OPERATION & SERVICE MANUAL

Mincon HDD60 Pilot Hammer
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1 Introduction

This document covers the HDD60 Horizontal Directional Drilling System. The system connected to the drill using the following:

- HDD60 Horizontal Directional Hammer
- Support Station
- Compressor
- Water supply

The basic setup is shown below.

**Horizontal Directional Drill**

Including but not limited to:
- Astec DD4045, DD 6, DD8, AUDD9014
- Ditch Witch JT4020 M1, 7020, JT100
- Vermeer 36X50, 80X100, 100X120

The Installation and Operation section will deal with setup of the system and basic operation. Following that we will deal with disassembly and servicing. When dealing with the HDD60 in the service section we will separate it into two parts: Firstly the Horizontal Directional Drilling hammer component that makes drilling possible and secondly the Sonde housing component that makes steering possible.
2 Safety

Be sure to work safely at all times. Wear protective clothing and safety equipment and observe all safety regulations as prescribed by your employer, Government, or the site on which you work. Do not wear loose clothing that may get caught in rotating parts and cause serious personal injury.

Remember that a “Down-the-Hole” percussive hammer emits noise and you should therefore take every precaution to safeguard your hearing against damage by using proper hearing protection. Use eye protection at all times. Rock chips and dust which may be discharged from the face of the bit or bore hole at high velocities and can cause severe injury.

Hammers can be heavy – Always use proper and approved lifting equipment and take every precaution to safeguard yourself against injury. Keep hands clear at all times – Beware of getting fingers trapped between the chuck and bit and do not use hands or feet to clear the top of the borehole at any time. Other safety advice is given throughout this document which you are advised to read.

3 Hammer Care.

3.1 Storage

It is important to take the following steps in order to ensure smooth operation when hammer is to be re used. When the hole is completed and the hammer is to be inactive for some time the following steps should be taken.

**Short Term Storage** (e.g. 1 - 2 weeks)
- Using high pressure air, blow the hammer clear of all water.
- Turn oiler or support station up full and cycle hammer until oil is running out the shank of the drill bit.
- If there is not an automatic oiler, pour 1 liter (2 pints) of rock drill oil in to the backhead.
- Turn the air on and cycle for 10 seconds. This will lubricate the internal parts.
- Seal the hammer at the Sonde backhead and chuck end to exclude any dust or foreign particles.
- Store the hammer horizontally in a clean dry environment.

**Long Term storage** (e.g. 1 month or longer)
- Using high pressure air, blow the hammer clear of all water.
- Break out the Sonde Backhead, Bent Sub joints and Chuck.
- Disassemble the Hammer and Sonde Housing.
- Inspect and clean all hammer components.
- Lubricate all the internal components with rock drill oil.
- Reassemble the Hammer and Sonde Housing, and seal the Sonde Backhead and Chuck end.
- Store horizontally in a clean and dry environment.
- Periodically rotate the hammer as the oil will settle.

Before restarting any hammer after prolonged periods of inactivity, disassemble and inspect all internal parts. Clean and remove any oxidation with an emery cloth. Re-lubricate all internal components with rock drill oil and reassemble the hammer. Full assembly and disassembly instructions can be found further on in this manual.

4 Installation and Operation

4.1 Set up of HDD60 Hammer and Sonde

4.1.1 Installation of Sonde into Sonde Carriage

Depending on which model of Sonde you are using, the following procedures should be used to install the Sonde Beacon into the Sonde Carriage.
### Mincon DCI 15” Sonde Carriage Parts List and Assembly Instructions

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Part Number</th>
</tr>
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<tbody>
<tr>
<td><strong>A+B</strong></td>
<td>Mincon DCI 15” Sonde Carriage</td>
<td>MN585</td>
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<tr>
<td>A</td>
<td>DCI 15” Sonde Inner Tube Assembly</td>
<td>MN51000</td>
</tr>
<tr>
<td>1</td>
<td>DCI 15” Sonde Inner End Cap</td>
<td>MN51030</td>
</tr>
<tr>
<td>2</td>
<td>Sonde Shock Ring</td>
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<td>3</td>
<td>DCI 15” Sonde Inner Tube</td>
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<tr>
<td>4</td>
<td>DCI 15” Sonde (Not Included)</td>
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<td>5</td>
<td>DCI 15” Sonde Inner Locating Cap</td>
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<td><strong>B</strong></td>
<td>Outer Carriage Assembly</td>
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<td>6</td>
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<td>7</td>
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<td>8</td>
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<td>Shock Spring (4”)</td>
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<td>11</td>
<td>O Ring</td>
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<td><strong>Tools</strong></td>
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<td>13</td>
<td>Sonde Line Up Tool (Not Included)</td>
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<td>14</td>
<td>Sonde Torque Wrench (Not Included)</td>
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<td><strong>Other Options</strong></td>
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</table>

### Mincon DCI 15” Sonde Carriage Assembly Instructions

#### Assembly A - DCI 15” Sonde Inner Tube Complete:
Please refer to the exploded view above. Insert the locating tab on the Sonde Inner Locating Cap (Item 5) into the slot of the DCI Sonde (Item 4). Insert the DCI Sonde and Locating cap into the Sonde Inner Tube (Item 3) and screw together. Tighten with the small end of the Sonde Torque Wrench (Item 14). Do not over tighten. Take care not to cross thread the connection. Thread the Sonde Inner End Cap (Item 1) onto the inner tube and check to see if there is any slop with the DCI Sonde within the tube. If there is some slop, unscrew the Inner End Cap and insert the Sonde Shock Ring (Item 2) on top of the Sonde within the Sonde Inner Tube and reinstall the Inner End Cap. Tighten with the small end of the Sonde Torque Wrench (Item 14). Do not over tighten.

#### Assembly B + A - Outer Carriage Complete with Inner Tube Complete:
Place O Ring (Item 7) onto Outer Retrieval Cap (Item 6) so that it sits in the groove at the end of the threads. Place O Ring (Item 11) onto Outer Locating Cap (Item 12) in the same manner. Screw the Outer Retrieval Cap into the Outer Carriage Tube (Item 9). Tighten with the large end of the Sonde Torque Wrench (Item 14). Do not over tighten. Drop the Shock Spring (Item 8) into the Outer Carriage Tube so that it sits on top of the Outer Retrieval Cap. Insert Assembly A into the Outer Carriage Tube with the Inner End Cap (Item 1) end of the assembly first. Place the Second Shock Spring (Item 10) into the Outer Carriage Tube on top of the Inner Locating Cap (Item 5). Identify the locating dot (12 O Clock) on the end of the hex section of the Inner Locating Cap (Item 5) and align the slot (12 O Clock) on the Outer Locating Cap (Item 12) with it. Push the Outer Locating cap over the Inner Locating Cap keeping the alignment and compress the spring and screw in. Tighten with the large end of the Sonde Torque Wrench (Item 14). Do not over tighten.
### 4.1.1.3 Mincon DCI 19” Sonde Carriage Parts List and Assembly Instructions

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+B</td>
<td>Mincon DCI 19” Sonde Carriage</td>
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<td>A</td>
<td>DCI 19” Sonde Inner Tube Assembly</td>
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<td>DCI 19” Sonde Inner End Cap</td>
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<td>Sonde Shock Ring</td>
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<td>3</td>
<td>DCI 19” Sonde Inner Tube</td>
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<td>4</td>
<td>DCI 19” Sonde (Not Included)</td>
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<td>12</td>
<td>Outer Locating Cap</td>
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#### Assembly A - DCI 19” Sonde Inner Tube Complete

Please refer to the exploded view above. Insert the locating tab on the Sonde Inner Locating Cap (Item 5) into the slot of the DCI Sonde (Item 4). Insert the DCI Sonde and Locating cap into the Sonde Inner Tube (Item 3) and screw together. Tighten with the small end of the Sonde Torque Wrench (Item 14). Do not over tighten.

