M73 Turbochargers

(Feb 2015)
(Corr.1 Apr 2016)
(Rev.1 Mar 2022)
(Rev.2 May 2023)

Notes:

1. The requirements of UR M73, except for M73.4, are to be uniformly implemented by IACS Societies to turbochargers with the date of application for certification of the new turbocharger type on or after 1 July 2016.

   The requirements of M73.4 are to be uniformly implemented by IACS Societies to turbochargers with the date of application for certification of an individual turbocharger on or after 1 July 2016.

2. The “date of application for certification” is the date of whatever document the Classification Society requires/accepts as an application or request for certification of a new turbocharger type or of a turbocharger type that has undergone substantive modifications in respect of the one previously type approved, or for renewal of an expired type approval certificate.

3. The requirements of UR M73 Rev.1, except for M73.4, are to be uniformly implemented by IACS Societies to turbochargers with the date of application for certification on or after 1 January 2023. Turbochargers with an existing type approval on 1 January 2023 are not required to be re-type approved in accordance with this UR until the current Type Approval reaches its expiry date.

   The requirements of M73.4 Rev.1 are to be uniformly implemented by IACS Societies to turbochargers with the date of application for certification of an individual turbocharger on or after 1 January 2023.

4. The requirements of UR M73 Rev.2, except for M73.4, are to be uniformly implemented by IACS Societies to turbochargers with the date of application for certification on or after 1 July 2024. Turbochargers with an existing type approval on 1 July 2024 are not required to be re-type approved in accordance with this UR until the current Type Approval reaches its expiry date.

   The requirements of M73.4 Rev.2 are to be uniformly implemented by IACS Societies to turbochargers with the date of application for certification of an individual turbocharger on or after 1 July 2024.

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1. Scope

1.1 These requirements are applicable for turbochargers regarding design approval, type testing and certification and their matching on engines.
Turbochargers are to be type approved, either separately or as a part of an engine. The requirements are written for exhaust gas driven turbochargers but apply in principle also for engine driven chargers.

1.2 The requirements escalate with the size of the turbochargers. The parameter for size is the engine power (at MCR) supplied by a group of cylinders served by the actual turbocharger, (e.g., for a V-engine with one turbocharger for each bank the size is half of the total engine power).

1.3 Turbochargers are categorised in three groups depending on served power by cylinder groups with:

- Category A: ≤ 1000 kW
- Category B: > 1000 kW and ≤ 2500 kW
- Category C: > 2500 kW

2. Documentation to be submitted

2.1 Category A:

On request

- Containment test report.
- Cross sectional drawing with principal dimensions and names of components.
- Test program.

2.2 Category B and C:

- Cross sectional drawing with principal dimensions and materials of housing components for containment evaluation.
- Documentation of containment in the event of disc fracture, see M73.3.2.
- Operational data and limitations as:
- Maximum permissible operating speed (rpm)
- Alarm level for over-speed
- Maximum permissible exhaust gas temperature before turbine
- Alarm level for exhaust gas temperature before turbine
- Minimum lubrication oil inlet pressure
- Lubrication oil inlet pressure low alarm set point

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- Maximum lubrication oil outlet temperature
- Lubrication oil outlet temperature high alarm set point
- Maximum permissible vibration levels, i.e. self- and externally generated vibration

(Alarm levels may be equal to permissible limits but shall not be reached when operating the engine at 110% power or at any approved intermittent overload beyond the 110%.)

- Arrangement of lubrication system, all variants within a range.
- Type test reports.
- Test program.

2.3 Category C:

- Drawings of the housing and rotating parts including details of blade fixing.
- Material specifications (chemical composition and mechanical properties) of all parts mentioned above.
- Welding details and welding procedure of above mentioned parts, if applicable.
- Documentation*) of safe torque transmission when the disc is connected to the shaft by an interference fit, see M73.3.3.
- Information on expected lifespan, considering creep, low cycle fatigue and high cycle fatigue.
- Operation and maintenance manuals*).

