR may be proposed by the manufacturer. The alternative testing arrangements are to be agreed by the classification society.

2. Recognised Standards

2.1 EN ISO 16852:2010: Flame arresters – Performance requirements, test methods and limits for use.

2.2 ISO/IEC EN 17025:2005: General requirements for the competence of testing and calibration laboratories.

2.3 EN 1070:1998: Safety of Machinery – Terminology.

2.4 VDI 3673: Part 1: Pressure Venting of Dust Explosions.

2.5 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

Note:

(1) *Engines are to be fitted with components and arrangements complying with this UR when:*

(i) *The engine is installed on existing ships (i.e. ships for which the date of contract for construction is before 1 January 2008) and the date of application for certification of the engine is on or after 1 January 2008; or*

(ii) *The engine is installed on new ships (i.e. ships for which the date of contract for construction is on or after 1 January 2008).*

(2) *The "contracted for construction" date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of "contract for construction", refer to IACS Procedural Requirement (PR) No. 29.*

3. Purpose

3.1 The purpose of type testing crankcase explosion relief valves is fourfold:

3.1.1 To verify the effectiveness of the flame arrester.

3.1.2 To verify that the valve closes after an explosion.

3.1.3 To verify that the valve is gas/air tight after an explosion.

3.1.4 To establish the level of over pressure protection provided by the valve.

4. Test facilities

4.1 Test houses carrying out type testing of crankcase explosion relief valves are to meet the following requirements:

4.1.1 The test houses where testing is carried out are to be accredited to a National or International Standard, e.g. ISO/IEC 17025, and are to be acceptable to the classification societies.

4.1.2 The test facilities are to be equipped so that they can perform and record explosion testing in accordance with this procedure.

4.1.3 The test facilities are to have equipment for controlling and measuring a methane gas in air concentration within a test vessel to an accuracy of ± 0.1%.

4.1.4 The test facilities are to be capable of effective point-located ignition of a methane gas in air mixture.

4.1.5 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 events during an explosion. The result of each test is to be documented by video recording and by recording with a heat sensitive camera.

4.1.6 The test vessel for explosion testing is to have documented dimensions. The dimensions are to be such that the vessel is not “pipe like” with the distance between dished ends being not more than 2.5 times its diameter. The internal volume of the test vessel is to include any standpipe arrangements.

4.1.7 The test vessel is to be provided with a flange, located centrally at one end perpendicular to the vessel longitudinal axis, for mounting the explosion relief valve. The test vessel is to be arranged in an orientation consistent with how the valve will be installed in service, i.e., in the vertical plane or the horizontal plane.

4.1.8 A circular plate is to be provided for fitting between the pressure vessel flange and valve to be tested with the following dimensions:

(a) Outside diameter of 2 times the outer diameter of the valve top cover.
(b) Internal bore having the same internal diameter as the valve to be tested.

4.1.9 The test vessel is to have connections for measuring the methane in air mixture at the top and bottom.

4.1.10 The test vessel is to be provided with a means of fitting an ignition source at a position specified in item 5.3.

4.1.11 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 in UR M9.3 for the free area of explosion relief valve to be not less than 115cm2/m3 of crankcase gross volume.

Notes:

(1) *This means that the testing of a valve having 1150cm2 of free area, would require a test vessel with a volume of 10m3.*

(2) *Where the free area of relief valves 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.*

5. Explosion test process

5.1 All explosion tests to verify the functionality of crankcase explosion relief valves are to be carried out using an air and methane mixture with a volumetric methane concentration of 9.5% ±0.5%. The pressure in the test vessel is to be not less than atmospheric and is not to exceed the opening pressure of the relief valve.

5.2 The concentration of methane in the test vessel is to be measured at the top and bottom of the vessel and these concentrations are not to differ by more than 0.5%.

5.3 The ignition of the methane and air mixture 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.

5.4 The ignition is to be made using a maximum 100 joule explosive charge.

6. Valves to be tested

6.1 The valves used for type testing (including testing specified in item 6.3) are to be selected from the manufacturer's normal production line for such valves by the classification society witnessing the tests.

6.2 For approval of a specific valve size, three valves are to be tested in accordance with 6.3 and 7. For a series of valves item 9 refers.

6.3 The valves selected for type testing are to have been previously tested at the manufacturer's works to demonstrate that the opening pressure is in accordance with the specification within a tolerance of ± 20% and that the valve is air tight at a pressure below the opening pressure for at least 30 seconds.

Note:

This test is to verify that the valve is air tight following assembly at the manufacturer's works and that the valve begins to open at the required pressure demonstrating that the correct spring has been fitted.

6.4 The type testing of valves is to recognise the orientation in which they are intended to be installed on the engine or gear case. Three valves of each size are to be tested for each intended installation orientation, i.e. in the vertical and/or horizontal positions.

7. Method

7.1 The following requirements are to be satisfied at explosion testing:

7.1.1 The explosion testing is to be witnessed by a classification society surveyor.

7.1.2 Where valves are to be installed on an engine or gear case with shielding arrangements to deflect the emission of explosion combustion products, the valves are to be tested with the shielding arrangements fitted.

7.1.3 Successive explosion testing to establish a valve's functionality is to be carried out as quickly as possible during stable weather conditions.

7.1.4 The pressure rise and decay during all explosion testing is to be recorded.

7.1.5 The external condition of the valves is to be monitored during each test for indication of any flame release by video and heat sensitive camera.

7.2 The explosion testing is to be in three stages for each valve that is required to be approved as being type tested.

7.2.1 Stage 1:

7.2.1.1 Two explosion tests are to be carried out in the test vessel with the circular plate described in 4.1.8 fitted and the opening in the plate covered by a 0.05mm thick polythene film.