Assembly B + A - Outer Carriage Complete with Inner Tube Complete

Insert Assembly A into the Outer Carriage Tube with the Inner End Cap (Item 1) end of the assembly first. Place the Second Shock Spring (Item 10) into the Outer Carriage Tube on top of the Inner Locating Cap (Item 5). Identify the locating dot (12 O Clock) on the end of the hex section of the Inner Locating Cap (Item 5) and align the slot (12 O Clock) on the Outer Locating Cap (Item 12) with it. Push the Outer Locating cap over the Inner Locating Cap keeping the alignment and compress the spring and screw in. Tighten with the large end of the Sonde Torque Wrench (Item 14). Do not over tighten.
4.1.1.5  Mincon DCI 8” Sonde Carriage Parts List and Assembly Instructions

<table>
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4.1.1.6  Mincon DCI 8” Sonde Carriage Assembly Instructions

Assembly A - DCI 8” Sonde Inner Tube Complete: Please refer to the exploded view above. Insert the locating tab on the Sonde Inner Locating Cap (Item 5) into the slot of the DCI Sonde (Item 4). Insert the DCI Sonde and Locating cap into the Sonde Inner Tube (Item 3) and screw together. Tighten with the small end of the Sonde Torque Wrench (Item 14). Do not over tighten. Take care not to cross thread the connection. Thread the Sonde Inner End Cap (Item 1) onto the Inner tube and check to see if there is any slop with the DCI Sonde within the tube. If there is some slop, unscrew the Inner End Cap and insert the Sonde Shock Ring (Item 2) on top of the Sonde within the Sonde Inner Tube and reinstall the Inner End Cap. Tighten with the small end of the Sonde Torque Wrench (Item 14). Do not over tighten.

Assembly B + A - Outer Carriage Complete with Inner Tube Complete: Place O Ring (Item 7) onto Outer Retrieval Cap (Item 6) so that it sits in the groove at the end of the threads. Place O Ring (Item 11) onto Outer Locating Cap (Item 12) in the same manner. Screw the Outer Retrieval Cap into the Outer Carriage Tube (Item 9). Tighten with the large end of the Sonde Torque Wrench (Item 14). Do not over tighten. Drop the Shock Spring (Item 8) into the Outer Carriage Tube so that it sits on top of the Outer Retrieval Cap. Insert Assembly A into the Outer Carriage Tube with the Inner End Cap (Item 1) end of the assembly first. Place the Second Shock Spring (Item 10) into the Outer Carriage Tube on top of the Inner Locating Cap (Item 5). Identify the locating dot (12 O Clock) on the end of the hex section of the Inner Locating Cap (Item 5) and align the slot (12 O Clock) on the Outer Locating Cap (Item 12) with it. Push the Outer Locating cap over the Inner Locating Cap keeping the alignment and compress the spring and screw in. Tighten with the large end of the Sonde Torque Wrench (Item 14). Do not over tighten.
4.1.7 Mincon DCI 19” Cable Sonde Carriage Parts List and Assembly Instructions

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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<td>Grounded Sonde Spacer Assembly</td>
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<td>Sonde Make Up Seal</td>
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<td>7</td>
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<tr>
<td>18</td>
<td>Sonde Torque Wrench (Not Included)</td>
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</tr>
</tbody>
</table>

*This Grounded Sonde Spacer is used for all models except the HDD90 and HDD30. The HDD30 is not compatible with cable sondes.

4.1.8 Mincon DCI 19” Cable Sonde Assembly Instructions

Assembly A - DCI 19” Sonde Inner Tube Complete: Please refer to the exploded view above. Insert the locating tab on the Sonde Inner Locating Cap (Item 4) into the slot of the DCI Sonde (Item 3). Thread the cable on the sonde through the Sonde Inner Tube (Item 2) and insert the DCI Sonde and Locating Cap into the Sonde Inner Tube (Item 2) and screw together. Tighten with the small end of the Sonde Torque Wrench (Item 17). Do not over tighten. Take care not to cross thread the connection. Pass the cable on the sonde through the Sonde Inner End Cap (Item 1) and thread the Sonde Inner End Cap (Item 1) onto the Inner tube. Tighten with the small end of the Sonde Torque Wrench (Item 14). Do not over tighten.

Assembly B + A - Outer Carriage Complete with Inner Tube Complete: Disassemble the Outer Retrieval Cap Assembly (Items 6-10). Use a 7/64” Allen Wrench to unscrew the 6-32 x 3/8” Socket Screws. Place O Ring (Item 11) onto Outer Retrieval Bottom Cap (Item 10) so that it sits in the groove at the end of the threads. Place O Ring (Item 15) onto Outer Locating Cap (Item 16) in the same manner. Create a loop about 1/2” wide on the cable where the cable comes out of the Inner Sonde Tube Assembly (Item A). This loop will act as a spring to remove any stress on the cable going into the Sonde during drilling operations. Place the Shock Spring (Item 14) onto the Outer Locating Cap (Item 16). Identify the locating dot (12 O Clock) on the end of the hex section of the Inner Locating Cap (Item 4) and align the slot (12 O Clock) on the Outer Locating Cap (Item 16) with it. Push the Outer Locating cap over the Inner Locating Cap keeping the alignment and Thread the cable and Inner Tube Assembly (Item A) into the Outer Carriage Tube (Item 13) and screw the Outer Locating Cap (Item 16) and Outer Carriage Tube (Item 13) together. Tighten with the large end of the Sonde Torque Wrench (Item 17). Do not over tighten and ensure the Inner Tube Assembly does not disengage from the Outer Locating Cap. Place the currently assembled parts upright with the Outer Locating Cap at the bottom. Place the cable through the Shock Spring (Item 12) and seat the spring on top of the Inner End Cap (Item 1). Thread the cable through the hole on of the Outer Retrieval Bottom Cap (Item 10) and push the Outer Retrieval Bottom Cap over the half loop on the cable and screw the Outer Retrieval Bottom Cap onto the Outer Carriage Tube. Thread the O Ring (Item 9) over the cable and...
seat it in the O Ring Groove on the Outer Retrieval Bottom Cap (Item 10). Bend the Cable 90° to far edge of the inner clamping surface of the Outer Retrieval Bottom Cap (Item 10). Bend the cable again 90° so it is now perpendicular to the inner clamping surface of the Outer Retrieval Bottom Cap (Item 10). Thread the cable through the hole on of the Outer Retrieval Top Cap (Item 8) and push it down onto the Outer Retrieval Bottom Cap (Item 10). Apply blue or red Loctite, or equivalent to all screws. Align the holes on both and insert and screw the 6-32 x 3/8" Socket Screws in to secure the both halves of the Outer Retrieval Cap together. Tighten with the large end of the Sonde Torque Wrench (Item 14). Do not over tighten.
4.1.1.9 Mincon Subsite New Style 86 Series Sonde Carriage Parts List and Assembly Instructions

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+B</td>
<td>Mincon Subsite Sonde Carriage</td>
<td>MN591</td>
</tr>
<tr>
<td>A</td>
<td>Subsite Sonde Inner Assembly</td>
<td>MN51000</td>
</tr>
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<td>1</td>
<td>Sonde Inner End Cap</td>
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<td>2</td>
<td>Sonde Shock Ring</td>
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<td>Inner Locating Cap Split Collar B</td>
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<td>8</td>
<td>10-32 x (\frac{5}{8})&quot; Socket Screw (Qty 2)</td>
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<td>B</td>
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<td>6</td>
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<td>7</td>
<td>O Ring</td>
<td>MN50040</td>
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<td>8</td>
<td>Shock Spring (4&quot;)</td>
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<tr>
<td>9</td>
<td>Outer Carriage Tube</td>
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<td>Shock Spring (4&quot;)</td>
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<tr>
<td>11</td>
<td>O Ring</td>
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<td>Tools</td>
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<td>Sonde Line Up Tool (Not Included)</td>
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<td>14</td>
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<td>MN595</td>
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<tr>
<td>Battery Pack 3.6V Super Cell (qty. 3)</td>
<td>MN596</td>
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</tr>
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4.1.1.10 Mincon Subsite New Style 86 Series Sonde Carriage Assembly Instructions