*) Applicable to two sizes in a generic range of turbochargers.

3. Design requirements and corresponding type testing

3.1 General

3.1.1 The turbochargers shall be designed to operate under conditions given in M46 and M28. The component lifetime and the alarm level for speed shall be based on 45°C air inlet temperature.

3.1.2 The air inlet of turbochargers shall be fitted with a filter.

3.2 Containment

3.2.1 Turbochargers shall fulfil containment in the event of a rotor burst. This means that at a rotor burst no part may penetrate the casing of the turbocharger or escape through the air intake. For documentation purposes (test/calculation), it shall be assumed that the discs disintegrate in the worst possible way.

3.2.2 For category B and C, containment shall be documented by testing. Fulfilment of this requirement can be awarded to a generic range**) of turbochargers based on testing of one specific unit. Testing of a large unit is preferred as this is considered conservative for all

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smaller units in the generic range. In any case, it must be documented (e.g. by calculation) that the selected test unit really is representative for the whole generic range.

**) A generic range means a series of turbocharger which are of the same design, but scaled to each other.

3.2.3 The minimum test speeds, relative to the maximum permissible operating speed, are:

- For the compressor: 120%.
- For the turbine: 140% or the natural burst speed, whichever is lower.

3.2.4 Containment tests shall be performed at ~~working temperature~~ a temperature which is not lower than the maximum allowable temperature of the turbocharger to be specified by the manufacturer.

3.2.5 Manufacturers are to determine whether cases more critical than those defined in M73.3.2.3. and M73.3.2.4 exist with respect to containment safety. Where such a case is identified, evidence of containment safety shall also be provided for that case.

3.2.5~~6~~A numerical analysis ~~(~~simulation~~)~~ such as Finite Element Method (FEM) of sufficient containment integrity of the casing based on calculations by means of a simulation model may be accepted in lieu of the practical containment test, provided that:

1) The numerical simulation model has been tested and its suitability/accuracy has been proven by direct comparison between calculation results and the practical containment test for a reference application (reference containment test). This test shall be performed at least once by the manufacturer for acceptance of the numerical simulation method in lieu of tests.

2) The corresponding numerical simulation for the containment is performed for the same speeds as specified for the containment test.

3) Material properties for high-speed deformations are to be applied in the numeric simulation. The correlation between normal properties and the properties at the pertinent deformation speed are to be substantiated.

4) The design of the turbocharger regarding geometry and kinematics is to be similar to the turbocharger that was used for the reference containment test. ~~In general, totally new designs will call for a new reference containment test.~~

3.2.7 In cases where a totally new design***) is adopted for a turbocharger for which an application for type approval certification has been requested, new reference containment tests are to be performed.

***) Totally new design means the principal differences between a new turbocharger and previous ones are related to geometry and kinematics. The turbochargers are to be regarded as having a totally new design if the structure and/or material of the turbocharger casings are changed, or any of, but not limited to, the following items is changed from the previous design.

- Maximum permissible exhaust gas temperature
- Number of bearings
- Number of turbine blades
- Number of turbine wheels and/or compressor wheels

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- Direction of inlet air and/or exhaust gas (e.g., axial flow orientation, radial flow orientation)
- Type of the turbocharger drive (e.g., axial turbine type, radial turbine type, mixed flow turbine type)

3.3 Disc-shaft shrinkage fit

3.3.1 Applicable to Category C

3.3.2 In cases where the disc is connected to the shaft with interference fit, calculations shall substantiate safe torque transmission during all relevant operating conditions such as maximum speed, maximum torque and maximum temperature gradient combined with minimum shrinkage amount.

3.4 Type testing

3.4.1 Applicable to Categories B and C

3.4.2 The type test for a generic range of turbochargers may be carried out either on an engine (for which the turbocharger is foreseen) or in a test rig.

