Cylinder Liner

Ident No.: 0743173-3

Tarkalloy-C/A, Cylinder Liners

This document is valid for existing engine types on order as of the date of this document:

Engine types:

All two-stroke engine types.

Quality Specification

0743173-3.7

February 2016

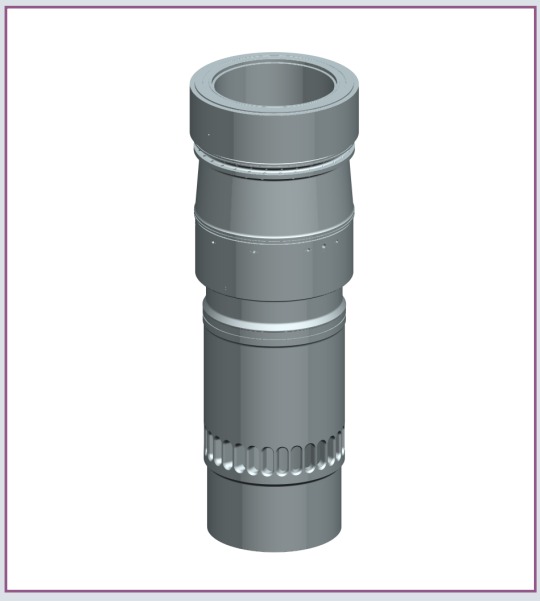
Info No: 393322

Structure No: 21-2210

Replaces: 0598217-3

Scope and Field of Application

This specification describes acceptance criteria and how to test/verify and document the quality achieved in daily production of cylinder liners.



Document history

Date	Designer	Checked	AC	Revision change	Revision
2005-08-10	KNM	KDS			0
2013-07-17	NIST		Z3	Figures and text are updated	5
2014-11-11	NWRA	LNU	Z3	Section 6 updated	6
2016-02-02	NWRA	KIM	Z3	Section 7 is new	7

MAN Diesel & Turbo
Teglholmsgade 41, 2450 Copenhagen SV, Denmark
Phone +45 33 85 11 00
E-mail mandieselturbo-cph@mandieselturbo.com
Web www.mandieselturbo.com

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Changes in this revision:

Section 7 is new.

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1. Introduction

This specification is valid for cylinder liners of Tarkalloy C and Tarkalloy A.

Producers of cylinder liners must be approved in a First-Time Production Approval process as specified in MAN B&W Quality Control No. 0741412-0; *Cylinder Liners Tarkalloy-C/A, First-Time Production Approval*.

2. References

MAN B&W Quality Control:

No. 0741412-0; Cylinder Liners Tarkalloy-C/A, First-Time Production Approval.
No. 0742619-9; Dimensional Inspection
No. 0742637-8; Mark and Stamps on Cylinder Liner.
No. 0743668-3; Evaluation of Microstructure in Cylinder Liner Material based on Image Analysing Equipment/software.

MAN B&W Quality Specification:

No. 0743525-7; Pressure and Functional Test of Components.

MAN B&W Material Specification:

P676 for Cast Iron for Cylinder Liners type Tarkalloy C.
P677 for Cast Iron for Cylinder Liners type Tarkalloy A.

ISO 185: Grey Cast Iron - Classification.

3. Documentation and marking

The documentation shall include the following information:

- Serial no.
- Charge or ladle (tap) no.
- Order No and customer name - or any other identification agreed upon with the customer.
- Engine type.
- Identification No (= drawing no).
- Results of material testing, including:
  - Chemical analysis.
  - Hardness test.
  - Mechanical testing (Tensile Strength, Elongation).
  - Microstructure evaluation.
- Certificate from Classification Society(ies) on pressure testing.
- Dimensional inspection of inside diameters.
- Inspection/defect reports.