Assembly A - Subsite Sonde Inner Assembly Complete: Please refer to the exploded view above. Remove the battery cap from the Subsite Sonde and remove the spring from the battery cap. Insert the spring into the Sonde Inner End Cap (Item 1) and place the Sonde Shock Ring (Item 2) over the spring. Screw the Sonde Inner End Cap into the Subsite Sonde. Tighten with the small end of the Sonde Torque Wrench (Item 14). Do not over tighten. Disassemble the Inner locating cap assembly. Use a 5/32" Allen Wrench to remove the Inner Locating Cap Hex (Item 7) from the Inner Locating Cap Split Collar assembly (Items 5 & 6). Use a 7/64" Allen Wrench to separate the Inner Locating Cap Split Collar assembly (Items 5 & 6). Remove the rubber protector cap from the end of the Subsite Sonde to expose the locating flat on the Sonde. Place the Flat on the tab of the Inner Locating Cap Split Collar A (Item 5) against the locating flat on the Sonde. Apply blue or red Loctite, or equivalent to all screws. Place the Inner Locating Cap Split Collar B in place to complete the sub assembly and secure in place with the 6-32 x \(\frac{1}{2}\)"Socket Screws (Item 6). Locate the half circle witness mark on the side of the Inner Locating Cap Hex (Item 7) and match it up with the witness mark on the side of the Inner Locating Cap Split Collar A (Item 5). Secure Inner Locating Cap Hex (Item 7) with the 10-32 x \(\frac{5}{8}\)" Socket Screws (Item 8).

Assembly B + A - Outer Carriage Complete with Inner Tube Complete: Place O Ring (Item 7) onto Outer Retrieval Cap (Item 6) so that it sits in the groove at the end of the threads. Place O Ring (Item 11) onto Outer Locating Cap (Item 12) in the same manner. Screw the Outer Retrieval Cap into the Outer Carriage Tube (Item 9). Tighten with the large end of the Sonde Torque Wrench (Item 14). Do not over tighten. Drop the Shock Spring (Item 8) into the Outer Carriage Tube so that it sits on top of the Outer Retrieval Cap. Insert Assembly A into the Outer Carriage Tube with the Inner End Cap (Item 1) end of the assembly first. Place the Second Shock Spring (Item 10) into the Outer Carriage Tube on top of the Inner Locating Cap (Item 5). Identify the locating dot (12 O Clock) on the end of the hex section of the Inner Locating Cap (Item 5) and align the slot (12 O Clock) on the Outer Locating Cap (Item 12) with it. Push the Outer Locating cap over the Inner Locating Cap keeping the alignment and compress the spring and screw in. Tighten with the large end of the Sonde Torque Wrench (Item 14). Do not over tighten.
### 4.1.2 Installation of Sonde Carriage into Sonde Housing

The following series of picture will detail the installation of a DCI Sonde into the HDD60. The same procedure should be used for servicing or changing the Sonde at a later date.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Unscrew and remove Sonde Housing Backhead from the Sonde Housing Sleeve.</td>
</tr>
<tr>
<td>2.</td>
<td>Insert and screw the Sonde Line Up Tool into the Sonde Carriage retrieval cap and pull out the complete Sonde Carriage assembly.</td>
</tr>
<tr>
<td>3.</td>
<td>Align the Sonde Carriage Locating Cap Groove with the DCI Adaptor Locking Dimple and push the cap on so that the hex socket of the Carriage Locating Cap fits over the DCI Adaptor and then screw the Carriage Locating Cap in place.</td>
</tr>
<tr>
<td>4.</td>
<td>Push the Sonde carriage into the Sonde Housing Sleeve with the Sonde Carriage Locating cap entering first.</td>
</tr>
<tr>
<td>5.</td>
<td>Screw the Retrieval bar into the Sonde Carriage and push forward until it stops. Turn gently until you feel the Sonde Carriage go forward and the Sonde Carriage Locking Cap groove seats over the Sonde Carriage Locating pin.</td>
</tr>
<tr>
<td>6.</td>
<td>Above picture shows the Sonde Carriage Locating Pin. The pin is in the Bent Sub set so that the Sonde will be aligned correctly in the twelve O’clock position.</td>
</tr>
<tr>
<td>7.</td>
<td>Place the compression ring over the end of the outer retrieval cap. Insert and screw the Sonde Housing Backhead in place.</td>
</tr>
</tbody>
</table>
4.2 Drill Bit Care and Installation

Your Mincon HDD drill bit is at the working end of drilling and just like the hammer, it will perform extremely well if cared for. Good drill bit care and maintenance helps ensure the longest life and best performance from that bit. The following gives recommendations on how to best care for your Mincon Drill Bits and install them correctly to maximize performance, productivity and longevity.

4.2.1 Drill Bit Handling

A drill bit is capable of taking considerable punishment in drilling operations; however, care must be taken while handling them to ensure that the bit you are drilling with is in sound condition. Drill bit foot valves or blow tubes are manufactured from hard plastics and can be easily broken if dropped or something heavy is dropped on them.

The tungsten carbide buttons on a bit are extremely hard to fracture the rock they are drilling in. Dropping the bits onto hard surfaces (such as metal) can cause the buttons to crack and break. All care must be made to ensure drill bit heads do not come in heavy contact as the buttons striking each other can also cause damage.

4.2.2 Drill Bits: Prior to Use

Prior to using a new or used drill bit it should be inspected for the following and lubricated with rock drill oil:

- Check the condition of all the carbides and ensure that no damage has occurred and that the carbides are sharp.
- Inspect the face and head of the bit for any cracking or damage that could be detrimental to the drill bit.
- Make sure the gauge row carbides have sufficient clearance from the head of the bit.
- Inspect the foot valve (blow tube) for damage or cracking.
- Check that the foot valve is not loose, and check the length of the foot valve from the strike face of the bit to the top of the foot valve. This dimension is critical in the correct operation of the DTH hammer and drill bit. The length of the foot valve above the drill bit strike face for the shanks used in Mincon HDD hammers can be found below.
- Inspect the splines of the drill bit and chuck. Remove any burrs that have formed. Excessive wear to the splines of the bit and/or chuck will cause the hammer to run loose and can cause broken foot valve, shanking of the bit, or damage to the strike face of the piston and/or drill bit.

<table>
<thead>
<tr>
<th>Shank</th>
<th>Length Above Drill Bit Strike Face</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inches</td>
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<tr>
<td>HDD40</td>
<td>2.300</td>
</tr>
<tr>
<td>HDD60</td>
<td>2.200</td>
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<td>HDD60</td>
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</tr>
<tr>
<td>HDD90</td>
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4.2.3 Installation of Drill Bit

When installing a new drill bit into a new hammer lubricate the splines on the bit with rock drill oil. When using the drill machines rotary head to screw the chuck into the hammer, take care not to cross thread the chuck. With the head of the bit in the bit basket, torque up the bit in the hammer. See later for torque recommendations.

