Guide for judging condition of relevant piston-running components (liners, pistons and piston rings)

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1 Purpose of this booklet

This booklet shall serve as a guide for judging the condition of relevant components (liners, pistons and piston rings) for the condition-based maintenance during piston and liner overhauls of engines with latest piston-running standard with full CC (chromium ceramic) piston ring packages or CC top ring and lower RC (running-in coating) rings for smaller bores.

Actual wear rates strongly depend on operational factors, such as fuel oil in use, engine load profile, ambient conditions etc. Especially with today’s slow steaming, engines may suffer from cold corrosion resulting in an increased wear on cylinder liners and piston rings, considerably reducing the TBO (time between overhauls). With this guide the overhauls can be planned, taking the operational conditions into account.

On the other hand, for engines running under moderate operation conditions, piston overhauls can be extended, and piston TBO beyond 30'000 hours is achievable.

By visual inspections, critical conditions of liners and piston rings can be detected at an early stage and if appropriate countermeasures are taken, sudden severe wear (scuffing), losing liners and pistons rings, can be avoided and the reliability enhanced.

Other measures such as analysis of piston underside drain or scrape oil sample (see technical bulletin TB RT-138) will provide further information to monitor the liner and piston ring conditions.

We recommend carrying out visual piston underside inspections every four to eight weeks. Inspections with measurements of piston ring coating thickness, ring groove clearance and loss of material on top piston land should be carried out two to three times per year.

By no means can guides such as these cover all possible conditions and in case of questions we suggest contacting Wärtsilä. For contact details, see chapter 12.

2 Requirements to extend piston TBO

The TBO can be extended based on the following requirements:

- Visual conditions as shown in chapter 6.1
- Remaining CC coating for top piston rings greater than 50 µm and for lower CC coated rings greater than 20 µm. (Below those limits, piston ring replacement should be planned)
- Ring groove clearances within acceptable limit see maintenance manual and TB RT-149
- Loss of material on top piston land within limits
- No water or oil leakages from liners, valves or pistons inside of combustion space and piston underside

As guidance the following specific guide wear rates can be considered:

- Liner specific wear rates (diametrical) from 0.03 to 0.10 mm/1000 hours are considered as acceptable
- Top ring specific wear rates (radial) of ~0.01 mm/1000 hours are to be considered as acceptable
- Ring groove specific wear rates of ~0.01 mm/1000 hours are to be considered as acceptable
3 Preparation for piston underside inspection

Before entering the piston underside make sure that the necessary safety precautions are met:

- Inspection to be done with another person
- Open air spring drain valve 36HA to open the exhaust valves during the inspection for air circulation and to check for oil leakage through valve spindle
- Engage turning gear and make sure that indicator cocks are open, if not done already
- Starting-air shut off valve 2.03 to be closed
- Protect yourself with adequate equipment such as oil resistant gloves and protecting overalls. Do not enter piston underside without protection equipment. Fuel oil residues in piston underside may be harmful to the skin!
- Install adequate air blowers for ventilation of piston underside and to provide fresh air during the inspection
- After inspection, before closing inspection doors make sure that nothing is left inside

➢ Before entering piston underside for inspection, review previous reports and check previous liner and piston measurement sheets for reference.
➢ For the inspection, the jacket cooling water system should run to detect possible water leakages due to leaking O-rings or cracked parts. Lowering of the cylinder cooling water temperature may reduce the temperature in the piston underside.
➢ Keep also the main lubricating oil pumps running, avoiding dry turning of bearings and to check for possible oil leakage from pistons and valve spindles.
➢ To get a clear picture of the piston ring condition, it is recommended that all piston rings are checked around their full circumference, if space in piston underside permits it. If space is limited use a mirror for visual inspection.
➢ Scorings / initial scuffing marks are often first found on the lower rings. Hence all piston rings are always to be checked visually.
➢ Designation of piston rings is normally A for the top ring B for the 2nd, C and D for third and fourth ring
➢ Use expression as per OM for designating positions e.g. EXH (exhaust side), DE (driving end), FP (fuel pump side) and FE (free end)
➢ For correct piston ring designations please refer to bulletin RT-135 and RT-135_A1
➢ Mark the unit number and piston rings properly with paint marker
➢ Be aware of the condition in which the engine was operated before the inspection:
  - Extended period of low load
  - Sulphur content of fuel oil in use
  - A long period of manoeuvring which would result in a high lubricating oil consumption
  - If the engine was changed over to MDO
  - Type and grade of cylinder oil in use (Base number)
➢ Check cylinder block and receiver structure, water separators and non-return flaps for abnormalities
4 Tools and equipment