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Marking/stamping on the liner according the class rules Including:

- Drawing No., Producer name, Engine type and Serial no./Charge no., etc. See Production Specification No. 0742637-8; *Mark and Stamps on Cylinder Liner.*

4. Heat treatment

4.1. Statically cast liners

All liners, which are removed from the mould at (liner) temperatures above 300°C must be stress relieved in furnace after rough machining in accordance with MAN B&W Material Specifications P676 and P677. Liners, which are removed from the mould at (liner) temperatures below 300°C can be used without applying further stress relieving heat treatment.

4.2. Centrifugally cast liners

Stress relieving heat treatment after rough machining must be carried out in accordance with MAN B&W Material Specifications P676 and P677.

5. Material testing

The material properties must fulfil the requirements stated in the actual material specification.

The following tests are to be carried out on each cylinder liner:

- Chemical analysis: Final charge analysis.
- Brinell hardness.

To be measured on the inside of the cylinder liner, 100 mm from the top:

- Mechanical testing: Tensile strength (minimum 2 test pieces).

After establishing the relation between tensile strength in the riser and in the upper part of the liner, - see MAN B&W Quality Control No. 0741412-0: *Cylinder Liners Tarkalloy-C/A First-Time Production Approval*.- The tensile strength can be determined by means of test specimens from the lower part of the riser.

- Stress-strain diagram (minimum 1 test piece Ø14 mm).

For determination of total elongation at fracture, Atot, electrical stress-strain signals referring to a well-defined gauge length on the test piece are to be recorded on a x-y recorder, see MAN B&W Quality Control No. 0741896-0; *Determination Of Modulus Of Elasticity And Total Elongation In Cast Iron.*

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Atot is defined as the total elastic + plastic elongation.

Note! In case the tensile strength determined on the test piece (ø14 mm) for determination of elongation, is on or slightly below the lower limit, a re-testing carried out on a ø20 mm test piece must fulfil the specified tensile strength.

Test pieces according to ISO 185 Grey Cast Iron Classification.

- Microstructure.

The microstructure can be determined in the lower part of the riser near the inner surface, - provided that a satisfactory similarity has been found between this part and the inner surface in the upper part of the liner.

The following observations are to be recorded:

- Type and size of graphite.
- Per cent cementite + steadite.
- Per cent ferrite.

Examinations to be carried out using magnifications x50, x100 and x200.

6. Pressure testing

The cylinder liners are to be water pressure tested, in accordance with the rules of the Classification Societies, in the whole water cooled length.
Testing with inside or outside pressure is optional.

Test pressure and time to be according to MAN B&W Quality Specification No. 0743525-7; *Pressure and functional Test of Components*.

Judgment is carried out when liner is still under pressure:

- If “dark spots” or drops of water are observed, wipe off with a clean rag.
- If the formation of drops or “sweating” continues in the water-cooled length, i.e. from contact surface for cylinder cover to the lowermost edge of the lowest O-ring groove, the liner is not acceptable.

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7. Cleaning

The internal surface of the cylinder liner shall be thoroughly cleaned by means of high pressure cleaning using warm water at a pressure of minimum 100 bar. After cleaning the cylinder liner is treated with a water repellent rust preventative fluid such as Dinitrol 25 or a similar product which is capable of repelling water from the surfaces of iron or steel parts and leave a rust preventative film after drying.

8. Inspection of surfaces

An all-over final visual inspection of the finish-machined cylinder liner must be carried-out.

8.1. Inside running surface

Check of the general uniformity of surface appearance including registration of:

- Macro defects:
  Surface defects which can easily be seen by the naked eye, such as sand and slag inclusions, larger gas holes, pin holes, shrinking porosities, etc. Defects of these types will often appear as single defects.
- Micro defects:
  Surface condition which can be observed as a coarse-to-open material structure.
  The defects can occur as small spots or groups of spots with coarse grained material structure.

8.2. Outside surfaces

All over visual inspection of all outside surfaces must be carried out including:

- Contact faces to cylinder cover and cylinder frame (a).
- Drilled cooling bores (e).
- Grooves in area of cooling bore, roundings and transitions (b).
- “O-ring” grooves, bores for cylinder lubrication, scavenge air ports etc. (c).