When installing a new bit on a used hammer it is important to inspect the chuck for wear to the body and splines. In soft and broken drilling conditions there is often excessive bit travel that results in uneven wear to the splines. Where this wear is excessive the chuck should be replaced as failure to do this will result in premature wear to the splines of the new drill bit, and possible damage to other components in the hammer due to lateral movement of the drill bit in the hammer.

The following sequence of instructions is used to correctly fit the bit in the correct orientation for drilling.
Step 1: Unscrew and remove the Chuck from the Hammer.

Step 2: Remove Bit Retaining Ring from the Chuck and screw the Chuck back in place.

Step 3: Insert the bit into the Chuck so that the Bent Sub wear carbides are aligned in a straight line with the three bit wear carbides as illustrated above.

Step 4: Unscrew the Chuck and Bit from the hammer making sure that the bit does not come out of the Chuck.

Step 5: Insert the Bit Retaining Rings back into the Chuck as shown above making sure that the Bit does not come out of the Chuck.
Step 6: Push the Chuck forward to secure the Bit Retaining Ring in place against the rear splines. Screw the Chuck, Bit and Bit Retaining Rings in place.

5  Pilot Hammer Set Up

5.1  The Effect of Temperature and Altitude on Compressed Air

Both temperature and altitude have an effect on air and consequently on compressed air. Higher temperatures and higher altitudes result in air becoming thinner, less dense, and the effect of this is a reduction in a compressor’s delivery pressure.

The table below shows just how much operating pressure can be affected by these two factors. For example, if we take a compressor which will deliver 1000 cfm (28.3 M³/Min) at sea level and a temperature of 68° F, this same compressor will only deliver 745 cfm (21.1 M³/Min) at 9,000ft (2744m), given a temperature of 40° F (4.4° C).

<table>
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<th>°F</th>
<th>°C</th>
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<th>1524m</th>
<th>2134m</th>
<th>2744m</th>
<th>3354m</th>
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<td>-40</td>
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5.2  Up-hole Air Bailing Velocity Requirements

The up-hole air bailing velocity is the velocity of the air as it exhausts from the hole and returns to the surface carrying cuttings. Sufficient volume of compressed air is required to maintain pressure at the hammer and to maintain sufficient bailing energy to clean the hole.

Bailing velocity requirements vary with bailing rates, material hardness, density and depth of hole. The higher the drilling rate and density of the material the higher the bailing velocity must be.
Bailing velocity for hammers with operating pressures in the range of 200 to 350 psi should be 3000 feet (900m) per minute minimum. Recommended minimum bailing velocity is 5000-7000 feet (1500-2100m) per minute. Velocities in excess of 7000 feet (2100m) per minute are not uncommon but in abrasive material this can cause rapid erosion of the bit body and hammer.

Bailing velocities are calculated by using hole diameter, drill pipe diameter and the actual volume of air delivered down the hole. Make sure to allow for the affect of altitude and temperature when calculating the actual volume.

\[ VF = \frac{Y(\text{CFM}) \times 183.40}{DL^2 - di^2} \]

- VF = Velocity in feet per minute.
- Y(\text{CFM}) = CFM of air passed by hammer
- DL2 = diameter of hole squared in inches
- di2 = diameter of drill tube squared in inches

\[ VM = \frac{X(M^3)}{DM^2 - dm^2} \times 1273406.57 \]

- VM = Velocity in meters per minute
- X(M^3) = M3/min of air passed by hammer
- DM2 = diameter of hole squared in mm
- dm2 = diameter of drill tube squared in mm

### 5.3 Diverter Plug Selection

The Diverter plug removes some of the air flow from the hammer cycle and diverts it at the Sonde Backhead to aid in cuttings removal. To determine the amount of air that will be bypassed, the following formula can be used.

\[ F = 9.71 \times D^2 \times P \]

Where:
- F = Flow in scfm
- D = Plug hole diameter
- P = Pressure in psig

It is assumed that the flow coefficient is 0.7, temperature is 120°F and gas is air.

For example: If a \( \frac{1}{8} \)" choke is installed in a hammer then the additional air required to operate the hammer at 350 psi would be:

\[ F = 9.71 \times 0.125^2 \times 350 \]

\[ F = 53.1 \text{ scfm} \]

### 5.4 Torquing Up a HDD Hammer

Mincon HDD hammers use a patented three piece seating ring system and a compression ring to ensure that the hammers top end components are held firmly in place. This is extremely important as any movement of these components will result in premature wear and loss of performance. When a Mincon HDD hammer's bent sub is closed up by hand there is a gap between the wear sleeve and bent sub shoulder known as stand-off. All Mincon HDD hammers have 0.030" (0.76mm) stand-off.

The stand-off must be completely closed as part of the locking system for the hammer. Recommendations for closing the hammer are to have it torque to between 750 - 1000 ft.lb per inch of hammer diameter. A Thread Locking compound should be used to ensure the joint does not come loose while steering.

### 5.5 Lubrication

It is vital for HDD hammers to receive a constant supply of proper rock drill oil to protect the internal components and to provide a good air seal between the piston and the inner cylinder, and the piston and the wear sleeve for efficient drilling. Mincon recommends the use of Mincon Envirosafe® rock drill oil (RDO) to maintain optimal performance and extend the life of the internal components of your hammer.

The correct consumption of oil is dependent upon the air volume and conditions. Please refer to the lubrication graph below for recommendations. There should be visual evidence of oil around the drill bit shank and within the tube joints when changing tubes. When using the recommended Mincon Envirosafe® RDO the consumption can be reduced to 70 percent of the amount outlined in the consumption graph.

If using petroleum based rock drill oils, the recommended grade of oil is dependent on the ambient temperature in which drilling is taking place as well as the operating pressure. As a rule of thumb, ISO320 grade rock drill oil should be used whenever possible as the hammer is a high frequency tool, however, where the pump cannot pump the oil in colder conditions, a lower grade of oil can be used as per the graph below. The viscosity of Mincon Envirosafe® RDO is such that it can be used at any time without it becoming too tacky to pump.

When using water injection to flush and clean the hole, the quantity of rock drill oil being used must be increased. When drilling with 1 gallon (3.8 liters) a minute then the quantity of oil used should be increased by half. When drilling with 2 gallons (7.6 liters) a minute then the quantity of oil used should be doubled.
Remember: Insufficient lubrication or incorrect lubrication grades may result in damage being caused to the hammer and it’s components. Hydraulic oils, engine oils, gear oils and diesel are not recommended for lubricating DTH hammers.

5.6 Operation

Be sure to familiarize yourself with the controls of the machine and work in accordance with the manufacturers recommendations. The percussive mechanism begins to operate as the air supply is turned on and when the drill bit is pushed firmly into the hammer. Excessive thrust pressures are not needed to make it work. The thrust controls on the drill should be adjusted to the correct pressure and should be readjusted to take account of the weight of any extra tubes added so that the thrust pressure remains constant and not excessive. Insufficient thrust pressure will make the hammer drill erratically and less efficiently and cause premature wear to the bit and chuck splines with likely damage to the hammer components and threads.

When the hammer is lifted from the rock face, the drill bit extends from the chuck and the percussive action ceases. Extra air will pass through the hammer, which can be used to flush the hole clean. Whenever possible, the pressurized air in the hammer should be drilled out to avoid situations where back hammering can occur. This is not always possible in conditions where the rock is quite fractured and broken.

When changing drill rods, ensure that the drill string has been depressurized before breaking the tool joint. Rapid depressurization of the drill string can cause a sudden pressure drop in the hammer forcing debris from the bottom of the hole into the hammer. Before adding drill tubes make sure that the threads are clean and well-greased and that there are no contaminants likely to enter the hammer to cause damage and early wear.