For visual inspections:
- Flash or head light
- Mirror
- Digital camera
- Paint marker
- Protective equipment as described above
- Rags
- Turning gear remote control

For inspection with measurements on piston rings, ring grooves and piston crown, additional equipment is required:
- Coating thickness measuring device (Fischer Dualscope MP0, Order code number: 94356) Make sure, that the device is properly calibrated on piston ring base material (use upper flank of a spare top ring) according to manual.
- Feeler gauge
- Recording templates
- Template 94366a to check loss of material on piston crown

5 Wear modes

5.1 Piston ring

While defining the wear mode that has taken place, one can refer to the following table summarising the typical wear pattern. The proposed flow diagram depicts some typical wear scenarios that may have taken place.

<table>
<thead>
<tr>
<th>Wear type</th>
<th>Wear characteristic pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adhesion</td>
<td>• Material transfer from the softer to the harder material. Brownish deposits on piston rings</td>
</tr>
<tr>
<td></td>
<td>• Plastic deformation</td>
</tr>
<tr>
<td></td>
<td>• Micro marks with irregular border (scores)</td>
</tr>
<tr>
<td>2 body abrasion</td>
<td>• Micro marks with regular border (scratch)</td>
</tr>
<tr>
<td>3 body abrasion</td>
<td>• Random orientation grooves</td>
</tr>
<tr>
<td></td>
<td>• Micro marks with regular border (scratch)</td>
</tr>
<tr>
<td></td>
<td>• Indents</td>
</tr>
<tr>
<td></td>
<td>• Plastic deformation</td>
</tr>
<tr>
<td>Corrosion</td>
<td>• Coloured surface film</td>
</tr>
<tr>
<td></td>
<td>• Non uniform aspect</td>
</tr>
<tr>
<td></td>
<td>• Pits aspect on the liner</td>
</tr>
<tr>
<td>Delamination fatigue</td>
<td>• Fracture parallel to the surface</td>
</tr>
<tr>
<td></td>
<td>• Pits, flakes</td>
</tr>
</tbody>
</table>
5.2 Typical liner wear patterns

The wear pattern on the liner itself also gives some indication as to the nature of the cylinder liner wear and may differ from engine type to engine type.

The actual wear on cylinder liners and piston rings is not simply a linear function, but depends on operating conditions and can be a combination of above wear modes.
6 Condition assessment for piston rings and cylinder liner
6.1 Normal and acceptable conditions
6.1.1 Piston rings

<table>
<thead>
<tr>
<th>Ring type</th>
<th>SCP1CC20, A ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>Normal condition, secondary crack network slightly visible</td>
</tr>
<tr>
<td>Acceptance</td>
<td>Normal</td>
</tr>
<tr>
<td>Action</td>
<td>No action required</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ring type</th>
<th>SCP1CC20, A ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>Normal condition, regular secondary crack network</td>
</tr>
<tr>
<td>Acceptance</td>
<td>Normal</td>
</tr>
<tr>
<td>Action</td>
<td>No action required</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ring type</th>
<th>SCP1CC20, A ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>Abrasion (3 body abrasion) can be caused by catalyst fines in fuel oil, or foreign hard particles (e.g. sand in intake air).</td>
</tr>
<tr>
<td>Acceptance</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Action</td>
<td>See technical bulletin RT-140</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ring type</th>
<th>SCP1RC16, B ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>RC running-in coating in spotless condition</td>
</tr>
<tr>
<td>Acceptance</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Action</td>
<td>No action required</td>
</tr>
</tbody>
</table>
6.1 Normal and acceptable conditions

