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CLASSIFICATION NOTES

Type Testing Procedure for Crankcase Explosion Relief Valves

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Type Testing Procedure for Crankcase Explosion Relief Valves

1. Scope, Application

- 1.1 This type testing procedure specifies standard conditions under which crankcase explosion relief valves intended to be fitted to diesel engines can be tested to demonstrate that they satisfy IRS and engine builder's requirements for type testing.
- 1.2 This test procedure is also applicable to explosion relief valves intended for gear cases.
- 1.3 Standard repeatable test conditions have been established using methane gas and air mixture.
- 1.4 The 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 Classification Notes may be proposed by the manufacturer. The alternative testing arrangements are to be agreed by IRS.

- 1.5 Engines are to be fitted with components and arrangements complying with these Notes when:
 - i) the engine is installed on existing ships (i.e. ships for which the date of contract for construction is before 1 July 2008) and the date of application for certification of the engine is on or after 1 July 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 July 2008).

2. Recognised Standards

- 2.1 EN 12874:2001: Flame arresters-Performance requirements, test methods and limits for use.
- 2.2 EN ISO/IEC 17025:2005: General requirements for the competence of testing and calibration laboratories.
- 2.3 EN 1127-1:1998: Explosive atmospheres-explosion prevention and protection. Part 1. Basic concepts and methodology.

- 2.4 EN 1070:1998: Safety of Machinery-Terminology.
- 2.5 VDI 3673: Part 1: Pressure Venting of Dust Explosions.
- 2.6 IMO MSC/Circular 677-Revised Standards for the Design, Testing and Location of Devices to Prevent the Passage of Flame into Cargo Tanks in Tankers.

3. Purpose

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

- 3.1.1 verify the effectiveness of the flame arrester.
- 3.1.2 verify that the valve closes after an explosion.
- 3.1.3 verify that the valve is gas/air tight after an explosion.
- 3.1.4 establish the level of over pressure protection provided by the valve.

4. Test Facilities

4.1 *The test facilities for carrying out type testing of crankcase explosion relief valves are to meet the following criteria:*

4.1.1 It should be accredited to a National or International Standard e.g. ISO/IEC 17025 for the testing of explosion protection devices and acceptable to IRS.

4.1.2 The test facilities are to have:

- Necessary equipments so that they can control and record explosion testing in accordance with this procedure.
- Equipment for controlling and measuring a methane gas in air concentration within a test vessel to an accuracy of $\pm 0.1\%$.
- Effective means for point – located ignition of methane gas in air mixture.

4.1.3 The 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 center. The measuring arrangements are to be capable of measuring and recording the pressure changes throughout an explosion test. The result of each test is to be documented by video recording and if necessary by recording with a heat sensitive camera.

- 4.1.4 The dimensions of the vessel 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.
- 4.1.5 The test vessel for explosion testing is to be provided with a flange for mounting the explosion relief valve in an orientation consistent with manner in which it will be installed in service, i.e. in the vertical plane or the horizontal plane. The flange arrangement is to be located centrally at one end perpendicular to the vessel’s longitudinal axis.
- 4.1.6 A circular plate having the following dimensions is to be provided for fitting between the pressure vessel flange and valve under test.
- Outside diameter = 2 x D where D is the outer diameter of the valve top cover. The circular plate is to provide simulation of the crankcase surface.
 - Internal bore having the same internal diameter of the valve to be tested.
- 4.1.7 The test vessel for explosion testing is to have connections for measuring the methane in air mixture in at least two positions, i.e. top and bottom.
- 4.1.8 The test vessel for explosion testing is to be provided means for fitting an ignition source at a position specified in para 5.3.
- 4.1.9 The volume of the test vessel is to be as far as practicable, related to the size and capacity of relief valve to be tested. The free area of explosion relief valve is to be not less than $115 \text{ cm}^2/\text{m}^3$ of crankcase gross volume, i.e. the testing of a valve having 1150 cm^2 of free area, would require a test vessel with a volume of 10m^3 . Where the free area of relief valves is greater than $115 \text{ cm}^2/\text{m}^3$ of the crankcase gross volume, the volume of the test vessel is to be consistent with the design ratio. In any case the volume of the test vessel is not to vary by more than + 15% to –15% from the design cm^2/m^3 volume ratio.

5. Explosion Test Process

- 5.1 All explosion tests to verify the working/operation of crankcase explosion relief valves, are to be carried out using an air and methane mixture with a volumetric methane concentration of $9.5\% \pm 0.5\%$. The pressure in the test vessel is to be not less than atmospheric and not exceeding 0.2 bar.
- 5.2 The concentration of methane in the test vessel is to be measured in the top and bottom of the vessel and is not to differ by more than 0.5%.