5.6.1 Commissioning a New HDD Pilot Hammer

Coat the drill bit shank and the hammer threads with rock drill oil for protection and easier break-out. Install the hammer onto the drill machine’s rotary head, place a piece of cardboard on the table, locate the hammer’s drill bit just over the cardboard and turn the air on low. When the cardboard becomes wet with rock drill oil all internal components should be sufficiently coated with oil.

When fitting the hammer to the drilling rig ensure no debris or dirt enters the hammer from the site, dirty tubes or from unclean air lines. Make sure that the coupling threads from the drill are of the same specification to that of the hammer and they are in good condition. Run the hammer at half the air flow for a few minutes to allow the oil to flow through and for internal components to settle in.

5.6.2 Collaring the Hole

Collaring the hole is a very important aspect of the drilling process. The following procedure should be used when collaring the hole in rock:

1. While rotating the hammer clockwise at very slow speed feed the hammer to a few inches from the surface.
2. Turn on the air at a reduced pressure and slowly feed the hammer into the ground and continue at low pressure and impact.
3. As the hammer drills into the ground increase the air pressure, feed pressure and rotation as the hole becomes stable. It is advisable to lift the hammer off bottom occasionally to clean the hole as necessary. The conditions will dictate this and will be required more often in more broken conditions.
4. Once the hole has been stabilized continue drilling as normal.

The following procedure should be used when collaring the hole in overburden:

1. While rotating the hammer clockwise at very slow speed feed the hammer to a few inches from the surface.
2. Turn on the air at a reduced pressure and slowly feed the hammer into the ground and continue at low pressure and impact.
3. As the hammer drills further into the ground increase rotation and feed pressure. Lift the hammer off bottom occasionally to clean the hole as necessary as drilling through the overburden continues. Use of water and/or foam may be necessary to maintain the integrity of the bore-hole walls.
4. Continue until the hammer enters consolidated rock and case the hole. Be sure to follow all regulations regarding depth of casing into rock.
5. In situations where casing in extremely difficult conditions where the stability of the bore-hole walls cannot be maintained, such as gravel, heaving or flowing sands etc. the use of specialized foams, eccentric or concentric casing systems should be employed.

5.6.3 Feed Force/Pressure

For shallow holes the hydraulic down pressure applied to the Rotary Head through the pull down cylinders provides the necessary additional force. This additional pull down force is usually shown as a PSI value on the Rig gauges. To convert this figure to a weight value you will need to multiply the PSI reading by the area of the pull down cylinders. This can then be added to the weight of the Rods, Rotary Head, and Hammer minus Piston, to give the total "Weight on Bit".

As the hole deepens with the addition of extra rods, a point is reached where the pull down force needs to be reversed to create a "hold back force" thus preventing too much weight being applied to the Bit. Since there are so many different types and sizes of rigs, it is not possible to give specific guidelines on the amount of additional down pressure as shown by the gauge. This becomes part of the necessary tuning by the drill operator. Regarding the actual figures for required weight the easiest way to calculate this is to use the two simplified formulae below:

1. When working with air pressure below 250PSI, (17.2bar) multiply the Bit Head Diameter by 500 for inches and by 9 for millimeters. Example: - A Button Bit with a 6" (152mm) diameter Head would require 3000Lbs “weight on bit” or 1365Kg.
2. When working with air pressure at 250PSI (17.2bar) and above, multiply the Bit Head Diameter by 800 for inches and 14 for millimeters. Example: - A Button Bit with a 6" (152mm) diameter Head would require 4800Lbs “weight on bit” or 2182Kg. Since these formulae have been simplified to allow for quick calculation you may find that, dependent upon ground conditions, slight alterations may need to be made to these values. Again this is a necessary part of the tuning process performed by the drill operator.

It is also important to bear in mind that underfeeding, or insufficient weight on the bit will result in the bit “bouncing” up and down in the chuck. This will lead to a build-up of very high temperatures between the splines of the chuck and the bit which will eventually lead to “spot welding” and burning marks which will soon lead to bit shank failures.

Underfeeding also results in other types of failures, particularly button pop out and striking face failures. This is a result of the energy developed by the piston impacts not being transferred efficiently into the rock. As a result, a percentage of this energy is contained in the drill bit where it will eventually lead to failure through the weakest part of the bit. The percussive mechanism begins to operate as the air supply is turned on and when the drill bit is pushed firmly into the hammer. Excessive thrust pressures are not needed to make it work. The thrust controls on the drill should be adjusted to the correct pressure and should be readjusted to take account of the weight of any extra tubes added so that the thrust pressure remains constant and not excessive. Insufficient thrust pressure will make the hammer drill erratically and less efficiently and cause premature wear to the bit and chuck splines with likely damage to the hammer components and threads.

The best way to ensure the correct feed pressure is to start drilling the hole and continue to increase the feed pressure until the drill string begins to bind in the hole and then reduce the feed pressure to achieve smooth drilling. If there is a concern for voids, the drilling should be closely monitored so that the feed pressure can be turned off and the hole cleaned before resuming drilling. Another method to identify the point at which optimal hold-down pressure is applied is to increase the feed pressure until the rotation pressure gauge starts to pulse and then reduce the feed pressure until the rotation pressure gauge stops pulsing. Ultimately whichever method is used, the optimum situation is to have enough weight on the bit to drill as fast as possible without having excessive rotational torque.

When the hammer is lifted from the rock face, the drill bit extends from the chuck and the percussive action ceases. Extra air will pass through the hammer, which can be used to flush the hole clean.

5.6.4 Rotation

The action of a percussive HDD button bit is to make indentations in the rock which, with the rotation of the bit, make chippings and these need to be carried away to the surface by the hammer exhaust air as quickly as possible. Button bits have no cutting or tearing action as such and the effect of over rotation and overfeeding can have a serious effect on the life of the bit, especially in
abrasive rock. This can wear away the outer carbide insert buttons or in more solid or dense material can cause the inserts to overheat causing micro-cracks which can lead to fracturing. If the drill string is rotated too slowly this will cause the button bit to re-drill previously cut chippings in the hole causing a drop in penetration rate and unnecessary wear on the buttons. As a guideline, the harder the rock and larger the bit diameter, the slower the rotation speed required. However it may be necessary to increase the RPM if in broken ground so as to prevent the bit jamming in the hole. Remember that this could also be caused by a badly worn bit and increasing RPM in these circumstances would only accelerate the problem. The controls of the drill should be adjusted in order to provide the largest drill chip size with the smoothest rotation and feed characteristics. Recommended rotation speeds would normally vary between 25 – 35 R.P.M. for most applications.

As the feed pressure is increased or decreased as rock conditions change, the rotation speed needs to be monitored and adjusted to maintain correct indexing of the bit face to new rock and maintain the largest chip size. To determine the correct rotation in relation to the feed pressure, adjust rotation so that it is \( \frac{5}{8} \) to \( \frac{7}{8} \) (12-16mm) of penetration per rotation. The use of a piece of chalk or soapstone applied to the drill pipe during operation will create a spiral that indicates the amount of penetration per rotation. The rotation should be adjusted to keep this between the recommended to \( \frac{5}{8} \) of penetration per rotation.

The effect of incorrect rotation speeds can be seen by observing the wear patterns on the drill bits carbides. Where the rotation is too slow, wear will be observed on the leading edge of the carbides (side facing direction of rotation), and rotation that is too fast shows wear on the trailing edge of the carbide.

It is essential to keep the hammer rotating clockwise at all times during drilling and tool recovery to avoid uncoupling of the drill bit, hammer and drill pipe or damage to the drill bit from point loading on anything that may fall back into the bore-hole.

5.6.5 Hole Cleaning, Flushing and Dust Suppression

Effective hole cleaning is essential to maintain a maximum penetration rate and extend the life of the drill bit, hammer and drill pipe. Ensure that sufficient air volume is available to maintain an effective up-hole bailing velocity as described previously.