6.1.1 Piston rings

<table>
<thead>
<tr>
<th>Ring type</th>
<th>Condition</th>
<th>Acceptance</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCP1RC15, C ring</td>
<td>RC running-in coating gone, ring running on base material, spotless condition</td>
<td>Acceptable</td>
<td>No action required</td>
</tr>
<tr>
<td>SCP1RC15, B and C ring</td>
<td>Some RC running-in layer spalling</td>
<td>Acceptable</td>
<td>No action required</td>
</tr>
<tr>
<td>SCP1RC16, C ring</td>
<td>RC running-in coating gone, ring running on base material, spotless condition</td>
<td>Normal</td>
<td>No action required</td>
</tr>
<tr>
<td>GTP1CF24, A ring</td>
<td>Bottom face Cr coating fretting</td>
<td>Acceptable</td>
<td>No action required</td>
</tr>
</tbody>
</table>
6.1 Normal and acceptable conditions

6.1.2 Liner

<table>
<thead>
<tr>
<th>Condition</th>
<th>Acceptance</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spotless condition of liner, honing marks clearly visible</td>
<td>Normal</td>
<td>No action required</td>
</tr>
<tr>
<td>Good liner condition, smooth and homogenous liner appearance, honing marks not visible anymore</td>
<td>Normal</td>
<td>No action required</td>
</tr>
<tr>
<td>Cylinder liner with minor cold corrosion (milky spots)</td>
<td>Normal</td>
<td>No action required</td>
</tr>
</tbody>
</table>
6.2 To be monitored
6.2.1 Piston rings

Ring type: SCP2CC20, D ring
Condition: Hard contact marks
Acceptance: To be monitored. Piston ring may recover
Action: Temporary increase of set feed rate by 0.2 g/kWh and if possible reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines. Consider exhaust gas deviation alarm.

Ring type: SCP1CC20, A ring
Condition: Hard contact marks
Acceptance: To be monitored. Piston ring may recover
Action: Temporary increase of set feed rate by 0.2 g/kWh and if possible reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines. Consider exhaust gas deviation alarm.

Ring type: SCP1RC20, B ring
Condition: Hard contact marks, RC coating gone, ring running on base material
Acceptance: To be monitored. Piston ring may recover
Action: Temporary increase of set feed rate by 0.2 g/kWh and if possible reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines. Consider exhaust gas deviation alarm.

Ring type: SCP1CC20, B ring
Condition: Scoring marks
Acceptance: To be monitored. Piston rings may recover
Action: Temporary increase of set feed rate by 0.2 g/kWh and if possible reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines. Consider exhaust gas deviation alarm.
6.2 To be monitored