See figure 1 for location of mentioned areas on the cylinder liner.

8.3. In- and outside dimension

With a view to later registration of the cylinder wear characteristics in service, the in- and outside dimension all new liners is to be measured and recorded according to MAN B&W Quality Control no. 0742619-9; *Dimensions inspection* as follows:

- Grooves in area of cooling bore, roundings and transitions (b).
- “O-ring” grooves, bores for cylinder lubrication, scavenge air ports etc. (c).

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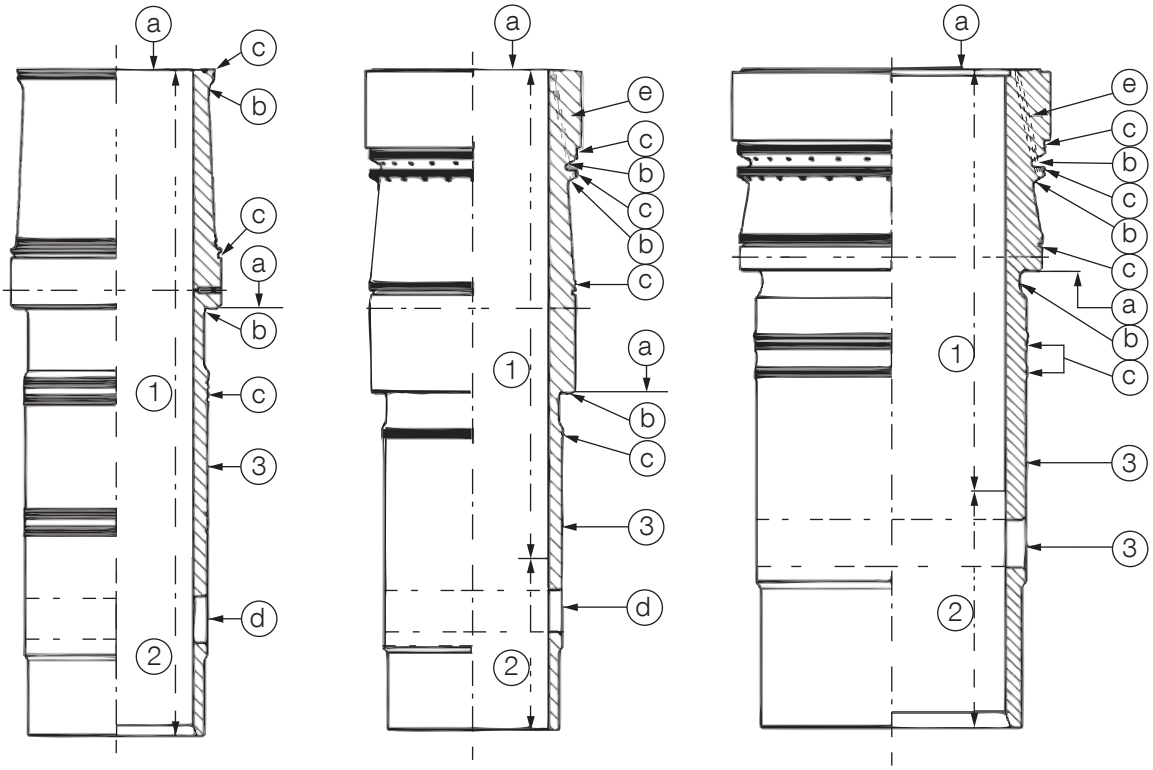
9. Judgment of surfaces - acceptance criteria

For the purpose of judging whether any surface irregularity found is permissible, the cylinder liner is divided into inspections zones, see figure 1.

Zone 1: Running surface from top of liner to 100 mm above scavenge air ports including lubricating oil grooves and the zone to be pressure tested.

Zone 2: Remaining lowermost part of running surface including scavenge air ports.