Use of a small quantity of water or polymer mix, usually less than 1 gallon per minute (3.8 Lpm) can be used for dust suppression. Larger volumes of water injection are usually required in more difficult bores to keep the hole clean. In situations where water is encountered in the hole dry cuttings from the bottom of the hole meet the water as they are bailed from the hole and create mud rings that stick to the hole causing a restriction. Water injection is required to moisten the cuttings to prevent this from occurring.

It is important to remember that the water or polymer mix injected into the hammer is a restriction in the operating cycle of the hammer and as such should be kept to a minimum as allowed by the conditions during drilling operations.

5.7 Hammer Service

5.7.1 General

Dismantling the Hammer for servicing or to change the bit can be made easier if the chuck threads are regularly greased and the backhead threads are well greased at any time the hammer is opened for servicing. We recommend that a good quality thread grease be used. In acidic conditions, we do not recommend copper based greases as this can trigger a galvanic reaction with corrosive effect to damage the root of the threads and cause failure. Care should be taken when working on the hammer and all safety guidelines should be followed for the equipment being used. Personal protective equipment should also be worn while working.

5.7.2 Breaking Out Chuck Bent Sub and Sonde Housing Backhead

Proper drill guides and break out systems must be used which suit the diameter of the hammer. All tools and spanners used for the drill bit and break out flats must fit properly. Make certain that the hammer is stationary when applying spanner or breakout tools. Do not rotate the hammer with a spanner attached to the drill string unless it is safely captivated within the breakout clamp.

The threads used in Mincon Hammers are right hand threads. Proper tools and break-out systems should be used at all times to dismantle DTH hammers, otherwise damage may be caused to the components which could result in eventual failure or affect the performance of the Hammer.

When using Petol wrenches or similar break-out systems, ensure that the wrench is not placed on the threaded section of the wear sleeve. Inspect the wrench jaws to confirm they are in good condition. It is good practice to keep a spare set of jaws with the rig. Do not strike or hit the outer components as this could weaken the heat treated steels. Hitting the hammer may also cause hard metal fragments to be chipped off which may be projected and cause personal injury or eyesight loss. Follow all instructions for the use of the break-out system being employed.

The hammer is connected to the Sonde Housing by the Bent Sub. The Bent Sub threads are secured in place with a thread epoxy. To remove the hammer and sonde housing from the bent sub, the thread epoxy bond must be removed. To do this, the threaded section should be heated above 500°F (260°C). Before doing this, remove the sonde carriage from the sonde housing to protect it and the electronics from heat. Care should be taken not to overheat. Use of welding heat sticks or an infrared temperature gauge is strongly recommended. Open Bent Sub joints as described above.

Do not apply excessive heat to the hammer (over 600°F/315°C), as this can alter the metallurgical composition and result in premature failure. Additionally, applying excessive heat can also cause distortion to the wear sleeve, which in turn would lead to failure. Do not trap the hammer under drill rig tracks or vehicle wheels which could cause bending and distortion of the hammer body. Failures caused by these actions cannot be supported by warranty. Take care when dismantling the hammer to make sure that parts and drill bits do not become detached and cause damage or personal injury.
5.7.3 Breaking Out Chuck to Change Drill Bit

When possible, dismantling the Hammer to change the drill bit is preferably done in a workshop environment to avoid the risk of injury and for cleanliness. Be careful to ensure that the drill bit and chuck are fully supported together so that there is no risk of them becoming detached and causing injury. Before fitting a new drill bit visually inspect the splines of the chuck and the piston striking face to ensure that both are not damaged in any way.

Place chuck onto the bit, and secure with the bit retaining ring. Liberally grease the threads on the chuck. Screw chuck into wear sleeve by hand, alternatively, if using the rig to screw chuck on, ensure that no cross threading occurs. Prior to use, place bit in a bit basket and torque up the chuck. This is essential, as the chuck can loosen if not properly torqued, and premature chuck failure can occur.

5.7.4 Disassembly for Full Servicing of Hammer

The hammer is connected to the Sonde Housing by the Bent Sub. The Bent Sub threads are secured in place with a thread epoxy. To remove the hammer and sonde housing from the bent sub, the thread epoxy bond must be removed. To do this, the threaded section should be heated above 500°F (260°C). Before doing this, remove the sonde carriage from the sonde housing to protect it and the electronics from heat. Care should be taken not to overheat. Use of welding heat sticks or an infrared temperature gauge is strongly recommended. Open Bent Sub joints as described above.

Breakout the Chuck on the hammer, remove the bit retaining ring from the bit and slide the chuck off the bit. Mark the wear sleeve to indicate which end is the chuck or backhead end for reassembly later. The following steps should be followed to complete the disassembly of the hammer for inspection:

1. Once the bent sub has been removed, check the operation of the check valve to confirm it has been working correctly and is not stuck. Remove the check valve and spring from the hammer.
2. Stand hammer up with the chuck end uppermost. Using a mild steel bar, tap the strike face of the piston to remove the air distributor and inner cylinder. The steel make-up ring and lock ring should fall out during this process, if so remove them and continue until the top of the air distributor is at the top of the wear sleeve.
3. Place the hammer flat on the ground or place onto a suitable vice and secure. Use the mild steel bar to hit the piston strike face from the chuck end to completely remove the air distributor, inner cylinder and piston.
4. If the hammer has a bit aligner or bit ring spacer, stand the wear sleeve up with the chuck end on the ground. Invert the piston and drop into the wear sleeve so that it is upside down. Take care to ensure that fingers do not get caught between the piston and wear sleeve. Tap the piston strike face with the mild steel bar to remove the aligner or bit ring spacer. A number of blows may be necessary as there is an interference fit between the parts.
5. The piston retaining ring can be removed by using a mild steel bar and hitting the section opposite the gap on the ring which will ride up the taper on the wear sleeve and come out. It can then be pulled out by hand.

5.7.5 Inspection

Prior to inspection, thoroughly clean all parts using a suitable cleaning agent. Diesel is not recommended for cleaning as it can cause erosion to components, and damage to health.

All parts should be visually inspected for any signs of damage, wear or cracking. The inner cylinder, wear sleeve and lock rings can be checked for unseen cracking by suspending them and lightly tapping with a screw driver. If they emit a ringing tone then they should be sound. However, a dull flat tone if emitted may indicate cracking, and the part should be replaced.

Take particular care to check the internal bore of the wear sleeve for pick-up marks and galling. If these are present, the barrel of the wear sleeve should be honed out, using a hand hone to remove them.

Inspect the surface of the piston for pick-up marks and galling (usually caused through poor lubrication or the presence of contaminants) and smooth out with emery paper or a hand held grit stone. Where galling of the piston has occurred, substantial heat has been generated and quite often, micro cracking has occurred on the piston. In these cases, the piston should be replaced if there is evidence of such cracking. Check the strike face of the piston for cracking or damage. If the piston has strike face damage, the face can be turned on a lathe to remove this up to 1/16" (1.5mm).

Inspect the threads of the chuck and backhead paying close attention to the locking side of the threads. The locking side of the chuck and backhead threads is the side facing away from the top of the wear sleeve. Look for signs of galling which would indicate that the chuck or backhead is coming loose during drilling and there is friction in the threads. Any galling can lead to the failure of the chuck, backhead and/or wear sleeve.

5.7.6 Checking Wear Limits

The performance of the hammer is dependent on the amount of wear the critical components have. These should be measured and recorded in the Service log in the appendix. The service log gives the location of where measurements should be taken. Depending on how many parts need to be replaced, it may be economical to replace the hammer all together.