6.2.1 Piston rings

<table>
<thead>
<tr>
<th>Ring type</th>
<th>Condition</th>
<th>Acceptance</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCP1CC20, A ring</td>
<td>Cracked CC coating and spalling</td>
<td>To be monitored. Limited size of spalling</td>
<td>In case spalling is less than 20 mm in length and less than half of the ring height the condition is still acceptable</td>
</tr>
<tr>
<td>SCP2CC20, C ring</td>
<td>Scoring and hard contact marks</td>
<td>To be monitored. Piston rings may recover</td>
<td>Temporary increase of set feed rate by 0.2 g/kWh and if possible reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines. Consider exhaust gas deviation alarm</td>
</tr>
<tr>
<td>GTP1CC24, A ring</td>
<td>Corrosive attack of CC coating</td>
<td>To be monitored. Corrosion may result in high wear on ring and liner</td>
<td>Check correct cylinder oil feed rate setting in line with technical bulletins (TB) RT-161, RT-138 and recommendations as given in TB RTA-79.2 resp. RT-flex-08.2. Check residual base number (BN) in piston underside drain oil in line with TB RT-138.</td>
</tr>
<tr>
<td>SCP1CC20, A ring</td>
<td>Ring with severe corrosion spots</td>
<td>To be monitored. Corrosion may result in high wear on ring and liner</td>
<td>Check correct cylinder oil feed rate setting in line with technical bulletins (TB) RT-161, RT-138 and recommendations as given in TB RTA-79.2 resp. RT-flex-08.2. Check residual BN in piston underside drain oil in line with TB RT-138. Check remaining CC coating thickness</td>
</tr>
</tbody>
</table>
6.2 To be monitored

6.2.2 Liner

Condition: Cylinder liner with quite some cold corrosion and some black lacquer

Acceptance: To be monitored

Action: Check correct cylinder oil feed rate setting in line with technical bulletins (TB) RT-161, RT-138 and recommendations as given in TB RTA-79.2 resp. RT-flex-08.2. Check residual BN in piston underside drain oil in line with TB RT-138.

Condition: Cylinder liner with black lacquer and cold corrosion

Acceptance: To be monitored

Action: Check correct cylinder oil feed rate setting in line with technical bulletins (TB) RT-161, RT-138 and recommendations as given in TB RTA-79.2 resp. RT-flex-08.2. Check residual BN in piston underside drain oil in line with TB RT-138.

The formation and extent of this lacquer formation depends mainly on engine load, sulphur content in fuel oils (~2.7% or higher), set cylinder oil feed rate and air humidity.
6.2 To be monitored
6.2.2 Liner

**Condition:** Single scoring marks on cylinder liner

**Acceptance:** To be monitored, piston rings have to be checked all around

**Action:** In case the liner scoring develops further, the unit should be overhauled at the next opportunity and local scoring is to be dressed up
6.3 Action required
6.3.1 Piston rings

Ring type: SCP1CC20
Condition: Active scuffing, CC coating destroyed, active scuffing
Acceptance: Critical condition
Action: Unit to be overhauled. Temporary increase of set cylinder oil feed rate by \(-0.2 \text{ g/kWh}\) and reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines until unit is overhauled. Consider exhaust gas deviation alarm. If ships schedule permits it, switch off the unit, till unit is overhauled.

Ring type: SCP1CC20, C ring
Condition: Scuffed, CC coating destroyed and cohesive spalling, active scuffing
Acceptance: Critical condition
Action: Unit to be overhauled. Temporary increase of set cylinder oil feed rate by \(-0.2 \text{ g/kWh}\) and reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines until unit is overhauled. Consider exhaust gas deviation alarm. If ships schedule permits it, switch off the unit, till unit is overhauled.

Ring type: SCP2CC20, C ring
Condition: Scuffed with some CC remaining active scuffing
Acceptance: Critical condition
Action: Unit to be overhauled. Temporary increase of set cylinder oil feed rate by \(-0.2 \text{ g/kWh}\) and reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines until unit is overhauled. Consider exhaust gas deviation alarm. If ships schedule permits it, switch off the unit, till unit is overhauled.
6.3 Action required
6.3.1 Piston rings

**Ring type:** SCP2CC20, D ring
**Condition:** Partly recovered from scuffing, sharp edges with burrs, coating worn down
**Acceptance:** Critical condition
**Action:** Unit to be overhauled. Temporary increase of set cylinder oil feed rate by ~0.2 g/kWh and reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines until unit is overhauled. Consider exhaust gas deviation alarm

**Ring type:** SCP1CC20, A ring
**Condition:** CC coating worn down to base material, corrosion on remaining CC coating
**Acceptance:** Critical condition, further operation of such rings will result in a greater liner wear and increased risk for scuffing
**Action:** Unit to be overhauled
**Remark:** See next picture for possible root cause

