Amendment on 27 June 2024
Resolved by Technical Committee on 30 January 2024

Turbocharger Type Approval Tests

Object of Amendment

Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use

Reason for Amendment

IACS Unified Requirement (UR) M73 adopted in June 2016 specifies design requirements for turbochargers, test requirements related to type approval, etc. These requirements have already been incorporated into the NK Rules.

The UR specifies that if a high-speed rotating part breaks due to some kind of malfunction, a containment test needs to be conducted on another turbocharger of the same type to confirm that in such cases fragments do not penetrate the turbocharger's casing and fly out into the surrounding area. On the other hand, if it can be confirmed through numerical analysis that the scattering of broken parts can be prevented, the UR specifies that this numerical analysis may be accepted in lieu of such a practical containment test.

Recently, IACS received an inquiry from a turbocharger manufacturer regarding the extent of design changes that would require retesting of a practical containment test. In response, IACS agreed on some examples of design changes that require retesting and also reviewed the conditions for type approval testing, and adopted UR M73 (Rev.2) in May 2023.

Accordingly, relevant requirements are amended based upon UR M73 (Rev.2).

Outline of Amendment

The main contents of this amendment are as follows:

(1) Clarifies examples of design changes that require containment tests.
(2) Specifies that manufacturers are to consider whether there are any conditions that are more critical than the test conditions specified by the Society regarding practical containment tests.
(3) Clarifies that testing for at least 500 load cycles is required for turbochargers regardless of engine rated speed.

Effective Date and Application

This draft amendment applies to the following turbochargers:

(1) those for which the application for approval is submitted to the Society on or after 1 July 2024, or
(2) those for which the application for renewal is submitted to the Society on or after 1 July 2024.

ID: DD23-18

Amended-Original Requirements Comparison Table (Turbocharger Type Approval Tests)

Amended	Original	Remarks
GUIDANCE FOR THE APPROVAL AND TYPE APPROVAL OF MATERIALS AND EQUIPMENT FOR MARINE USE **Part 6 MACHINERY** **Chapter 11 APPROVAL OF USE FOR EXHAUST DRIVEN TURBOCHARGERS** **11.4 Approval Tests** **11.4.2 Details of Tests** **1** Turbochargers for any speed engines are to be subjected to at least 500 load cycles (idle - full load - idle) at the limits of their operation. However, this test may be waived if the turbocharger together with the engine is subjected to this kind of low cycle testing under the approval of use of reciprocating internal combustion engines in **Chapter 8, Part 6**. The suitability of the turbocharger for such kind of operation is to be stated in advance by the manufacturer. **2** The rotor vibration characteristics are to be measured and recorded in order to identify possible sub-synchronous vibrations and resonances. **3** After the tests in **-1** and **-2** above are completed, a hot running test is to be carried out at maximum permissible speed combined with maximum permissible temperature for at least one hour. **4** After the test in **-3** above is completed, the	**GUIDANCE FOR THE APPROVAL AND TYPE APPROVAL OF MATERIALS AND EQUIPMENT FOR MARINE USE** **Part 6 MACHINERY** **Chapter 11 APPROVAL OF USE FOR EXHAUST DRIVEN TURBOCHARGERS** **11.4 Approval Tests** **11.4.2 Details of Tests** **1** Turbochargers are to be subjected to at least 500 load cycles (idle - full load - idle) at the limits of their operation. However, this test may be waived if the turbocharger together with the engine is subjected to this kind of low cycle testing under the approval of use of reciprocating internal combustion engines in **Chapter 8, Part 6**. The suitability of the turbocharger for such kind of operation is to be stated in advance by the manufacturer. **2** The rotor vibration characteristics are to be measured and recorded in order to identify possible sub-synchronous vibrations and resonances. **3** After the tests in **-1** and **-2** above are completed, a hot running test is to be carried out at maximum permissible speed combined with maximum permissible temperature for at least one hour. **4** After the test in **-3** above is completed, the	UR M73 3.4.3

Amended-Original Requirements Comparison Table (Turbocharger Type Approval Tests)