If the hammer’s wear sleeve is reversible and the reverse wear limit has been reached on the outer diameter at the chuck end of the wear sleeve, the hammer can be reassembled with the backhead end becoming the chuck end. Additionally if the internal running surface in the wear sleeve for the piston is excessive, the wear sleeve can be reversed.

5.7.7 Reassembly

The hammer can be reassembled in the following manner, referring to the exploded view of the hammer in the appendix. Ensure all components are liberally coated with good quality rock drill oil and threads with thread grease. Replace all O Rings.
5.8 Sonde Housing Service

If the sonde housing sleeve is to be replaced due to wear, the following procedures should be used to disassemble and reassemble the sonde housing. Please refer to the exploded view of the hammer and sonde housing in the Appendix while performing these tasks.

5.8.1 Disassembly of Sonde Housing

1) Break out the sonde housing backhead as described above and remove the sonde spacer from the sonde housing backhead.
2) Remove the sonde carriage from the sonde housing and remove the compression ring from the outer retrieval cap of the sonde carriage.
3) Break out the bent sub from the sonde housing sleeve as described above.
4) Remove the seating ring from the bent sub end of the sonde housing sleeve.
5) Place the hammer flat on the ground or place onto a suitable vice and secure. Use the mild steel dolly and mild steel bar to hit the carriage guide and drive the carriage drive, sealing sleeve and diverter out of the sonde housing sleeve. Take care when the diverter is nearly out so that it does not fly out and injure someone or get damaged. Similar care should be taken for the other two parts.

5.8.2 Inspection

Prior to inspection, thoroughly clean all parts using a suitable cleaning agent. Diesel is not recommended for cleaning as it can cause erosion to components, and damage to health.

All parts should be visually inspected for any signs of damage, wear or cracking or melting. Replace any parts found to be damaged.

5.8.3 Assembly

1) Place the sonde housing sleeve on the ground with the end that has the timing slots closer to the threads facing up.
2) Place o-rings on the diverter, sealing sleeve, and carriage guide and apply a liberal coat of oil to each.
3) Place the diverter with the smaller end facing down and use a steel dolly to begin driving the diverter into the sonde housing sleeve until the sealing sleeve can be placed in on top of the diverter.
4) Install the sealing sleeve into the sonde housing sleeve on top of the diverter and use the steel dolly to continue driving the diverter and sealing sleeve into the sonde housing sleeve until there is sufficient space to install the carriage guide on top of the sealing sleeve.
5) Install the carriage guide with the flat end going in first and beveled end facing up and use the steel dolly to drive the carriage guide, sealing sleeve and diverter into place. The carriage guide should be in place when it clears the shoulder beyond the threads.

6) Place the seating ring on top of the carriage guide and ensure that the bevel on the carriage guide and the bevel on the seating ring match up.

7) Use a degreaser to clean the sonde housing sleeve threads till they are clean and dry.

8) Install the locating pin in the bent sub.

9) Use a degreaser to remove all dirt and grease from the bent sub and sonde housing sleeve threads so they are clean and dry.

10) Mix thread epoxy as per manufacturer's instructions and apply liberally to the bent sub threads that have the locating pin installed.

11) Screw the sonde housing assembly onto the bent sub.

12) Torque up both bent sub connections as recommended previously.

13) Allow twenty four hours for the thread epoxy to cure before using the tool.

14) Use a mild steel dolly on top of the diverter and tap with a sledge hammer to ensure the sonde housing assembly parts are fully seated against the bent sub.

15) Install Sonde carriage as previously described. And place the compression ring over the outer retrieval cap of the sonde carriage.

16) Install the sonde spacer into the sonde housing backhead with the four holes in the sonde spacer closest to the sonde housing backhead.

17) Coat the sonde housing backhead threads with a quality thread grease and screw into the sonde housing sleeve.

18) Torque the sonde housing backhead as recommended previously.
# Appendix

## 6.1 Mincon HDD60 Sonde Housing and Hammer Parts and Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mincon HDD60 Sonde Housing</td>
<td>MHS501AS01</td>
</tr>
<tr>
<td>2</td>
<td>Sonde Housing Backhead (3 ½&quot; API Reg. Pin)</td>
<td>MHS501BH01</td>
</tr>
<tr>
<td>3</td>
<td>Air Diverter Plug (1/8&quot; Orifice)</td>
<td>MHS409DP02</td>
</tr>
<tr>
<td>4</td>
<td>Sonde Spacer</td>
<td>MHS402SS01</td>
</tr>
<tr>
<td>5</td>
<td>Compression Ring</td>
<td>MHS305LR01</td>
</tr>
<tr>
<td>6</td>
<td>Sonde Carriage (Not Included)</td>
<td>MN585</td>
</tr>
<tr>
<td>7</td>
<td>O Ring</td>
<td>MHS421OR01</td>
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<tr>
<td>8</td>
<td>Diverter</td>
<td>MHS405DV01</td>
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<td>9</td>
<td>O Ring</td>
<td>MHS421OR01</td>
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<td>10</td>
<td>Sealing Sleeve</td>
<td>MHS406SL01</td>
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<tr>
<td>11</td>
<td>Sonde Spacer</td>
<td>MHS402SS01</td>
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<td>12</td>
<td>Compression Ring</td>
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<td>13</td>
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<td>14</td>
<td>O Ring</td>
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<td>15</td>
<td>Sealing Ring</td>
<td>MHS408SR01</td>
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<tr>
<td>16</td>
<td>Locating Pin</td>
<td>MHS508LP01</td>
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</table>

### Service Kit
- MHS426SK01
  - Air Diverter Plug (Solid) | MHS409DP01
  - O Ring Kit (Items 6, 8, 10, 12, 14) | MHS425OK01

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Part Number</th>
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<tbody>
<tr>
<td>17</td>
<td>Mincon HDD60 Hammer</td>
<td>MHD501AS01</td>
</tr>
<tr>
<td>18</td>
<td>Bent Sub</td>
<td>MHD501BH01</td>
</tr>
<tr>
<td>19</td>
<td>Choke Blank</td>
<td>MB506CH01</td>
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<tr>
<td>20</td>
<td>Check Valve</td>
<td>MB502CV01</td>
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<tr>
<td>21</td>
<td>Spring</td>
<td>MB503SP01</td>
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<tr>
<td>22</td>
<td>Steel Make up Ring</td>
<td>MB504SM01</td>
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<tr>
<td>23</td>
<td>Lock Ring</td>
<td>MB505LR01</td>
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<tr>
<td>24</td>
<td>Air Distributor</td>
<td>MB507DR01</td>
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<tr>
<td>25</td>
<td>O Ring</td>
<td>MB521OR01</td>
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<tr>
<td>26</td>
<td>O Ring</td>
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<td>27</td>
<td>Sealing Ring</td>
<td>MB509SR01</td>
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<td>28</td>
<td>Inner Cylinder</td>
<td>MB508IC02</td>
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<td>29</td>
<td>Piston</td>
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<td>30</td>
<td>Wear Sleeve</td>
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<td>31</td>
<td>Piston Retaining Ring</td>
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<td>32</td>
<td>O Ring</td>
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<td>33</td>
<td>Aligner</td>
<td>MB517BB01</td>
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<td>O Ring</td>
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<td>35</td>
<td>Bit Retaining Ring</td>
<td>MB513BR03</td>
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<td>36</td>
<td>Chuck HDD60</td>
<td>MHD514CK02</td>
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<tr>
<td>37</td>
<td>Drill Bit</td>
<td>62HDD60SDIRD</td>
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### Service Kit
- MHD526SK01
  - Choke Blank | MB506CH01
  - Choke 1/8" (3.2mm) | MB506CH02
  - Choke 3/16" (4.8mm) | MB506CH03