Zone 3: Outside areas including contact surface for cylinder cover and cylinder frame, cooling bores, roundings/transitions and “O-ring” grooves, etc.



A
Slime line S-MC

B
Bore-cooled S-MC

C
Bore-cooled K-MC

Figure 1: Definition of zones and areas on different types of cylinder liners.

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Zone 1 and 2, Running surface general:
The inside running surface must appear uniform in its whole length with regard to material (colour, microstructure, homogeneity, etc.) and with regard to profile of machining - circular shape/semi honing, profile of oil grooves, etc.

Micro defects will normally be acceptable on the condition that the requirements to hardness and microstructure in the area is fulfilled.

Single macro defects will be acceptable within the dimensions and number stated below, on the condition that they appear clean, smooth and without loose slag particles. See also section 9.

Profile of final machined running surface and oil grooves, as well as surface roughness must be checked and fulfil the requirements specified on actual drawing(s).

The maximum dimensions of a single defect is calculated on basis of the wavelength, W, of the wavecut on the running surface. The wavelength is illustrated in figure 2.

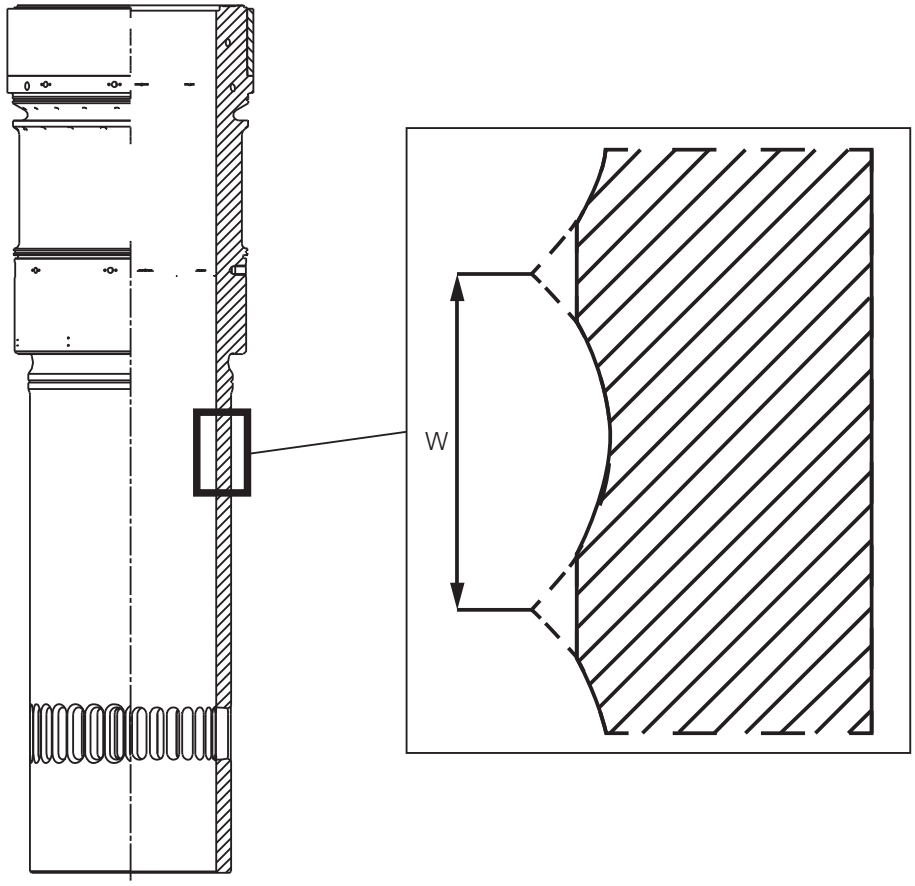

Figure 2: Illustration of the nominal wavelength, W, of the wavecut, as stated on the relevant drawing.