Note:

These tests establish a reference pressure level for determination of the capability of a relief valve in terms of pressure rise in the test vessel, see 8.1.6.

7.2.2 Stage 2:

7.2.2.1 Two explosion tests are to be carried out on three different valves of the same size. 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 4.1.8 located between the valve and pressure vessel mounting flange.

7.2.2.2 The first of the two tests on each valve is to be carried out with a 0.05mm thick polythene bag, having a minimum diameter of three times the diameter of the circular plate and 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 Section 2.

Note:

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.

7.2.2.3 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 the second explosion test, the valve is to be visually monitored for any indication of combustion outside the flame arrester and video records are to be kept for subsequent analysis. The second test is required to demonstrate that the valve can still function in the event of a secondary crankcase explosion.

7.2.2.4 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.

7.2.3 Stage 3:

7.2.3.1 Carry out two further explosion tests as described in Stage 1. These further tests are required to provide an average baseline value for assessment of pressure rise, recognising that the test vessel ambient conditions may have changed during the testing of the explosion relief valves in Stage 2.

8. Assessment and records

8.1 For the purposes of verifying compliance with the requirements of this UR, the assessment and records of the valves used for explosion testing is to address the following:

8.1.1 The valves to be tested are to have evidence of design appraisal/approval by the classification society witnessing tests.

8.1.2 The designation, dimensions and characteristics of the valves to be tested are to be recorded. This is to include the free area of the valve and of the flame arrester and the amount of valve lift at 0.2bar.

8.1.3 The test vessel volume is to be determined and recorded.

8.1.4 For acceptance of the functioning of the flame arrester there is not to be any indication of flame or combustion outside the valve during an explosion test. This should be confirmed by the test laboratory taking into account measurements from the heat sensitive camera.

8.1.5 The pressure rise and decay during an explosion is to be recorded, with indication of the pressure variation showing the maximum overpressure and steady under- pressure in the test vessel during testing. The pressure variation is to be recorded at two points in the pressure vessel.

8.1.6 The effect of an explosion relief valve in terms of pressure rise following an explosion is ascertained from maximum pressures recorded at the centre of the test vessel during the three stages. The pressure rise within the test vessel due to the installation of a relief valve is the difference between 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 pressure rise is not to exceed the limit specified by the manufacturer.

8.1.7 The valve tightness is to be ascertained by verifying from the records at the time of testing that an underpressure of at least 0.3bar is held by the test vessel for at least 10 seconds following an explosion. This test is to verify that the valve has effectively closed and is reasonably gas-tight following dynamic operation during an explosion.

8.1.8 After each explosion test in Stage 2, the external condition of the flame arrester is to be examined for signs of serious damage and/or deformation that may affect the operation of the valve.

8.1.9 After completing the explosion tests, the valves are to be dismantled and the condition of all components

ascertained and documented. In particular, any indication of valve sticking or uneven opening that may affect operation of the valve is to be noted. Photographic records of the valve condition are to be taken and included in the report.

9. Design series qualification

9.1 The qualification of quenching devices to prevent the passage of flame can be evaluated for other similar devices of identical type where one device has been tested and found satisfactory.

9.2 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 (a) and (b) being satisfied.

(a) (b)

$n1 = S1$
$n2 \quad S2$

$A1 = S1$
$A2 \quad S2$

Where:

n1 = total depth of flame arrester corresponding to the number of lamellas of size 1 quenching device for a valve with a relief area equal to S1

n2 = total depth of flame arrester corresponding to the number of lamellas of size 2 quenching device for a valve with a relief area equal to S2

A1 = free area of quenching device for a valve with a relief area equal to S1

A2 = free area of quenching device for a valve with a relief area equal to S2

9.3 The qualification of explosion relief valves of larger sizes than that which has been previously satisfactorily tested in accordance with Sections 7 and 8 can be evaluated where valves are of identical type and have identical features of construction subject to the following:

9.3.1 The free area of a larger valve does not exceed three times + 5% that of the valve that has been satisfactorily tested.

9.3.2 One valve of the largest size, subject to 9.3.1, requiring qualification is subject to satisfactory testing required by 6.3 and 7.2.2 except that a single valve will be accepted in 7.2.2.1 and the volume of the test vessel is not to be less than one third of the volume required by 4.1.11.

9.3.3 The assessment and records are to be in accordance with Section 8 noting that 8.1.6 will only be applicable to Stage 2 for a single valve.

9.4 The qualification of explosion relief valves of smaller sizes than that which has been previously satisfactorily tested in accordance with Sections 7 and 8 can be evaluated where valves are of identical type and have identical features of construction subject to the following:

9.4.1 The free area of a smaller valve is not less than one third of the valve that has been satisfactorily tested.

9.4.2 One valve of the smallest size, subject to 9.4.1, requiring qualification is subject to satisfactory testing required by 6.3 and 7.2.2 except that a single valve will be accepted in 7.2.2.1 and the volume of the test vessel is not to be more than the volume required by 4.1.11.

9.4.3 The assessment and records are to be in accordance with Section 8 noting that 8.1.6 will only be applicable to Stage 2 for a single valve.

10. The report

10.1 The test facility is to deliver a full report that includes the following information and documents:

10.1.1 Test specification.

10.1.2 Details of test pressure vessel and valves tested.

10.1.3 The orientation in which the valve was tested, (vertical or horizontal position).

10.1.4 Methane in air concentration for each test.

10.1.5 Ignition source.

10.1.6 Pressure curves for each test.

10.1.7 Video recordings of each valve test.

10.1.8 The assessment and records stated in 8.

11. Approval

11.1 The approval of an explosion relief valve is at the discretion of individual classification societies based on the appraisal plans and particulars and the test facility's report of the results of type testing.