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Part Number</th>
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<tbody>
<tr>
<td>17</td>
<td>Spring</td>
<td>MB503SP01</td>
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<tr>
<td>18</td>
<td>O Ring Kit (Items 24, 25, 31, 33)</td>
<td>MHD525OK01</td>
</tr>
<tr>
<td>Specifications</td>
<td>Metric</td>
<td>Imperial</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>----------</td>
<td>-----------</td>
</tr>
<tr>
<td>Hammer Outside Diameter</td>
<td>124mm</td>
<td>4.88&quot;</td>
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<tr>
<td>Hammer Length (Sonde Backhead Shoulder to Chuck)</td>
<td>2057mm</td>
<td>81&quot;</td>
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<tr>
<td>Backhead Spanner Flat Size</td>
<td>115mm</td>
<td>4.53&quot;</td>
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<td>Drill Bit Shank Type</td>
<td>HDD60</td>
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<tr>
<td>Pilot Bit Size</td>
<td>159mm</td>
<td>6.25&quot;</td>
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<td>Hammer Weight (Less Bit)</td>
<td>137Kgs</td>
<td>302Lbs</td>
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<td>Piston Weight</td>
<td>15 Kgs</td>
<td>33.6 Lbs</td>
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<td>Bent Sub to Backhead Stand Off</td>
<td>0.75mm</td>
<td>0.030&quot;</td>
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<tr>
<td>Make Up Torque</td>
<td>5085 – 6780 NM</td>
<td>3750 – 5000 FT Lbs</td>
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<tr>
<td>Recommended Minimum Air Package (&lt;250ft Bore Length)</td>
<td>425 l/s @ 24.1 Bar</td>
<td>900 cfm @ 350 psi</td>
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<td>Recommended Minimum Air Package (&gt;250ft Bore Length)</td>
<td>519 l/s @ 24.1 Bar</td>
<td>1100 cfm @ 350 psi</td>
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<tr>
<td>Recommended Minimum Air Package</td>
<td>425 l/s @ 24.1 Bar</td>
<td>900 cfm @ 350 psi</td>
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6.2 Mincon HDD60 Hammer Service Log

**WEARSLEEVE / PISTON CLEARANCE**

<table>
<thead>
<tr>
<th>Part</th>
<th>New Dimension</th>
<th>As Measured</th>
<th>Wear</th>
<th>Actual Clearance</th>
<th>Discard Clearance</th>
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<tbody>
<tr>
<td>Wearsleeve</td>
<td>A 3.930&quot; (99.84mm)</td>
<td>C</td>
<td>C-A</td>
<td>C-D</td>
<td>≥ 0.010&quot; (0.25mm)</td>
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<td>Piston OD</td>
<td>B 3.925&quot; (99.70mm)</td>
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<td>B-D</td>
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**INNER CYLINDER / PISTON CLEARANCE**

<table>
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<tr>
<th>Part</th>
<th>New Dimension</th>
<th>As Measured</th>
<th>Wear</th>
<th>Actual Clearance</th>
<th>Discard Clearance</th>
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</thead>
<tbody>
<tr>
<td>Cylinder ID</td>
<td>A 3.386&quot; (86.00mm)</td>
<td>C</td>
<td>C-A</td>
<td>C-D</td>
<td>≥ 0.010&quot; (0.25mm)</td>
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<tr>
<td>Piston OD</td>
<td>B 3.381&quot; (85.89mm)</td>
<td>D</td>
<td>B-D</td>
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</table>

**DISTRIBUTOR PROBE / PISTON ID CLEARANCE**

<table>
<thead>
<tr>
<th>Part</th>
<th>New Dimension</th>
<th>As Measured</th>
<th>Wear</th>
<th>Actual Clearance</th>
<th>Discard Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distributor Probe OD</td>
<td>A 1.248&quot; (31.70mm)</td>
<td>C</td>
<td>C-A</td>
<td>C-D</td>
<td>≥ 0.010&quot; (0.25mm)</td>
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<tr>
<td>Piston ID</td>
<td>B 1.256&quot; (31.90mm)</td>
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<td>B-D</td>
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</table>

**ALIGNER / BIT BEARING CLEARANCE**

<table>
<thead>
<tr>
<th>Part</th>
<th>New Dimension</th>
<th>As Measured</th>
<th>Replace dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aligner ID (Unscalloped End)</td>
<td>A 3.018&quot; (76.65mm)</td>
<td>B</td>
<td>3.627&quot; (92.13mm)</td>
</tr>
<tr>
<td>Bit Bearing Surface OD</td>
<td>3.006±0.002&quot; (76.35±0.05mm)</td>
<td>Note: The head of the bit should wear out before the bearing surface does</td>
<td></td>
</tr>
</tbody>
</table>

**EXTERNAL WEAR**

<table>
<thead>
<tr>
<th>Description</th>
<th>Wear Limit</th>
<th>As Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wearsleeve Discard Dimension:</td>
<td>4.488&quot; (114.0mm)</td>
<td>See next page for measuring procedure.</td>
</tr>
</tbody>
</table>

Note: Chuck should be replaced when wear transfers to wearsleeve.
1. Measure the wear sleeve diameter between the 12 O clock position and the 6 O clock position (A).
2. Measure the wear sleeve diameter between the 9 O clock position and the 3 O clock position (B).
3. Subtract the smaller diameter from the larger diameter (B-A) to get the difference (C).
4. Subtract the difference from the smaller diameter (A-C=D). If this resulting number (D) is equal to or less than the discard diameter we recommend changing the wear sleeve. Failure to do so could result in the loss of the tool in the hole.
Suppliers warrant that the Mincon Hard Rock Horizontal Directional Drilling Systems (the “Products”) and spare parts therefore, manufactured by Suppliers and delivered to the initial user shall be free of defects in materials or workmanship for a period of 1 month after initial operation or 3 months from the date of shipment to the initial user, whichever occurs first. Suppliers may elect to repair any defective part or issue full or partial credit towards the purchase of a new part. The extent of credit issued will be determined on a pro-rata basis bearing in mind the service life of the defective part against the normal service life of that part. The part will be replaced or repaired without charge to the initial user at the Suppliers’ designated place of business during normal working hours. All non-Mincon manufactured components (including but not limited to pumps, hoses, KZ valves, KZ Controllers, KZ wire harness) will follow component manufacturers warranty to the letter for failures not related to the assembly or workmanship of Mincon.

This warranty applies only to the value of any replacement parts. Mincon does not accept any liability for additional or incidental costs (including but not limited to transportation, mileage, labor etc.). The user must present proof of purchase at the time of exercising the warranty.

The warranty applies only to failures resulting from defects in the material or workmanship and does not apply to failures occurring as a result of abuse, misuse, corrosion, erosion, negligent repairs and normal wear and tear. Failure to follow recommended operating and maintenance procedures which result in component failure will not be considered for warranty.

This warranty is in lieu of all other warranties, other than title, expressed or implied.

Limitation of Liability

Suppliers will not accept any remedies to the user other than those set out under the provisions of warranty above. The total liability of Suppliers with respect to the sale of the Products or spare parts therefor, whether based on contract, negligence, warranty, indemnity or otherwise shall not exceed the purchase price of the product upon which such liability is based. Suppliers shall in no event be liable to any party relating to this sale for any consequential, indirect, special or punitive damages arising out of this sale or any breach thereof, or any defects in or failure of or malfunction of the Products or spare parts.

Warranty will be voided where:

- There is evidence of damage resulting from insufficient or incorrect lubrication.
- There is evidence of misuse through the application of heat, welding or of being struck.
- There is evidence of distortion or bending however caused.
- There is damage caused as a result of using incorrect servicing tools or procedures.
- If it is evident that the Product or its components have achieved a reasonable proportion of their anticipated life.
- There is evidence of improper installation of or a modification to the Product other than as authorized by Suppliers.