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Zone 1:

Running surface:

Single scattered surface defects will be acceptable:

- Max dimension of single defect: 1.0 × W.
- Max number of defects: 0.01 × Di.
- Di: Numerical value of liner diameter (mm).

Zone 2:

Running surface:

Single scattered surface defects will be acceptable:

- Max dimension of single defect : 1.5 × W.
- Max number of defects: 0.01 × Di.

Scavenge port area (d):

- Macro defects including grinding-out will not be acceptable in the scavenge port ribs including a zone of 20 mm above and below the scavenge ports.

Zone 3:

Outside surfaces:

Contact face to cylinder cover and Cylinder frame (a):

- The upper and lower flange/contact face (a) to cylinder cover and cylinder frame, respectively, must be completely free from defects such as holes, inclusions and porosities which might affect the intended sealing function.
- Grinding-out on sealing faces will not be acceptable.

Roundings and transitions (b):

- Rounding in bottom of groove in area of inlet for cooling water bores and transition rounding in area of contact face to cylinder frame as well as transitions in general must appear free from defects.
- Single local surface defects can be removed by smooth grinding over a suitable area so that no local indentation occurs. The maximum depth of grinding in this area is 2 mm.

“O”-ring grooves (c):

- “O”-ring grooves must appear smooth and free from material defects or defects related to improper machining, which might influence the intended sealing effect.
- Grinding-out will not be acceptable.

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Cooling bores (e):

- Visual check of final machined cooling bores to be carried out.
- Shrinkage cavities covering more than 0.5 × diameter of cooling bore must be evaluated individually.
- Report is to be prepared for the liner in question indicating type, position, size, and depth of observed defects and/or grindings.

10. Rectification and repair

10.1. Grinding-out of defects

Grinding-out of macro defects must be carried out in accordance with the following principles:

- Micro defects are not normally ground.
- Slag and sand inclusions, crack-like defects and defects appearing with sharp edges must be cleaned of all loose particles, and sharp edges must be ground and rounded.

Zone 1 and 2:

Running surfaces:

- Allowed grinding-out as stated below in table 1.
- Zone 3, outer surface:

Zone 3:

Outer surface:

- Maximum depth of grinding out is as specified for inner running surface zone 2, however, grinding out on the outer surfaces must be made with a larger and smooth transition radius to the surrounding surface.

Note! In the transition rounding t o the contact face for the cylinder frame (a), single local surface defects can be removed by smooth grinding over a suitable area so that no local indentation occurs. The maximum depth of grinding in this area is 2 mm.

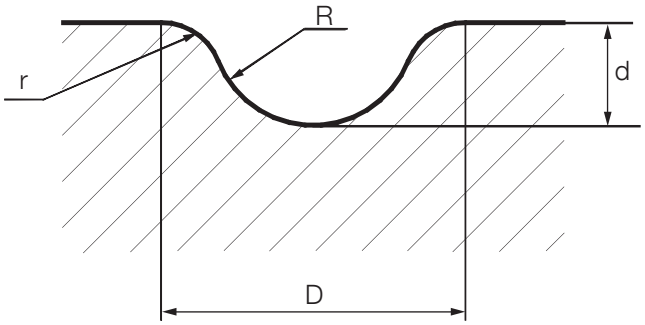

Figure 3: Geometry of ground out area.

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The dimensions of grindings seen in figure 3 must be according to the values stated in table 1. Maximum diameter of grinding out, D, is calculated on basis of the wavelength, W, of the wavecut on the running surface. The wavelength is illustrated in figure 2.

Table 1: Acceptance criteria for removal of defects.

Inside surface:	Zone 1	Zone 2 and 3
D: Max. diameter grinding-out	1 × W*	1.5 × W*
d: Max. depth of grinding-out	0.5 × D	0.5 × D
R: Min. radius of bottom	0.3 × D	0.3 × D
r: Min. radius of edge	0.2 × D	0.2 × D

* W is the nominal “wavelength” of the wavecut, as stated on the relevant drawing, see figure 2.

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