3.4.3 Turbochargers for the low, medium, and high-speed engines are to be subjected to at least 500 load cycles at the limits of operation. This test may be waived if the turbocharger together with the engine is subjected to this kind of low cycle testing, see M71.

3.4.4 The suitability of the turbocharger for such kind of operation is to be preliminarily stated by the manufacturer.

3.4.5 The rotor vibration characteristics shall be measured and recorded in order to identify possible sub-synchronous vibrations and resonances.

3.4.6 The type test shall be completed by a hot running test at maximum permissible speed combined with maximum permissible temperature for at least one hour. After this test, the turbocharger shall be opened for examination, with focus on possible rubbing and the bearing conditions.

3.4.7 The extent of the surveyor’s presence during the various parts of the type tests is left to the discretion of each Society.

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4. Certification

4.1 The manufacturer shall adhere to a quality system designed to ensure that the designer's specifications are met, and that manufacturing is in accordance with the approved drawings.

4.2 For category C, this shall be verified by means of periodic product audits of an Alternative Certification Scheme (ACS; see UR Z26) by the Society.

4.3 These audits shall focus on:

- Chemical composition of material for the rotating parts.
- Mechanical properties of the material of a representative specimen for the rotating parts and the casing.
- UT and crack detection of rotating parts.
- Dimensional inspection of rotating parts.
- Rotor balancing.
- Hydraulic testing of cooling spaces to 4 bars or 1.5 times maximum working pressure, whichever is higher.
- Overspeed test of all compressor wheels for a duration of 3 minutes at either 20% above alarm level speed at room temperature or 10% above alarm level speed at 45°C inlet temperature when tested in the actual housing with the corresponding pressure ratio. The overspeed test may be waived for forged wheels that are individually controlled by an approved non-destructive method.

4.4 Turbochargers shall be delivered with:

- For category C, a society certificate, which ~~at~~ as a minimum cites the applicable type approval and the ACS, when ACS applies.
- For category B, a work's certificate, which ~~at~~ as a minimum cites the applicable type approval, which includes production assessment.

4.5 The same applies to replacement of rotating parts and casing.

4.6 Alternatively to the above periodic product audits, individual certification of a turbocharger and its parts may be made at the discretion of the Society. However, such individual certification of category C turbocharger and its parts shall also be based on test requirements specified in the above mentioned bullet points.

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5. Alarms & Monitoring

5.1 For all turbochargers of Categories B and C, indications and alarms as listed in the table are required.

5.2 Indications may be provided at either local or remote locations.

Pos.	Monitored Parameters	Category of Turbochargers				Notes
		B		C		
		Alarm	Indication	Alarm	Indication	
1	Speed	High (4)	X (4)	High (4)	X (4)	
2	Exhaust gas at each turbocharger inlet, temperature	high (1)	X (1)	high	X	High temp. alarms for each cylinder at engine is acceptable (2)
3	Lub. oil at turbocharger outlet, temperature			high	X	If not forced system, oil temperature near bearings
4	Lub. oil at turbocharger inlet, pressure	low	X	low	X	Only for forced lubrication systems (3)

(1) For Category B turbochargers, the exhaust gas temperature may be alternatively monitored at the turbocharger outlet, provided that the alarm level is set to a safe level for the turbine and that correlation between inlet and outlet temperatures is substantiated.

(2) Alarm and indication of the exhaust gas temperature at turbocharger inlet may be waived if alarm and indication for individual exhaust gas temperature is provided for each cylinder and the alarm level is set to a value safe for the turbocharger.

(3) Separate sensors are to be provided if the lubrication oil system of the turbocharger is not integrated with the lubrication oil system of the diesel engine or if it is separated by a throttle or pressure reduction valve from the diesel engine lubrication oil system.

(4) On turbocharging systems where turbochargers are activated sequentially, speed monitoring is not required for the turbocharger(s) being activated last in the sequence, provided all turbochargers share the same intake air filter and they are not fitted with waste gates.

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