**Ring type:** GTP1CF24, A ring
**Condition:** Locally scuffed, CC coating destroyed and spalling, scuffing not active
**Acceptance:** Critical condition
**Action:** Unit to be overhauled. Temporary increase of set cylinder oil feed rate by ~0.2 g/kWh and reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines until unit is overhauled. Consider exhaust gas deviation alarm

**Ring type:** SCP1CC20, A ring
**Condition:** Excessive deposits on ring inner diameter (backside)
**Acceptance:** Critical condition, may lead to high ring wear and ring can stick
**Action:** Unit to be overhauled
6.3 Action required

6.3.1 Piston rings

Ring type: SCP1CC20, A ring
Condition: Completely worn CC coating
Acceptance: Critical condition, further operation of such rings will result in a greater liner wear and increased risk for scuffing.
Action: Unit to be overhauled

Ring type: SCP1CC20, A ring
Condition: Scoring marks on a worn CC ring
Acceptance: Critical condition
Action: Unit to be overhauled. Temporary increase of set cylinder oil feed rate by ~0.2 g/kWh and reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines until unit is overhauled. Consider exhaust gas deviation alarm.

Ring type: SCP1CC20, A and B ring
Condition: A ring with some corrosion, B ring lost tension, with excessive deposits, cylinder oil feed rate, BN and fuel oil sulphur content not matching
Acceptance: Critical condition
Action: Unit to be overhauled. Check correct cylinder oil feed rate setting in line with technical bulletins (TB) RT-161, RT-138 and recommendations as given in TB RTA-79.2 resp. RT-flex-08.2. Check residual BN in piston underside drain oil in line with TB RT-138.
6.3 Action required

6.3.1 Piston rings

**Ring type:** SCP1CC20, A ring  
**Condition:** Ring collapsed, with excessive deposit  
**Acceptance:** Critical condition  
**Action:** Unit to be overhauled. Switch-off unit

**Ring type:** SCP1CC20, A ring  
**Condition:** Ring broken  
**Acceptance:** Critical condition  
**Action:** Unit to be overhauled. Switch-off unit

**Ring type:** SCP1CC16, A ring  
**Condition:** A ring with excessive spalling across full ring height  
**Acceptance:** Critical condition  
**Action:** Unit to be overhauled. Temporary increase of set cylinder oil feed rate by ~0.2 g/kWh and reduce injection correction factor in flexView to 80% or install spacer in fuel pump for RTA engines until unit is overhauled. Consider exhaust gas deviation alarm

**Ring type:** GTP1CF24, A ring  
**Condition:** Bottom face Cr coating spalling  
**Acceptance:** Critical condition  
**Action:** Piston ring to be replaced
6.3 Action required
6.3.2 Liner

**Condition:** Cylinder liner with scoring marks

**Acceptance:** Critical condition

**Action:** Depending on piston ring condition unit should be overhauled and liner re-honed. If piston rings are in spotless condition, the unit can be kept in operation.

**Condition:** Liner with local scoring and scuffing, marks

**Acceptance:** Critical condition

**Action:** Depending on piston ring condition unit should be overhauled and liner dressed-up or re-honed. If piston rings are in spotless condition, the unit can be kept in operation.

**Condition:** Scuffing marks on liner

**Acceptance:** Critical condition

**Action:** Unit to be overhauled. Local scoring and scuffing marks are to be dressed up or re-honed.
6.3 Action required
6.3.2 Liner

Condition: Totally scuffed unit with dull appearance. Note the reddish spots on the piston crown top, which are oxidised iron from the liner

Acceptance: Critical condition

Action: Such a liner has to be replaced as soon as possible

Other indications to identify a scuffed liner (adhesive wear):

- Wear profile with greatest wear at measuring point C or mostly D, see also chapter 5.2
- Visual appearance of liner seems to be visually in homogenous condition, but microstructure of such a liner is destroyed
- Wear steps on running surface, in range of lubricating oil grooves or around scavenging air ports
- Sharp burrs on scavenging air ports

Adhesive wear (scuffing) results in a destroyed microstructure of the cast iron (thermo mechanical transformation layer), which is unfavourable for safe piston-running. If only the piston rings are replaced the piston running behaviour will be unstable and unit may fail again. Such a liner is to be replaced even if the wear limit has not yet been reached.