Amended	Original	Remarks
turbocharger is to be opened for examination, with focus on possible rubbing and the bearing conditions.	turbocharger is to be opened for examination, with focus on possible rubbing and the bearing conditions.	
5 After the test in **-4** above is completed, a containment test is to be carried out to confirm that the turbocharger fulfils containment in the event of a rotor burst. Testing method is to be in accordance with the following **(1)** to **(6)**. However, this test may be waived for a generic range of turbochargers which are of a design similar to the tested unit, if documents which confirm their containment ability based upon the testing of one turbocharger are submitted. Therefore, it is recommended that tests be carried out on the turbocharger with most severe construction from the viewpoint of containment.	**5** After the test in **-4** above is completed, a containment test is to be carried out to confirm that the turbocharger fulfils containment in the event of a rotor burst. Testing method is to be in accordance with the following **(1)** to **(4)**. However, this test may be waived for a generic range of turbochargers which are of a design similar to the tested unit, if documents which confirm their containment ability based upon the testing of one turbocharger are submitted. Therefore, it is recommended that tests be carried out on the turbocharger with most severe construction from the viewpoint of containment.	UR M73 3.2.4
(1) The test is to be carried out at a temperature which is not lower than the maximum allowable temperature of the turbocharger to be specified by the manufacturer.	(1) The test is to be carried out at working temperature.	
(2) The test speeds are not to be less than the following: (a) For the compressor, 120 % of the maximum permissible operating speed. (b) For the turbine, 140 % of the maximum permissible operating speed or the natural burst speed, whichever is lower.	(2) The test speeds are not to be less than the following: (a) For the compressor, 120 % of the maximum permissible operating speed. (b) For the turbine, 140 % of the maximum permissible operating speed or the natural burst speed, whichever is lower.	
(3) Manufacturers are to determine whether cases more critical than those defined in **(1)** and **(2)** exist with respect to containment safety. Where such a case is identified, evidence of containment safety is to be also be provided for that case.	(Newly added)	UR M73 3.2.5
(4) Notwithstanding **(1)** and **(2)** above, a numerical analysis simulation such as Finite Element Method (FEM) of sufficient containment integrity of the casing based upon calculations by means of a simulation model may be accepted in lieu of the practical containment test. In such cases, the	(3) Notwithstanding **(1)** and **(2)** above, a numerical analysis of sufficient containment integrity of the casing based upon calculations by means of a simulation model may be accepted in lieu of the practical containment test. In such cases, the following **(a)** to **(d)** apply:	UR M73 3.2.6

Amended-Original Requirements Comparison Table (Turbocharger Type Approval Tests)

Amended	Original	Remarks
following **(a)** to **(d)** apply: (a) The numerical simulation model has been tested and its suitability and accuracy has been proven by direct comparison between calculation results and the practical containment test for a reference application (reference containment test). This test is to be performed at least once by the manufacturer for acceptance of the numerical simulation method in lieu of the practical test. (b) The corresponding numerical simulation for the containment is performed for the same speeds specified in **(2)**. (c) Material properties for high-speed deformations are to be applied to the numeric simulation. The correlation between normal properties and the properties at the pertinent deformation speed are to be substantiated. (d) The design of the turbocharger regarding geometry and kinematics is similar to the turbocharger that was used for the reference containment test in **(a)**.	(a) The numerical simulation model has been tested and its suitability and accuracy has been proven by direct comparison between calculation results and the practical containment test for a reference application (reference containment test). This test is to be performed at least once by the manufacturer for acceptance of the numerical simulation method in lieu of the practical test. (b) The corresponding numerical simulation for the containment is performed for the same speeds specified in **(2)**. (c) Material properties for high-speed deformations are to be applied to the numeric simulation. The correlation between normal properties and the properties at the pertinent deformation speed are to be substantiated. (d) The design of the turbocharger regarding geometry and kinematics is similar to the turbocharger that was used for the reference containment test in **(a)**. <u>In general, totally new designs will call for a new reference containment test.</u>	UR M73 3.2.7
<u>(5) In cases where a totally new design is adopted for a turbocharger has been requested, new reference containment tests are to be performed. Here the wording "totally new design" means the principal differences between a new turbocharger and previous ones are related to geometry and kinematics. Turbochargers are to be considered totally new designs when any of the following **(a)** to **(h)** have been changed.</u> <u>(a) Structure or material of the turbocharger casing</u>	(Newly added)	

Amended-Original Requirements Comparison Table (Turbocharger Type Approval Tests)

Amended	Original	Remarks
(b) Maximum permissible exhaust gas temperature (c) Number of bearings (d) Number of turbine blades (e) Number of turbine wheels or compressor wheels (f) Direction of inlet air or exhaust gas (e.g. axial flow orientation, radial flow orientation) (g) Type of the turbocharger drive (e.g. axial turbine type, radial turbine type, mixed flow turbine type) (h) Other changes deemed necessary by the Society for reference containment tests (6) The manufacturer will have to compile all results in a report or calculation sheet, which will have to be handed over to the surveyor. It is to be documented through calculations, etc. that the selected test unit really is representative for the whole generic range. EFFECTIVE DATE AND APPLICATION **1.** The effective date of the amendment is 1 July 2024. **2.** Notwithstanding the amendment to the Guidance, the current requirements apply to turbochargers other than those that fall under the following: (1) turbochargers for which the application for approval is submitted to the Society on or after 1 July 2024, and (2) turbochargers for which the date of renewal of approval of use is on or after 1 July 2024.	(4) The manufacturer will have to compile all results in a report or calculation sheet, which will have to be handed over to the surveyor. It is to be documented through calculations, etc. that the selected test unit really is representative for the whole generic range.	