Cylinder liner variations

- Cast-in pipes with:
  - Shape Round cross-section and two bends
  - Shape Oval cross-section and one bend
- Bore cooled liner
- Slim liner
- Lubricating holes tangential
- Lubricating holes radial
- Short length for high topland
- Long length for low topland
- Differently situated O-rings
- Different numbers of lubricating holes
- Material tarkalloy - A
- Material tarkalloy - C
- Material cast Iron
- Scavenge ports different heights

A lot of possibilities to receive wrong deliveries from ungentine suppliers.

Genuine suppliers: MD-C and Engine builder.

Cylinder liners

<table>
<thead>
<tr>
<th>Cylinder liners</th>
<th>26 - 50MC</th>
<th>60 - 90MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 - 90MC</td>
<td>60 - 70MC</td>
<td>Second generation MC</td>
</tr>
</tbody>
</table>

First generation MC

Cast-in cooling pipes

“Slim line”

Bore cooled
Cylinder liner, 98MC/MC-C

Original design
Expected lifetime 80,000 hours.

MD-C produced liner
- Always made according to latest design
- Lower part of liner has been modified to reduce mean stress and stress amplitude
- Wave-cut and semi-honed surfaces

MD-C supply
- Ensures correct liner material for the original piston ring pack
- Ensures correct port height
- Ensures correct angle and number of lubricating holes
**Cylinder liner**

90MC/MC-C expected lifetime 80,000 hours.
80MC/MC-C expected lifetime 70,000 hours.

**Liners produced by MD Copenhagen**

Always made according to latest design.
MD-C produced liners
All types with wave cut and semi-honed surfaces.
Cast-in in cooling pipes with oval cross-section and one bend.

MD-C supply
• Ensures correct liner material for the original piston ring pack.
• Ensures correct port height.
• Ensures correct angle and number of lubricating holes.
Original design
70 MC/MC-C expected lifetime 70,000 hours.
60 MC/MC-C expected lifetime 60,000 hours.

MD-C produced liners
Always made according to latest design.
Bore-cooled liner with correct number of cooling bores
(increased from 24 to 30 for S type).
**MD-C produced liners**

All types with wave cuts and semi honed surfaces.

Cast-in in cooling pipes liner with oval pipes and one bend.

**MD-C supply**

- Ensures correct liner material for the original piston ring pack.
- Ensures correct port height.
- Ensures correct angle and number of lubricating holes.
- Ensures correct design: Slim liner or liner with casting cooling pipes.
Cylinder liner
70 MC/MC-C, 60 MC/MC-C

Cylinder liner for S70MC-C

The number of cooling bores have been increased from 24 to 30
Cylinder liners, 50 MC/MC-C, 46 MC/MC-C, 42 MC, 35 MC, 26 MC

Original design

50MC/MC-C:
Expected lifetime 60,000 hours

46MC/MC-C, 42MC, 35MC:
Expected lifetime 50,000 hours

26MC:
Expected lifetime 40,000 hours
**MD-C produced liners**

Always produced to the latest design.

Produced with wave-cut and semi-honed surfaces.

**MD-C supply**

- Ensures correct liner material for the original piston ring pack.
- Ensures correct port height.
- Ensures correct angles and number of lubricating holes.
Cylinder Condition

Cylinder liner standard as per 981001

**MC-engines**

**80/90/98**
- Bore cooled
- Piston cleaning ring (PC-ring)
- Tarkalloy-C
- Dry cylinder frame
  - **60/70**
    - Bore cooled (except S60MC + S60MC-C)
    - Tarkalloy-C (S60MC-C – Tarkalloy-A)
    - Dry cylinder frame
  - **26/35/42/46/50**
    - Slim liner
    - Tarkalloy-C
    - Dry cylinder frame (except L35/42)
Factors influencing cylinder wear

- **Corrosive wear**
  - H$_2$SO$_4$
  - HCl
  - Condensation in air cooler
  - Water leakages
  - ‘Cold’ liner wall
  - Cleaning agents
  - Lack of cylinder oil film

- **Abrasive wear**
  - Microseizure
  - Scratches
  - Cylinder oil film deficiencies
    - Material
    - Design
    - Machining
  - Liner
  - Ring
  - Skirt
  - Mechanical load
  - Thermal load
  - Deformation of piston rings (during fitting)
  - Misalignment
  - Too high cylinder oil dosage (deposits)

**Lack of cylinder oil film:**
- Cylinder oil/fuel oil matching
- Too low cylinder oil dosage
- Distribution
- Timing
- Water in cylinder oil
- Water leakage to cylinder

- Impurities in fuel oil
- Impurities in intake air
- Wearing particles
This chart has been made after a request from Mobil, and is based only on ships where MAN Diesel has been on board either to test engine components or as 'trouble-shooters'. Therefore, this chart is for guidance only.
A: Previous design

Cold corrosion on cylinder liners has been experienced in some cases

B: New design

Using an uncooled cylinder Frame, the temperature on the running surface has been increased in the lower part of the cylinder liner by about 60°C

Good experience
The general cylinder condition is improved
Cylinder Liner Crack Types

Blow-by crack:
Position of C-crack approx. between lowermost ring and skirt upper edge.

Two upper rings have lost tension and are possibly also broken.
Furthermore, ring Nos. 3 and 4 might be sticking.

Points to be checked/modified:
Performance (VIT, TC)
Atomizers (small holes, rounded inner edges)
Modified piston ring material
## Cylinder Condition

<table>
<thead>
<tr>
<th>Problem</th>
<th>Reason</th>
<th>Countermeasure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low TBO</td>
<td>Incorrect cylinder lube oil</td>
<td>For immediate improvements: Increase cylinder oil</td>
</tr>
<tr>
<td></td>
<td>feed rate</td>
<td>dosage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grading between S and K/L engines SL 94-318</td>
</tr>
<tr>
<td>High cylinder</td>
<td>Cold corrosion</td>
<td>Cooling water bypassing the cylinder frame</td>
</tr>
<tr>
<td>liner wear</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bore-polish</td>
<td>Stationary carbon scrape ring</td>
</tr>
<tr>
<td></td>
<td>Insufficient oil distribution</td>
<td>Two-stage lubrication</td>
</tr>
<tr>
<td>Insufficient gas</td>
<td>Relatively small gas buffer</td>
<td></td>
</tr>
<tr>
<td>sealing</td>
<td>volume around the top land</td>
<td></td>
</tr>
<tr>
<td>Collapsed rings</td>
<td>Increased thermal load of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>especially top and second</td>
<td></td>
</tr>
<tr>
<td>Broken rings</td>
<td>rings</td>
<td></td>
</tr>
<tr>
<td>High piston ring wear</td>
<td>Increased load on top ring</td>
<td>High top land</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High top rings</td>
</tr>
<tr>
<td></td>
<td>Material incompatibility</td>
<td>Improved material strength of top rings GT-CL top</td>
</tr>
<tr>
<td>Running-in problems</td>
<td>Mismatched surface roughness</td>
<td>top ring</td>
</tr>
<tr>
<td>Micro seizures and</td>
<td></td>
<td>Ceramic coating of top ring</td>
</tr>
<tr>
<td>scuffing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compatibility between rings and liner material</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Semi-honing of liners</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lube oil performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others?</td>
</tr>
</tbody>
</table>
Cylinder Condition

Piston cleaning ring

16 relief grooves