- 5.3 The ignition of the methane and air mixture is to be made at the centerline 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 Testing of Valves

- 6.1 The valves used for type testing (including testing as specified in para 6.3) are to be manufactured and tested in accordance with procedures acceptable to IRS and selected from the manufacturer's usual production line for such valves, by IRS or engine builder witnessing the tests.
- 6.2 For approval of a specific valve size, three valves are to be tested in accordance with paras 6.3 and 7. For a series of valves para 9 refers.
- 6.3 The valves selected for type testing should 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 $\pm 20\%$ 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 take into consideration 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 authorized personnel from IRS where type testing approval is required by IRS.
- 7.1.2 Valves are to be tested in the vertical or horizontal position consistent with the orientation in which they are intended to be installed on an engine or gear case, usually in the vertical position, see 6.4.

- 7.1.3 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.
- 7.1.4 Type testing is to be carried out for each range of valves that a manufacturer requires IRS approval.
- 7.1.5 Successive explosion testing to establish a valve's functionality is to be carried out as quickly as possible during stable weather conditions.
- 7.1.6 The pressure rise and decay during all explosion testing is to be recorded.
- 7.1.7 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.
- 7.1.8 The test facility is to produce a report on the explosion test findings.
- 7.2 Each valve undergoing type test is to be explosion tested in three stages as described below.
- 7.2.1 Stage 1:
- 7.2.1.1 Two explosion tests are to be carried out with the flange opening fitted with the circular plate covered by a 0.05mm thick polythene film. These tests establish a reference pressure level for determination of the effects of a relief valve 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 in which it requires approval for installation i.e., in the vertical or horizontal position with the circular plate described in 4.1.9 located between the valve and pressure vessel mounting flange.
- 7.2.2.2 The first test on each valve is to be carried out with a 0.05m 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 plastic 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 signs of damage to the flame arrester or valve, a second explosion test without the polythene bag arrangement is to be carried out. During the second explosion test, the valve is to be visually monitored for any indication of combustion outside the flame arrester. The second test is required to demonstrate that the valve can 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 base line value for assessment of pressure rise recognizing that the test ambient conditions may have changed during the testing of the explosion relief valves in Stage 2.

8. Assessment and Records

8.1 The explosion testing of the valves will be considered satisfactory and its conformance to the requirements given in the Classification Notes subject to following being complied with:

8.1.1 Design appraisal / approval of valves undergoing type tests by IRS.

8.1.2 Records as detailed below being submitted to IRS :

a) The designation, dimensions and characteristics of the valves to be tested including free area of the valve and the flame arrester and valve lift at 0.2 bar.

b) The test vessel volume as determined and recorded.

- 8.1.3 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.
- 8.1.4 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.
- 8.1.5 The effect of an explosion relief valve in terms of pressure rise following an explosion is ascertained from maximum pressures recorded at the center 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 Stage 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.
- 8.1.6 The valve tightness is to be ascertained by ensuring that at least 0.3 bar vacuum is maintained in 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.
- 8.1.7 After each explosion test in Stage 2, the external condition of the flame arrester is to be examined for signs of damage and/or deformation that may affect the operation of the valve.
- 8.1.8 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 is to be noted. Photographic records of the valve condition are to be taken and included in the report.

9. Approval of Design of Series Produced Valves

- 9.1 The approval of quenching devices to prevent the passage of flame can be evaluated for other similar devices of identical design where one device has been tested and found satisfactory.
- 9.2 The quenching ability of a flame screen 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 size of flame screen. This is subject to (a) and (b) being satisfied.

$$(a) \quad \frac{n_1}{n_2} = \sqrt{\frac{S_1}{S_2}}$$

$$(b) \quad \frac{A_1}{A_2} = \frac{S_1}{S_2}$$

Where:

n_1 = 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 S_1

n_2 = total depth of flame arrester corresponding to the number of lamella of size 2

quenching device 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

9.3 The approval of explosion relief valves of larger sizes than that which has been previously satisfactorily tested in accordance with Sections 7 and 8 can be considered provided 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% 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 instead of three as given 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 4.1.9.

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

9.4 The approval of explosion relief valves of smaller sizes than that which has been previously satisfactorily tested in accordance with Sections 7 and 8 can be considered provided 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 4.1.9.

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

10 Test Report

10.1 The report issued by the testing laboratories is to include 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 para 8.

11. Approval

IRS will accord approval to the explosion relief valve subject to satisfactory:

11.1 Appraisal of plans and particulars and

11.2 Review of results of type testing.