Visual examples, see next page
6.4 How to identify a scuffed liner

**Condition:** Totally scuffed liner surface and liner grooves partly worn down

**Condition:** Scuffed liner with wear step in the region of the liner grooves

**Condition:** Scuffed liner with wear step in the region of the scavenging air ports

**Condition:** Scuffed liner with burrs on the edges of the scavenging air ports
6.5 Possible actions for scuffed liners (temporary measures)

Possible action if a scuffed liner cannot be replaced (temporary measures)

- Lubricating groove re-grinding
- Remove sharp edges and burrs from scavenge air ports by grinding
- Remove wear ridge at TDC (top dead centre) by grinding
- Remove wear steps on running surface over whole stroke
- Local scoring and scuffing marks are to be dressed up

Dressing-up local scoring and scuffing marks

1. Material required

   - Angle grinder (100 mm or 180 mm diameter)
   - Serrated grinding disk and emery cloth (grain size 80 – 120)

2. Examples of local scoring and scuffing marks

3. Dressing-up procedure

   If the piston is installed, cover the top of the piston with rags to avoid ingress of dirt between liner, piston and piston rings. For such kind of scoring marks it is not the intention to remove them complete as this might result in a liner shape that is too uneven and causes blow by, but to break the surface of such scored liner structure.

   Scored surface before dressing up

4. Example of dressed liner surface

   Liner surface after dressing up
6.6 Pre-requisites for a cylinder liner before it can be re-honed

This requirements are valid for all cylinder liners of cast iron.

The cylinder liner must fulfil the following criteria:

- No cracks
- Honing is not recommended if the liner wear is eccentric and more than 1 mm out of centre. This can be difficult to measure, but one method is to compare the thickness of the wear edges around the liner.
- From the TDC of the top piston ring wear edge (measuring point B) to about mid-stroke (measuring point F), the inside diameter should not exceed that for a new liner by the value shown in the table below. For the position of measuring points, please refer to measuring gauge 94225.
- From about mid-stroke (measuring point G) to the bottom of the liner (measuring points G-K (L)), the inside diameter should not exceed that for a new liner by the value shown in the table below. For the position of measuring points, please refer to measuring gauge 94225.

<table>
<thead>
<tr>
<th>Bore diameter [mm]</th>
<th>350 – 580</th>
<th>600 – 760</th>
<th>820 – 960</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring Points B – F Original Ø + [mm]</td>
<td>0.8 – 1.4</td>
<td>1.5 – 1.9</td>
<td>2.2 – 2.5</td>
</tr>
<tr>
<td>Measuring Points G – K (L) Original Ø + [mm]</td>
<td>0.4 – 0.6</td>
<td>0.6 – 0.8</td>
<td>0.9 – 1.0</td>
</tr>
</tbody>
</table>

- O-ring grooves must be in good condition

Note: Liners which exceed the above mentioned diameter limits have to be scrapped!
### 7 Piston crown condition

**Top of piston crown is to be checked visually for oil or water leakage**

The top of piston land is to be checked with tool template 94366a to estimate the loss of material. Wear limits please refer to MM 3403–4.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Acceptance</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil on top of piston, leaking from valve shaft (rod joint ring)</td>
<td>Critical condition</td>
<td>Source of oil leak to be found and rectified</td>
</tr>
<tr>
<td>Water on top of piston leaking from a cracked valve seat, liner or cover</td>
<td>Critical condition</td>
<td>Source of water leak to be found and rectified</td>
</tr>
<tr>
<td>Loss of material, so-called 'paving stone' or 'elephant skin' appearance, indicating high-temperature corrosion</td>
<td>Acceptable</td>
<td>Wear to be checked and recorded (Template 94366a)</td>
</tr>
<tr>
<td>Excessive loss of material, above wear limit. See arrow, clearance between template 94366a and piston</td>
<td>Critical condition</td>
<td>Piston to be replaced</td>
</tr>
<tr>
<td>Piston cooling oil leakage caused by defective o-ring in piston crown</td>
<td>Critical condition</td>
<td>Source of oil leak to be found and rectified</td>
</tr>
</tbody>
</table>
8 Sample pictures for a visual inspection report

Condition of piston crown top and liner surface above scavenging air port

Liner surface as high as possible

Uncleaned piston ring package

Clean the ring package and mark the piston rings
Take picture of each piston ring, in case some abnormalities are noticed also take picture of these spots.
8 Sample pictures for a visual inspection report

- Carbon deposit
- Carbon deposit
- Piston top land
- Piston skirt
- Take picture of piston underside
- Piston rod

2-stroke Engines
8 Sample pictures for a visual inspection report

Piston underside space

Space after water separator
### PUS Inspection

<table>
<thead>
<tr>
<th>Installation:</th>
<th>Engine type:</th>
<th>Nom. power [kW]</th>
<th>Nom rpm:</th>
<th>Hull no.:</th>
<th>Eng. run hrs:</th>
<th>Date:</th>
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<tr>
<td>TIER II Delta Low TV</td>
<td>Cylinder lubricating system:</td>
<td>PLS Jet</td>
<td>Cylinder oil brand:</td>
<td>Cyltec 80</td>
<td>Fuel oil S cont. [%]:</td>
<td>Port.</td>
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<td>25'600</td>
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<tr>
<th>Unit 1 SLOC setting 1.10 (g/kW.h)</th>
<th>Running hours [hrs]</th>
<th>Coating</th>
<th>Coating thickness [μm]</th>
<th>Wear [mm/1000hrs]</th>
<th>Groove clearance [mm]</th>
<th>Condition</th>
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<td>Ring A</td>
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<td>CC</td>
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<td>0.007</td>
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<td>Ring B</td>
<td>12'500</td>
<td>CC</td>
<td>100</td>
<td>0.005</td>
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<td>Ring C</td>
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<td>CC</td>
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<td>Ring D</td>
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<td>Liner</td>
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<td>Skirt</td>
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<td>Fuel injectors</td>
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### Images

- Deposit on piston head top
- Deposit above top ring
- Piston head land surface
- Ring pack uncleaned
- Ring pack cleaned
- A ring
- B ring
- C ring
- D ring
- Liner lower part
- Liner upper part
10 List of technical bulletins and service letters

The following technical bulletins and service letters are mentioned in this guide or to be considered:

- RT-161, Cylinder lubrication
- RT-138, Lubricating oils, incl. appendix 1 validated lubricating oils
- RT-126, Diesel engine fuels
- RT-140, Catalyst fines in fuel oils
- RT-82, Distillate fuel use
- RT-149, Piston ring clearance and groove wear
- RTA-79.2, RT-flex-08.2, Continuous low load operation (Slow steaming)
- RTA-62, Prevention of Water Carry-Over and Liner Polishing
- RT-135, Piston rings, incl. Appendix RT-135 A1
- RT-110, CLU-4 pulse lubricating module: Pressure check and maintenance
- RT-117, Non-return valve of pulse feed lubricating system
- RT-147, Cylinder liner insulation and lubricating oil grooves (RTA96C, RTA96C-B, RT-flex96C-B)
- RT-157, Piston running behaviour (RTA82T, RT-flex82T)
12 Contacts

How to contact Wärtsilä

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